STRUCTURAL EQUATION MODELLING OF HOLISTIC HEALTH VARIABLES, HEALTHY DIET, PHYSICAL ACTIVITY, AND QUALITY OF LIFE: COMPARISON BETWEEN MALAYSIAN AND NIGERIAN UNDERGRADUATE STUDENTS

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LIST OF ABBREVIATIONS AND ACRONYMS

AVE	Average variance extracted
CFA	Confirmatory factor analysis
CFI	Comparative fit index
CR	Composite reliability
CSDH	Commission on social determinants of health
CVI	Content validity index
DL	Demands of life
DLQ	Demands of life questionnaire
EDH	Environmental determinants of health
EDHQ	Environmental determinants of health questionnaire
EFA	Exploratory factor analysis
FUD	Federal University Dutse
FVI	Face validity index
HD	Healthy diet
ICC	Intraclass correlation coefficient
IP	Individual potentials
IPAQ	International physical activity questionnaire
IPQ	Individual potentials questionnaire

JEPeM	Jawatankuasa Etika Penyelidikan Manusia
KMO	Kaiser-Meyer-Olkin
PA	Physical activity
RMSEA	Root Mean Square Error of Approximation
SDH	Social determinants of health
SDHQ	Social determinants of health questionnaire
SEM	Structural Equation Modelling
SRMR	Standardized Root Mean Square Residual
TLI	Tucker Lewis Index
USM	Universiti Sains Malaysia
WHO	Word Health Organization

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PEMODELAN PERSAMAAN STRUKTUR PEMBOLEHUBAH KESIHATAN HOLISTIK, PEMAKANAN SIHAT, AKTIVITI FIZIKAL DAN KUALITI HIDUP: PERBANDINGAN ANTARA PELAJAR SARJANA MUDA MALAYSIA DAN NIGERIA

ABSTRAK

Kesejahteraan timbul daripada interaksi antara potensi individu (IP), tuntutan hidup (DL), penentu sosial (SDH), dan penentu persekitaran (EDH). Pemakanan sihat (HD) dan aktiviti fizikal (PA) seterusnya menyumbang kepada kualiti hidup secara keseluruhan. Oleh itu, kajian ini bertujuan untuk menilai bagaimana SDH, EDH, IP, DL, HD, dan PA berinteraksi dalam model kesihatan holistik untuk mempengaruhi kualiti hidup. Kajian itu menggunakan pendekatan kaedah campuran, dijalankan dalam tiga fasa, untuk membangunkan dan mengesahkan model kesihatan holistik. Dalam Fasa I, empat instrumen baharu telah dibangunkan untuk mengukur penentu utama kesihatan holistik: Soal Selidik Penentu Sosial Kesihatan (SDHQ), Soal Selidik Penentu Kesihatan Persekitaran (EDHQ), Soal Selidik Permintaan Kehidupan (DLQ), dan Soal Selidik Potensi Individu (IPQ). Alat ini dibangunkan melalui kajian literatur yang meluas, temu bual mendalam, dan penilaian pakar untuk memastikan kandungan dan menghadapi kesahan. Fasa II merangkumi kajian pengesahan menggunakan tinjauan keratan rentas 1,460 pelajar sarjana muda (730 setiap seorang dari Nigeria dan Malaysia). Fasa ini menggunakan analisis faktor penerokaan dan pengesahan (EFA dan CFA), di samping penilaian kebolehpercayaan dan kesahan, termasuk kebolehpercayaan komposit (CR), varians purata yang diekstrak (AVE), alfa Cronbach dan kebolehpercayaan ujian semula. Fasa III menyiasat hubungan struktur antara SDH, EDH, DL, IP, HD, PA, dan kualiti hidup, menggunakan sampel bebas 1,140 pelajar (570 dari setiap negara), serta ukuran dan invarian struktur untuk mengesahkan kebolehgunaan silang budaya instrumen. Dalam Fasa I, empat soal selidik kesihatan holistik telah dibangunkan: SDHQ (20 item, 2 faktor), EDHQ (18 item, 2 faktor), DLQ (18 item, 3 faktor), dan IPQ (14 item, 2 faktor), semuanya menunjukkan kandungan yang boleh diterima dan kesahan muka (indeks = 0.83–1.00). Dalam Fasa II, menunjukkan kesahan dan kebolehpercayaan yang mencukupi merentas semua instrumen, dengan indeks kesesuaian yang mencukupi (CFI = 0.928–0.967; TLI = 0.910–0.957; SRMR = 0.039–0.080; RMSEA = 0.041–0.068 = 0.041–0.068) dan kebolehpercayaan tinggi 0.815–0.947; CR = 0.760–0.950; Dalam Fasa III, pemodelan persamaan struktur menyokong 8 daripada 10 laluan hipotesis dalam kedua-dua sampel Malaysia dan Nigeria, dengan kesesuaian model yang baik (CFI = 0.972-0.989, TLI = 0.954-0.982, SRMR = 0.021-0.026, RMSEA = 0.026, RMSEA = 0.006, RMSEA = 0.0. 0.110-0.879). Instrumen menunjukkan pengukuran dan invarian struktur merentas kedua-dua kumpulan (ΔCFI dan ΔTLI <0.01, ΔRMSEA <0.015), dan SEM berbilang kumpulan mengesahkan enam hubungan laluan yang sama (CFI = 0.982, TLI = 0.969, SRMR = 0.020, RMSEA2 = 0.020, RMSEA2 = RMSEA2. 0.360). Kajian itu mengesahkan bahawa SDHQ, EDHQ, DLQ dan IPQ adalah sah, boleh dipercayai dan invarian di seluruh pelajar Nigeria dan Malaysia, menjadikannya sesuai untuk menilai faktor kesihatan holistik. Ia juga memperkenalkan salah satu model kuantitatif pertama yang mengaitkan pembolehubah ini dengan HD, PA, dan kualiti hidup, menawarkan asas untuk penyelidikan antara disiplin masa depan tentang perkaitan antara penentu kesihatan sosial, alam sekitar dan individu.

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ABSTRACT

Holistic health is increasingly recognized as a comprehensive approach that considers the whole person and the interplay of multiple life dimensions. Well-being arises from the interaction between individual potentials (IP), demands of life (DL), social determinants (SDH), and environmental determinants (EDH). Healthy diet (HD) and physical activity (PA) further contribute to overall quality of life. This study therefore aims to evaluate how SDH, EDH, IP, DL, HD, and PA interact within a holistic health model to influence quality of life. The study applied a mixed-methods approach, conducted in three phases, to develop and validate a holistic health model. In Phase I, four new instruments were developed to measure key determinants of holistic health: the Social Determinants of Health Questionnaire (SDHQ), Environmental Determinants of Health Questionnaire (EDHQ), Demands of Life Questionnaire (DLQ), and Individual Potentials Questionnaire (IPQ). These tools were developed through extensive literature review, in-depth interviews, and expert evaluations to ensure content and face validity. Phase II covers a validation study using a cross-sectional survey of 1,460 undergraduate students (730 each from Nigeria and Malaysia). This phase employed exploratory and confirmatory factor analyses (EFA and CFA), alongside assessments of reliability and validity, including composite reliability (CR), average variance extracted (AVE), Cronbach's alpha, and test-retest reliability. Phase III investigated the structural relationships between SDH, EDH, DL, IP, HD, PA, and quality of life, using independent samples of 1,140 students (570 from each country), as well as the measurement and structural invariance to confirm the cross-cultural applicability of the instruments. Additionally, multigroup SEM was conducted to compare structural relationships across Nigerian and Malaysian samples. In Phase I, four holistic health questionnaires were developed: SDHQ (20 items, 2 factors), EDHQ (18 items, 2 factors), DLQ (18 items, 3 factors), and IPQ (14 items, 2 factors), all showing acceptable content and face validity (indices = 0.83–1.00). In Phase II, demonstrated adequate validity and reliability across all instruments, with adequate fit indices (CFI = 0.928–0.967; TLI = 0.910–0.957; SRMR = 0.039–0.080; RMSEA = 0.041–0.068) and high reliability (Cronbach's α = 0.815–0.947; CR = 0.760–0.950; ICC = 0.765–0.987). In Phase III, structural equation modeling supported 8 of 10 hypothesized pathways in both Malaysian and Nigerian samples, with good model fit (CFI = 0.972-0.989, TLI = 0.954-0.982, SRMR = 0.021-0.026, RMSEA = 0.039-0.060, RMSEA p-value = 0.110-0.879). The instruments demonstrated measurement and structural invariance across both groups (ΔCFI and ΔTLI < 0.01, ΔRMSEA < 0.015), and multigroup SEM confirmed six similar path relationships (CFI = 0.982, TLI = 0.969, SRMR = 0.020, RMSEA = 0.052, RMSEA p-value = 0.360). The study confirmed that the SDHQ, EDHQ, DLQ, and IPQ are valid, reliable, and invariant across Nigerian and Malaysian students, making them suitable for assessing holistic health factors. It also introduced one of the first quantitative models relating these variables to HD, PA, and quality of life, offering a foundation for future interdisciplinary research on the interrelationship of social, environmental, and individual determinants of health.

CHAPTER 1

INTRODUCTION

1.1 Background of the study

The initial concept behind the application of a holistic approach to human life to address both individual and societal issues is not a new idea; it can be traced back to ancient philosophers and prophets (Shahtahmasebi, 2006). For instance, the Persian philosopher and prophet Zoroaster emphasized a holistic approach to both physical and mental well-being (Shahtahmasebi, 2006). According to his ideology, merely doing good is not sufficient; one must also think good and be good. This interconnected model highlights a "feedback" effect among the three components. Similarly, the Ten Commandments, which are foundational to many religions and cultures, promote a holistic way of life (Shahtahmasebi, 2006). Moreover, the Holy Koran extends this approach beyond the individual, offering guidelines and teachings aimed at fostering a spiritually, mentally, and physically healthy society (Shahtahmasebi, 2006).

These beliefs laid the groundwork for many subsequent philosophers and medical professionals who adopted a holistic approach to treating illness (Bircher, 2020; Bircher & Kuruvilla, 2014; Mato-Juhasz et al., 2016; Saylor, 2004). The underlying rationale for this strategy is that physical symptoms often reflect underlying mental or spiritual issues, and vice versa (Bircher, 2020). Therefore, effective treatment must consider the interconnectedness of physical, mental, and spiritual aspects. This approach has proven successful in numerous cases (Bircher, 2020). However, as health care systems evolved increasingly sophisticated to address the population's various health demands, some practitioners started to associate resources with the growing demand and health disparities (Arcaya & Figueroa, 2017; Solar & Irwin, 2010; Thornton et al., 2016). McKinlay's retelling of the healthcare provider on the riverbank fable (McKinlay, 1979) may provide a better understanding of the issue:

"You know," he said, "sometimes it feels like this. There I am, standing by the shore of a swiftly flowing river, and I hear the cry of a drowning man. So, I jump into the river, put my arms around him, pull him to the shore, and apply artificial respiration. Just when he begins to breathe, there is another cry for help. So, I jump into the river, reach him, pull him to shore, apply artificial respiration, and then just as he begins to breathe, another cry for help. So back in the river again, reaching, pulling, applying breathing, and then another yell. Again and again, without end, goes the sequence. You know, I am so busy jumping in, pulling them to shore, and applying artificial respiration that I have no time to see who the hell is upstream pushing them all in a." (McKinlay, 1979, p. 502). This highlights the importance of viewing health not only from a curative perspective but also from a preventive one. With the increasing health challenges and the rise of various chronic diseases in our time, a holistic approach is essential to enhancing overall well-being and quality of life.

Researchers have proposed that healthcare systems should be viewed within a broader context, presenting a conceptual framework in which education, the economy, transportation, agriculture, the environment, nutrition, housing, industry, science and technology, medical science, and preventative care all play a role in shaping population health alongside health-specific parameters (Nordenfelt, 2007; Northridge et al., 2003; Shahtahmasebi, 2006; Solar & Irwin, 2010). This framework is structured into three layers: the top layer includes health factors, natural-biological, and socio-economic elements; the intermediate layer comprises living and working conditions, public health, and natural environments; and the lower layer reflects the individual's characteristics and social way of life, which are directly influenced by the upper two layers (Northridge et al., 2003). However, putting such a conceptual framework into practice remains a challenging task (Bird et al., 2018). Traditional approaches to quantifying and modelling these interrelationships have various limitations, as most involve dynamic processes and outcomes that are inherently dynamic (Bircher, 2020; Bird et al., 2018).

Researchers continue to recognize holistic health as a comprehensive approach to well-being that addresses the whole person, rather than concentrating solely on physical symptoms or specific illnesses (Bircher, 2020; Bird et al., 2018; Nordenfelt, 2007; Shahtahmasebi, 2006). It highlights the interrelationships of the physical, mental, emotional, spiritual, and social dimensions of life, stressing that achieving balance across these areas is critical for overall health (Bircher, 2020; Bird et al., 2018). The widely recognized definition of health originates from the world health organization (WHO) 1948 preamble, which describes health as a state of complete physical, mental, and social well-being, not merely the absence of disease or infirmity (WHO, 1948). However, this definition has been increasingly viewed as overly ambitious and is now often critiqued or rejected (Bircher, 2020). For example, Swedish health philosopher Lennart Nordenfelt offered an alternative perspective: a person is fully healthy if, and only if, they are in a physical and mental state that enables them to achieve their vital goals within the limits of standard situations (Nordenfelt, 2013a).

In Malaysia, non-communicable diseases (NCDs) such as cardiovascular disease, diabetes, and cancer pose a major health burden and public health challenge (Nurul-Farehah et al., 2022; Shanmuganathan et al., 2022). According to the Ministry of

Health Malaysia (MOH, 2020) and the World Health Organization (WHO, 2022), NCDs are leading causes of death and disability in the country. Current estimates show that 1 in 5 Malaysian adults have diabetes, 1 in 3 live with hypertension, and nearly half are overweight or obese (Razali, 2023). This rising prevalence continues to strain the nation's healthcare system. To address this, a range of strategies are being promoted to help individuals achieve and maintain overall health and well-being (Razali, 2023). These include holistic health approaches such as nutritional counselling, adequate physical activity, stress management techniques (e.g., meditation or deep breathing exercises), mind–body practices (e.g., yoga, mindfulness meditation), and complementary or alternative therapies (e.g., acupuncture, phytotherapy) (Goh et al., 2020; Koo et al., 2023; Razali, 2023). In addition, lifestyle changes such as improving sleep, reducing toxin exposure, learning new skills, engaging in hobbies like gardening, and maintaining strong social relations are also encouraged (Ismadi et al., 2024; Ismail & QI, 2025). Together, these approaches aim to reduce premature mortality from NCDs, support the body's natural healing processes, and enhance quality of life (Ismail & QI, 2025; Merlo et al., 2025).

Nigeria's population growth has contributed to significant health implications, influencing mortality patterns, life expectancy, and the overall health profile of its citizens (Adesola et al., 2024). This rapid population growth not only directly impacts education and healthcare demand but also poses a wide range of health challenges (Adesola et al., 2024). For instance, Nigeria bears the highest burden of neglected tropical diseases (NTDs) in sub-Saharan Africa, accounting for about 25% of the region's total NTD cases (Chowdhury et al., 2023). Among these, Buruli ulcer, leprosy, and lymphatic filariasis (manifesting as lymphedema and hydrocele) are prioritized for integrated case management (Chowdhury et al., 2023). The growing burden of both communicable and non-communicable diseases has highlighted the importance of adopting a holistic approach to health in Nigeria (Oso, 2023). Partners from the Ministry of Health at federal and state levels, alongside non-governmental development organizations, have recommended the need to expand beyond medical intervention to include sustainable, holistic support to improve overall well-being (Abdullahi et al., 2025; Oso, 2023). These underscore that, in the Nigerian context, a truly holistic approach to well-being must address not only medical treatment but also the broader social, cultural, and environmental determinants of health, making it a more comprehensive pathway to improving population health (Abdullahi et al., 2025).

Promoting the health of individuals and populations is a complex task that requires the involvement of multiple stakeholders, including governments, academics, administrators, development partners, corporations, the media, families, communities, and individuals, whose roles often overlap or intersect (Bircher, 2020; Bircher & Kuruvilla, 2014; Bird et al., 2018). Highlighting these relationships, a comprehensive definition of health can provide a systematic framework for identifying necessary actions and fostering collaboration. Beyond the individual, the scope of health determinants has expanded to include social and environmental factors (Bircher & Kuruvilla, 2014). In this context, Bircher and Kuruvilla (2014) introduced the Meikirch model, which defines health as "a state of well-being emerging from conducive interactions between an individual's potentials (IP), the demands of life (DL), the social determinants of health (SDH), and the environmental determinants of health (SDH)."

Furthermore, a healthy diet (HD) and regular physical activity (PA) play a key role in influencing holistic health and quality of life by addressing various interrelated dimensions of health: physical, mental, emotional, and even social and spiritual well-being (Serra et al., 2020; Smith, 2019; Tavares, 2014). Their combined action fosters balance and promotes general harmony within the body and mind (Batsis et al., 2021). In addition to preventing disease, a HD and regular PA improve quality of life by fostering resilience, balance, and a long life (Batsis et al., 2021). For example, a nutritious diet supplies vital nutrients (Cena & Calder, 2020; Gordon & Jin, 2017), while regular exercise develops bones and muscles, improves cardiovascular health, and strengthens the immune system (Cunningham et al., 2020; Rebar et al., 2015). When combined, they lower the chance of developing chronic conditions like diabetes, heart disease, obesity, and some types of cancer (Serra et al., 2020; Smith, 2019; Tavares, 2014). Therefore, this study aims to evaluate the holistic health model inspired by the Meikirch model to explore how the SDH, EDH, IP, and DL interrelate to influence quality of life. Healthy diet and physical activity were also included in the model because of their well-established relationship with overall well-being.

1.2 Problem statement

The WHO definition of health was criticized in 2010 by an international conference of experts, who stated that it "contributes to the medicalization of society, is inadequate for chronic diseases, and is neither operational nor measurable." According to these experts, "the resilience or capacity to cope and maintain and restore one's integrity, equilibrium, and sense of well-being" should be included in any definition of health (Huber et al., 2011). Although these helpful concepts were found during the conference, the participants were unsuccessful in going further as to create a new definition of health (Bircher, 2020; Bircher & Kuruvilla, 2014).

Over time, many researchers have developed the holistic model of health as a substitute for the conventional biological approach, which mostly concentrates on identifying and treating physical diseases (Bircher, 2020; Bircher & Kuruvilla, 2014; Bird et al., 2018; Kraja et al., 2013; Marmot & Bell, 2016; Nordenfelt, 2007; Nordenfelt, 2013a; Raphael, 2016; Smith et al., 2016; Täljedal, 2004). These researchers have helped to shape this concept by highlighting the connections between the physical, mental, emotional, spiritual, and social facets of human well-being. The holistic approach to health represents an increasing recognition that resolving the intricate interactions between various aspects of life is necessary to attain well-being. Health research, policy, and practice around the world are still influenced by this concept (Bircher, 2020; Bird et al., 2018).

In September 2015, the United Nations established the primary goals of sustainable development as part of the 2030 Agenda focused on sustainable development. For all age groups, the goals related to healthy lives and well-being included reducing maternal, newborn, and child mortality; eradicating severe diseases such as AIDS, tuberculosis, and malaria; and combating hepatitis and other infectious diseases (United Nations, 2015). However, achieving these sustainable development goals is challenging in the presence of widespread serious diseases, as they impede economic growth and efforts to alleviate poverty (Mato-Juhasz et al., 2016).

For centuries, individuals have judged their own health, determining whether they are well or ill without relying on formal or standardized criteria (Bircher, 2020). They simply knew when they were ill (Bircher, 2020). As a result, achieving a consensus and understanding of an individual's overall holistic health is crucial for meeting sustainable development goals and structuring systems like healthcare. However, to date, there is still no valid and effective method that has been developed.

The health and well-being of university students are increasingly recognized as aspects of their academic success, personal development, and long-term quality of life (Hernández-Torrano et al., 2020; Sining et al., 2022). In both Malaysia and Nigeria, young adults, mostly students, may face multiple health issues due to the rising rates of non-communicable diseases, unhealthy dietary practices, sedentary lifestyles, and exposure to social and environmental stressors (Nursiswati et al., 2025; Onwasigwe et al., 2024). While traditional health studies generally focus on specific factors such as physical activity or diet, there is growing evidence that health outcomes are better understood through a holistic approach that incorporates social determinants of health, environmental influences, individual potentials, and the demands of daily life (Bircher, 2020).

Despite this acknowledgement, little empirical studies have explored the ways in which these holistic health factors interact to influence quality of life, especially in the heterogeneous contexts of Malaysia and Nigeria. Most existing studies address these factors separately, overlooking their interrelated nature and the possibility of their cumulative or mediating effects (Bircher, 2020). Furthermore, there is a scarcity of cross-country comparative studies, leaving a gap in understanding how cultural, social, and environmental differences may shape these relationships. Hence, addressing this gap will provide understanding for developing holistic interventions that will promote overall well-being and quality of life.

1.3 Study rationale

The Meikirch model is currently regarded as one of the most comprehensive health models, encompassing key factors that define holistic health (Bircher, 2020). According to the Meikirch model (Bircher & Kuruvilla, 2014), health is shaped by four dimensions: Social Determinants of Health (SDH), Environmental Determinants of Health (EDH), Individual Potentials (IP), and Demands of Life (DL). The EDH contains two components: the natural and built environments. The DL consists of three components: physiological, psychosocial, and environmental demands. The IP consists of two components: personally acquired potential and biologically given potential. The primary limitation of the Meikirch model so far is that it has not been quantitatively tested, and there is a lack of valid and reliable measures to assess its dimensions both quantitatively and qualitatively (Bircher, 2020).

A cross-cultural holistic health approach is also essential for advancing equitable, efficient, and inclusive healthcare. In addition to addressing health inequities and ensuring that all facets of well-being—physical, mental, emotional, spiritual, and social—are taken into consideration, it guarantees that health treatments are culturally acceptable (Bircher, 2020; Bird et al., 2018; Mato-Juhasz et al., 2016; Săvoiu et al., 2023; Saylor, 2004; Shahtahmasebi, 2006). The United Nations advocated for a thorough understanding of health across various demographics, improved health outcomes, and deeper community ties as the results of this strategy (United Nations, 2015). SDG 3 set the stage for the worldwide achievement of more general sustainable development goals by focusing on universal health coverage, preventing and treating communicable and non-communicable diseases, and enhancing health systems in general (United Nations, 2015). In this study, we aim to develop and validate tools for evaluating the various dimensions of the Meikirch model in both Nigeria and

Malaysia, as well as examine their interrelationships and impact on quality of life, along with their cross-cultural applicability. The development of these measures will significantly enhance the practical use of the model and enable the assessment of its effect on overall well-being.

1.4 Operational definitions

1.4.1 Social determinants of health (SDH)

- SDH are referred to as social factors that affect an individual's or population's health as well as the social processes that lead to an unequal distribution of these factors among groups with unequal status in society (Kostelanetz et al., 2022; Marmot, 2017; Marmot & Bell, 2016). These factors include income, education, occupation, social class, gender, race, or ethnicity; material circumstances; psychological circumstances; behavioural and/or biological factors; and the quality and availability of health services, both of which were categorized as either structural determinants of health or intermediary determinants of health (WHO CSDH, 2008).

1.4.2 Environmental determinants of health (EDH)

- EDH refers to a set of factors involving both objective and subjective aspects of the environment (Schulz & Northridge, 2004; Tonne et al., 2021). These include air and water quality, noise levels, access to green spaces, neighbourhood safety, and expo sure to environmental hazards such as pollution or toxins (Naik et al., 2019). Subjective environmental aspects refer to individuals' perceived assessments or beliefs regarding the quality, safety, and influence of their surroundings on their overall well-being (Castaldo et al., 2018; Castilla et al., 2017).

1.4.3 Individual potentials (IP)

- IP is a person's capacity, resources, and abilities that allow them to meet life's challenges while preserving their health and well-being (Bircher, 2020; Bircher & Kuruvilla, 2014). According to the Meikirch model of health, IP is a crucial component that aids people in overcoming obstacles in life and reaching a state of well-being (Bircher, 2020; Bircher & Kuruvilla, 2014). Individual potentials are divided into two categories: biologically derived potentials and personally acquired potentials. These potentials form the basis of an individual's capacity to lead a healthy, fruitful life by utilizing their natural talents and learned skills to overcome obstacles in life while preserving overall health (Bircher, 2020; Bircher & Kuruvilla, 2014).

1.4.4 Demands of life (DL)

- DL refers to the various needs, stresses, and difficulties that people face during their lives and that have an effect on their health and general well-being (Bircher, 2020; Bircher & Kuruvilla, 2014). The Meikirch model of health states that in order to attain and preserve a condition of holistic health, these demands need to be properly handled and controlled (Bircher, 2020; Bircher & Kuruvilla, 2014). The model divides life's demands into three categories: physiological, psychosocial, and environmental needs. These categories reflect the different difficulties people encounter on a daily basis. Attaining holistic health and well-being requires the ability to effectively manage these demands by utilizing one's own potential (Bircher, 2020; Bircher & Kuruvilla, 2014).

1.4.5 Healthy diet (HD)

- The term "HD" describes a dietary pattern that lowers the risk of chronic diseases, promotes general well-being, and gives the body the vital nutrients it needs to operate well. Appropriate amounts of macronutrients (fats, proteins, and carbs), micronutrients (vitamins and minerals), and water are all part of a nutritious diet that is diverse and balanced (Ayob & Shukri, 2020; Cena & Calder, 2020; Paxton et al., 2011).

1.4.6 Physical activity (PA)

- PA refers to any movement of the body that involves the use of energy and is caused by the contraction of skeletal muscles (Andersen et al., 2016; Hills et al., 2015; Powell et al., 2011). From daily living activities to organized exercise and sports, it encompasses all types of movement, whether intentional or not (Andersen et al., 2016; Hills et al., 2015; Powell et al., 2011). Maintaining and enhancing general health and well-being requires regular PA. PA is generally categorized into three: low PA: those who do not fit into category 2 or 3; moderate PA: 3 or more days of strenuous exercise lasting at least 20 minutes each day, or 5 or more days of moderate-intensity exercise, such as walking for at least half an hour each day; and high PA: getting at least 1500 MET-minutes per week and engaging in vigorous-intensity exercise for at least 3 days (Craig et al., 2003).

1.4.7 Quality of life

- Quality of life refers to how people see themselves in relation to their objectives, aspirations, standards, and goals, as well as their place in life within the framework of their culture and societal systems (Chaturvedi & Muliyala, 2016; Nordenfelt, 2013b).

1.5 Research questions, objectives, and hypotheses

We presented the research questions, objectives, and hypotheses in alignment with phases I, II, and III, following the study's format and design.

1.5.1 Research questions

Phase I:

1. What are the constructs and items that can be used to assess the social determinants of health (SDH), environmental determinants of health (EDH), demands of life (DL), and individual potentials (IP)?
2. Are the newly generated constructs and items for assessing SDH, EDH, DL, and IP valid by using content and face validity among experts and undergraduate students in Nigeria?
3. Are the newly generated constructs and items for assessing SDH, EDH, DL, and IP valid by using content and face validity among experts and undergraduate students in Malaysia?

Phase II:

4. Are the newly developed questionnaires for assessing SDH, EDH, DL, and IP valid by using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) among undergraduate students in Federal University Dutse (FUD), Nigeria?
5. Are the newly developed questionnaires for assessing SDH, EDH, DL, and IP reliable by using Cronbach's alpha, composite reliability, and test-retest reliability among undergraduate students in FUD, Nigeria?

6. Are the newly developed questionnaires for assessing SDH, EDH, DL, and IP valid by using EFA and CFA among undergraduate students in Universiti Sains Malaysia (USM), health campus, Malaysia?
7. Are the newly developed questionnaires for assessing SDH, EDH, DL, and IP reliable by using Cronbach's alpha, composite reliability, and test-retest reliability among undergraduate students in USM, health campus, Malaysia?

Phase III:

8. Are there any significant structural relationships between SDH, EDH, DL, IP, healthy diet (HD), physical activity (PA), and quality of life among undergraduate students in FUD, Nigeria?
9. Are there any significant structural relationships between SDH, EDH, DL, IP, HD, PA, and quality of life among undergraduate students in USM, health campus, Malaysia?
10. Do the newly developed questionnaires for assessing SDH, EDH, DL, and IP have adequate measurement and structural invariance across Nigerian and Malaysian samples?
11. Are the structural relationships between SDH, EDH, DL, IP, HD, PA, and quality of life similar across Nigerian and Malaysian samples?

1.5.2 General objective

The overall aim of the current study is to develop holistic health questionnaires (i.e., SDH, EDH, DL, IP) and examine their structural relationships with HD, PA, and quality of life across the samples of Nigerian and Malaysian undergraduate students.

1.5.3 Specific objectives

Phase I:

1. To develop new holistic health questionnaires for assessing the social determinants of health (SDH), environmental determinants of health (EDH), demands of life (DL), and individual potentials (IP).
2. To determine the content validity and face validity of the newly developed questionnaires for assessing SDH, EDH, DL, and IP among experts and undergraduate students in Nigeria.
3. To determine the content validity and face validity of the newly developed questionnaires for assessing SDH, EDH, DL, and IP among experts and undergraduate students in Malaysia.

Phase II:

4. To determine the construct validity of the of the newly developed questionnaires for assessing SDH, EDH, DL, and IP using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) among undergraduate students in FUD, Nigeria.
5. To determine the reliability of the newly developed questionnaires for assessing SDH, EDH, DL, and IP using Cronbach's alpha, composite reliability, and test-retest reliability among undergraduate students in FUD, Nigeria.
6. To determine the construct validity of the of the newly developed questionnaires for assessing SDH, EDH, DL, and IP using EFA and CFA among undergraduate students in USM, health campus, Malaysia.

7. To determine the reliability of the newly developed questionnaires for assessing SDH, EDH, DL, and IP using Cronbach's alpha, composite reliability, and test-retest reliability among undergraduate students in USM, health campus, Malaysia.

Phase III:

8. To determine the structural relationship between SDH, EDH, DL, IP, healthy diet (HD), physical activity (PA), and quality of life among undergraduate students in FUD, Nigeria.
9. To determine the structural relationship between SDH, EDH, DL, IP, HD, PA, and quality of life among undergraduate students in USM, health campus, Malaysia.
10. To determine the measurement and structural invariance of the newly developed questionnaires for assessing SDH, EDH, DL, and IP across the samples of Nigerian and Malaysian undergraduate students.
11. To conduct an SEM multigroup comparison between samples of Nigerian and Malaysian undergraduate students.

1.5.4 Research hypotheses

Phase I:

1. Not applicable
2. The newly generated constructs and items for assessing SDH, EDH, DL, and IP are valid by using content and face validity among experts and undergraduate students in Nigeria.

3. The newly generated constructs and items for assessing SDH, EDH, DL, and IP are valid by using content and face validity among experts and undergraduate students in Malaysia.

Phase II:

4. The newly developed questionnaires for assessing SDH, EDH, DL, and IP are valid by using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) among undergraduate students in FUD, Nigeria.
5. The newly developed questionnaires for assessing SDH, EDH, DL, and IP are reliable by using Cronbach's alpha, composite reliability, and test-retest reliability among undergraduate students in FUD, Nigeria.
6. The newly developed questionnaires for assessing SDH, EDH, DL, and IP are valid by using EFA and CFA among undergraduate students in USM, health campus, Malaysia.
7. The newly developed questionnaires for assessing SDH, EDH, DL, and IP are reliable by using Cronbach's alpha, composite reliability, and test-retest reliability among undergraduate students in USM health campus, Malaysia.

Phase III:

8. There are significant structural relationships between SDH, EDH, DL, IP, healthy diet (HD), physical activity (PA), and quality of life among undergraduate students in FUD, Nigeria.
9. There are significant structural relationships between SDH, EDH, DL, IP, HD, PA, and quality of life among undergraduate students in USM, health campus, Malaysia.

10. The newly developed questionnaires for assessing SDH, EDH, DL, and IP have adequate measurement and structural invariance across Nigerian and Malaysian samples.
11. The structural relationships between SDH, EDH, DL, IP, HD, PA, and quality of life are similar across Nigerian and Malaysian samples.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter covered a review of current issues and understanding about holistic health based on previous studies. The review focused on the research questions and objectives expressed in the previous chapter. This chapter was divided into 23 sections: search terms, an overview of the current concept of health, the Meikirch model components, quality of life, healthy diet, physical activity, relationship between social determinants of health and quality of life, relationship between environmental determinants of health and quality of life, relationship between individual potentials and quality of life, relationship between demands of life and quality of life, relationship between healthy diet and quality of life, relationship between physical activity and quality of life, relationship between social determinants of health and individual potentials, relationship between social determinants of health and demands of life, relationship between environmental determinants of health and individual potentials, relationship between individual potentials and demands of life, general information on the qualitative and quantitative research methods employed in the present study, and conceptual framework of the study.

2.2 Databases and search terms

Web of Science, Google Scholar, PubMed, Scopus, and Academic Search Complete (EBSCO) database sources were among the search engines that were used. The following key phrases were used in the search: holistic health, social determinants of health, environmental determinants of health, individual potentials, demands of life, quality of life, healthy diet, physical activity, relationship between social determinants of health and quality of life, relationship between environmental determinants of health and quality of life, relationship between individual potentials and quality of life, relationship between demands of life and quality of life, relationship between healthy diet and quality of life, relationship between physical activity and quality of life, relationship between social determinants of health and individual potentials, relationship between social determinants of health and demands of life, relationship between environmental determinants of health and individual potentials, relationship between individual potentials and demands of life. In the literature search, the terms were put together using the Boolean operators "AND" and "OR."

Table 2.1: Summary of literature search

	Search engine				
	Web of Science	Google Scholar	PubMed	Scopus	EBSCO
Using phrases					
Holistic health	1116	49300	364	8526	11
Social determinants of health	11460	344000	8029	88	10
Environmental determinants of health	243	10100	433	266	3
Individual given potentials	80	4090	12034	4406	7
Demands of life	85	21400	8102	144	22
Quality of life	543222	45900	86673	654056	71
Healthy diet	7903	360000	4485	15773	3
Physical activity	251162	2720000	40921	272658	32
Applied Boolean operators and keywords (example)					
“Social determinants of health” AND “Quality of life”	529	56100	449	1284	0
“Environmental determinants of health” AND “Quality of life”	3	3160	20	8	1
“Individual potentials” AND “Quality of life”	2488	94100	300	1613	3
“Demands of life” AND “Quality of life”	752	3990	1388	963	8
“Healthy diet” AND “Quality of life”	412	55100	188	794	0
“Physical activity” AND “Quality of life”	24756	1420000	4585	30114	1
“Social determinants of health” AND “Environmental determinants of health”	37	3530	76	67	2
“Social determinants of health” AND “Individual potentials”	246	16500	84	280	2
“Social determinants of health” AND “Demands of life”	17	191	34	336	0
“Environmental determinants of health” AND “Individual potentials”	1	4	3	1	0
“Environmental determinants of health” AND “Demands of life”	5	51	3	5	0
“Individual potentials” AND “Demands of life”	86	2850	19	85	0

2.3 Overview of the current concept of health

Holistic health was believed to be influenced by one's lifestyle, activity, surroundings, and diet (Stanhope & Lancaster, 2000). But over time, physical health became the main focus of Western conceptions of health (Saylor, 2004). Prior to 1900, mental health was only gradually incorporated into the idea of health, which for many years had emphasised primarily physical wholeness. As medical research advanced through the 1900s and many diseases had efficient cures, freedom from disease—physical or mental—became the standard definition of health (Pender, 2011).

These early Western theories of health were built on a machine conception of the human body that broke down issues into manageable parts, giving rise to medical specialisations that focus on particular body systems (Saylor, 2004). Many people who still think that health is just the absence of symptoms still define health as being free from disease (Leonardi, 2018). Despite its flaws, this model has served as the inspiration for a lot of global medical research. Even though this idea may seem limited, it has given us a clear definition and laid the groundwork for huge leaps forward in medical research (Leonardi, 2018).

In 1948, the World Health Organization (WHO) defined health as "a state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity." This was the first time the idea of health as well-being was introduced (WHO, 1948). This definition has been widely accepted throughout the past century and has contributed significantly to the growth of national health care systems, pushing countries beyond the conventional limits of health care defined by the physical circumstances of people (Jadad & O'grady, 2008). Others have defined health as being able to live (Rochlen, 2005), feeling good while living a life of activity, enjoyment, and social connections (Fineberg, 2013), having optimistic expectations (Little et al., 2012), and having the best level of fitness for each person to live a full, satisfying life (Wills et al., 2016). In the WHO definition, attention was paid to a number of different aspects of health, such as physical (structure and function), social role, mental (emotional and intellectual), and general views of health status. So, many researchers consider it the first definition of health that takes the whole person into account, and it was an important step away from focusing on the physical parts of health (Badash et al., 2017; Bircher, 2020; Leonardi, 2018; Van Druten et al., 2022).

However, numerous critical evaluations have demonstrated that the WHO definition of health is no longer adequate for addressing the new issues brought on by the rising number of individuals suffering from chronic diseases (Baauw et al., 2019; Huber et al., 2011; Jadad & O'grady, 2008; Saracci, 1997). The likelihood of living longer and in excellent health into old age has never been higher than it is at the dawn of the twenty-first century, but this new perspective calls for a shift in the health paradigm (WHO, 2018). It is time to move on from the WHO's utopian approach; we can no longer define health as a condition of total physical, mental, and social well-being (Horton, 2014). For a more in-depth look, several researchers have summarised the main issues with the WHO definition.

The first one refers to "complete wellbeing," which is a status that is so extreme that it is practically unachievable. It is certainly never achievable for elderly people or patients with chronic illnesses, who make up an ever-increasing population due to the rate of ageing and the improvement in the prognosis for many diseases (Huber et al., 2011; Jadad & O'grady, 2008). Others, on the other hand, see complete well-being as a challenge because their daily lives show them that a long time without physical and mental symptoms is very unlikely. Science shows that the average adult experiences about four symptoms over the course of 14 days (Huber et al., 2011). In reality, a full state of wellbeing would also mean that there are no risk factors for diseases. This is a situation that is impossible for anyone to reach, because even the most optimistic health advocate has to admit that risk-free health is hard to achieve (Pender, 2011).

The second important aspect is how poorly the WHO definition is suitable for practical application (Boddington & Räisänen, 2009; Dugdale, 2020; Levesque et al., 2013): it has never produced practical and usable health standards and is not applicable in real-world circumstances because it is neither operational nor measurable (Dugdale, 2020). Although some significant attempts have been made, it is time to admit that utopian conceptions cannot be measured (Leonardi, 2018; Roux, 2016).

The third issue is a serious one that is frequently undervalued and is related to the vastness of the WHO definition of health. A complete state of physical, mental, and social well-being implies a life without poverty, evil, injustices, marginalisation, crime, persecution, and war, which are mainly challenges of living that cannot be considered medical issues (Manwell et al., 2015). It should be noted that this conception of health is potentially so broad that it confounds scientific assessments with moral and political arguments (Manwell et al., 2015). This notion of health was viewed as much more of a political statement than a scientific one, or a term much more closely related to happiness than health, because it implicitly contains existential issues, ethical arguments, moral implications, and political dimensions (Boddington & Räisänen, 2009; Carter, 2014; Little et al., 2012).

The growing medicalization of society is the fourth important factor. The broad scope of this definition and the idealised view of wellbeing cause all facets of life to get medicalized, and as a result, issues that are under the purview of other fields or the social sphere are viewed as falling under the purview of medicine (Bodai et al., 2018; Davis, 2015). If the nature of the problem is perceived to be medical, a medical remedy will be sought rather than any other form of treatment, even though this effect is certainly unintended. This indicates that every small departure from physical and psychological norms raises the possibility of health issues, which would in turn increase demand for health care (Boddington & Räisänen, 2009; Levesque et al., 2013).

The fifth one focuses on an important caveat: while the WHO definition assumes that health and well-being are always related, it does not take into account the possibility that this assumption may not always be true. People experience grief, not well-being, when coping with a negative situation; this emotion cannot be seen as a decline in health because otherwise everyone would experience health decline almost every day (Leonardi, 2018). Paradoxically, a complete state of well-being in comparable circumstances may indicate a change in the subjective experience of reality and, consequently, a loss of health. The lack of wellbeing in these common situations must be seen as an objective sign of a realistic view of the world (Leonardi, 2018). Additionally, a huge section of the population cannot be healthy because malaise is not included in the concept of health. In reality, older people and people with long-term illnesses may only think of their health as their ability to deal with their physical limitations, accept a deformity and its limits, and live with the illness (Flick et al., 2003; Sixsmith et al., 2014).

The final crucial component relates to a notable exemption. The WHO definition ignores some special cases, such as risk-taking behaviours, in which a decline in physical well-being may be linked to an increase in psychological or social well-being, or vice versa. This is because the WHO definition assumes that physical, psychological, and social wellbeing always possess a positive correlation between them, as commonly documented in the literatures (Boddington & Räisänen, 2009; Leonardi, 2018; Van Druten et al., 2022). These risk-taking behaviours are a minor but significant phenomenon that cannot be disregarded (Van Druten et al., 2022).

The significant contribution made by the WHO definition to all clinical disciplines cannot be diminished by these six critical aspects (Leonardi, 2018). It should also be highlighted that these components make sense when we take into account the specific context in which the WHO definition emerged, which was influenced by the end of the Second World War (Badash et al., 2017). Nonetheless, the definition of health obviously needs to adapt in light of the profound changes in socio-cultural, economic, and epidemiological situations (Leonardi, 2018). Subsequently, experts from many different fields have come up with different ways to define health. A few of them have come up with a simple statistical definition of health based on biological function; they have described health in terms of biological factors in an objective manner (Boorse, 2014; Khushf, 2007; Kingma, 2017, 2019; Schramme, 2007; Tengland, 2007). Other viewpoints that define health by putting a stronger emphasis on psychological and sociological factors have separated themselves from this biostatistical point of view (Hamilton, 2010; Huber et al., 2011; Igarashi, 2015; Khushf, 2007; Mittelmark & Bauer, 2017; Nordenfelt, 2007; Nordenfelt, 2013a; Ratcliff, 2017; Täljedal, 2004; Venkatapuram, 2013). We present some examples below.

To redefine health, Boorse (1997), used a statistical method. He proposed calculating statistical reference values for all potential human functions. Results that, for instance, fall within the 95 percent interval would indicate normal health, whereas those that fall outside of this range would indicate disease. It was noted that this concept could be quantified and did not rely on moral judgments. It was rejected mostly because it was excessively disassociated from the diversity and individuality of people's experiences with health (Bircher & Kuruvilla, 2014).

Lennart Nordenfelt came up with the following normative statement: to be a healthy person, one must be able to achieve one's set of critical goals under normal or reasonable circumstances. This description effectively balances abilities and objectives (Nordenfelt, 2007; Nordenfelt, 1995). However, defining typical conditions and essential objectives when taking into account the needs and available resources of specific patients or communities can be difficult (Bircher & Kuruvilla, 2014).

Sturmberg (2013), came to a different definition of health, stating that it is a subjective experience state that requires consideration of its physical, psychological, social, and semiotic elements at the same time. As a practising physician who is involved in systems theory, he lists four key characteristics of health but fails to distinguish between health and disease or examine how health is formed (Bircher & Kuruvilla, 2014).

Bircher and Kuruvilla (2014), released the final version of the Meikirch model in 2014, and it states that "health is a condition of wellbeing emerging from conducive interactions between individuals' potentials, life's demands, and social and environmental variables." In accordance with van Spijk (2015) definition of health as the absence of disease, a key factor in evaluating excellent human health is the perception of leading a meaningful life. These different authors enumerated the key components of a definition of health. At this point, the Meikirch model essentially encompasses them all (Bircher, 2020).

Bircher (2020) summarised the Meikirch model as follows: in order to be healthy, a human being must be able to meet life's demands. Each person has biologically predetermined as well as personally acquired potentials for this, both of which are highly correlated with their social and environments. The person can create a personal identity and continue to build it up to death due to the complex adaptive systems. The goal of healthcare is to enable each person to fully achieve optimal health. The Meikirch model offers a concept of health that is grounded in science and is capable of being scientifically evaluated. It generates theories that are comparable to how public health and medicine are now practised (Bircher, 2020; Bircher & Kuruvilla, 2014).

2.4 The Meikirch model components

The Meikirch model is comprised of four main variables: the social determinants of health (SDH), the environmental determinants of health (EDH), individual potentials (IP), and the demands of life (DL). A condition of wellbeing known as "health" results from favourable interactions between these four variables (Bircher & Kuruvilla, 2014). These variables can change both the demands of life and a person's potential to meet those demands successfully when they interact (Bircher & Kuruvilla, 2014). We now present and discuss each variable in the model.

2.4.1 Social determinants of health (SDH)

Although social determinants of health (SDH) are broadly defined as the circumstances under which people are born, grow, live, work, and age, it is a complex concept with numerous conceptualizations (Bryant et al., 2011; Islam, 2019). As a fundamental concept in the fields of population and public health, SDH have attracted a lot of interest in recent decades (Lucyk & McLaren, 2017). The keyword "social determinants of health" generates a large number of studies and documents, the majority of which have been published recently (Islam, 2019). Significant ambiguity surrounds this idea due to the need for a multidimensional approach to the SDH, the rapid emergence of theoretical frameworks and models, and the rise in the volume of research in a very short period of time (Marmot & Bell, 2016).

According to the World Health Organization, SDH are situations or circumstances under which people are born, grow, live, work, and age. Forces in politics, society, and the economy have an impact on these circumstances (WHO CSDH, 2008). Poor conditions could result from a toxic mix of faulty policies and programmes, unjust economic structures, and poor governance. A society's socio-political and economic framework should ideally be such that its members have access to a favourable range of social resources and that these resources are allocated equitably. A citizen's health and well-being are, in great part, determined by the quality, amount, and distribution of these resources. Among these resources are opportunities to pursue an education, a safe place to live, a good diet, access to healthcare, and employment (WHO CSDH, 2008).

The term "social determinants of health" has taken on a dual meaning, referring to both the social factors that affect an individual's or population's health as well as the social processes that result in an unequal distribution of these factors among groups with unequal status in society (Marmot & Bell, 2016). As a result, the key idea of SDH refers to both the elements that influence health and the elements that influence health disparities (Marmot & Bell, 2016). To put it another way, this idea has two aspects: one is the improvement of social factors that affect health, and the other is the equitable distribution of those factors. It was therefore suggested to change the phrase to something like "social determinants of health and related inequalities" so that it covers both the factors that affect health and the factors that affect health inequalities (Islam, 2019).

The wide and expanding number of societal factors that affect SDH serves as another source of complexity. Although initially a small number of factors—such as diet, education, employment, and living conditions—were frequently emphasised, the list has significantly expanded recently, both in peer-reviewed literature and academic textbooks. In fact, the list has become so lengthy that if someone desires a comprehensive list of SDH, their enthusiasm may immediately decrease upon learning how extensive it is (Islam, 2019). Education (Shankar et al., 2013), housing and/or living conditions (Bambra et al., 2010), wealth and its distribution (Raphael, 2016), stress, young life, social isolation, career, unemployment, social protection, addiction, food, and transportation (Wilkinson & Marmot, 2003) are some of the most prominent SDH that are common in the previous research. In more recent research, SDH have also been identified as the healthcare system, sexual identity, gender preference, the social security net (Raphael, 2016), traditions or cultural standards (Olson & Anderson, 2013), media, discrimination, and stigma (Hatzenbuehler et al., 2013), social status (ND, 2017), dispute, social order, racism, systemic racism, legal rights (Asad & Clair, 2018), uncontrolled migration (Castañeda et al., 2015), religious doctrine and family (Idler, 2014), marginalisation and colonisation (Lynam & Cowley, 2007). Also, other researchers have reported that economic sanctions (Kokabisaghi, 2017) and access to high-speed internet (Harerimana et al., 2018) are important parts of SDH.

There are implications for clinical practise and policymaking in this extensive list of SDH factors. For instance, a lengthy list can discourage doctors from considering the SDH screening (Islam, 2019). The work of the World Health Organization's Global Commission on Social Determinants of Health (CSDH) played a significant role in summarising the SDH framework into two important components: (1) structural determinants of SDH and (2) intermediary determinants of SDH that can be measured at the individual level (Solar & Irwin, 2010). The CSDH's guiding moral principle is health equity, which means that there are no unfair health differences between social groups that can be prevented or fixed (Solar & Irwin, 2010).

2.4.1(a) Structural determinants of social determinants of health

They are also referred to as "social determinants of health inequities." They are the factors that work in line with the surrounding circumstances to establish and strengthen class divisions that specify a person's socioeconomic position within hierarchies of authority, status, and resource access. These factors determine the health opportunities of social groups based on their position within chain of command, status, and access to resources (economic position). The major socioeconomic and political institutions and regulations serve as the foundation for these structural mechanisms (Solar & Irwin, 2010). According to CSDH, the most important indicators are income, education, occupation, social class, gender, and race/ethnicity.

2.4.1(a)(i) Income

Income is a measure of socioeconomic position that most accurately assesses the component of material resources. Income has a "dose-response" association with health just like other markers. It can have an impact on a variety of material factors that directly impact health (Pickett & Wilkinson, 2015). Income is the measure of a person's socioeconomic status that can change the most quickly, and it also has an effect on a person's life as a whole. But income is not a simple variable. Included in the components are income from wages, interest, dividends, child support, inheritance, transfer payments, and pensions (Solar & Irwin, 2010).

2.4.1(a)(ii) Education

Education is a significant predictor of future employment and income and represents the shift from parents' (received) socioeconomic position to adulthood's (own) socioeconomic position (Archer, 2005). It begins at a young age, is influenced by one's performance in primary and secondary school, and, for the vast majority of people, culminates in early adulthood (Archer, 2005). It reflects the material, intellectual, and other resources of the family of origin. As a result, it includes both the long-term effects of early life circumstances on adult health as well as the effects of adult resources (such as employment position) on health (Solar & Irwin, 2010). Also, poor health in childhood can make it harder to go to school or finish it, and it can make a person more likely to get sick as an adult. This has a selection effect on health inequities (Solar & Irwin, 2010).

2.4.1(a)(iii) Occupation

The occupation measure is important not only because it indicates exposure to specific occupational risks, such as toxic compounds, but also because it determines people's place in the societal hierarchy (Ullits et al., 2015). The relationship between occupation (parental or own adult) and income is substantial, and as a result, there may be a direct link between material resources—the money and other apparent benefits of employment—that determine material living standards and health (Solar & Irwin, 2010). The main difficulty, then, is how to group individuals with a particular occupation according to their standing in the social order. The most common method involves classifying people into various distinct categories or social classes depending on where they stand in the labour market (Solar & Irwin, 2010).

2.4.1(a)(iv) Social class

Relationships of ownership or control over productive resources serve to define social class (i.e., financial, physical, and organizational) (Solar & Irwin, 2010). Economic inequalities are produced, and their potential to have an adverse effect on health is explained by social class through an explicit relational mechanism (property, management). The impact of social class on people's lives is significant. The degree to which a person has legal authority over productive assets impacts their ideas and routines for generating income, which in turn determines their living standards (Solar & Irwin, 2010). One reason for the association between class (as opposed to status) and health is that some people in a given workplace put in less effort and energy and receive more in return (compensation, promotions, job security, etc.), whereas others receive less for more effort. Therefore, those who are less powerful run a higher risk of exhausting their energy reserves and developing a physical or mental "health deficit" (Solar & Irwin, 2010).

2.4.1(a)(v) Gender

"Gender" refers to those triads of men and women that are socially defined, while "sex" refers to those triads that are biologically constructed (Thompson & Prügl, 2015). Gender entails "culture-bound customs, roles, and behaviours" that influence how men and women, as well as boys and girls, relate to one another. The process by which members of a socially defined group are treated differently, especially unfairly, because they are members of that group can be defined as discrimination and is fundamentally based on gender in many societies (Kawachi & Subramanian, 2018). Socially constructed masculinity models can have negative health consequences for men and boys (for example, when these models encourage violence or alcohol abuse). Gender-based social structures, on the other hand, have a significantly negative impact on the well-being of women and girls (Kawachi & Subramanian, 2018). The girls' and women's lower social status, lack of control over resources, and gender inequalities within society expose them to health risks. Discrimination's negative impact on one's health can be severe and harsh (e.g., in cases of female infanticide or when women suffer genital mutilation, rape, or gender-based domestic violence) (Doyal, 2012).

2.4.1(a)(vi) Race or ethnicity

In many situations, social divisions and unfair treatment are caused by the way people see racial or ethnic differences (Solar & Irwin, 2010). It usually refers to social groups that are defined by institutions, where one group benefits from dominating other groups and identifies itself and others based on this dominance and the possession of certain subjective physical traits (like skin colour) (Kawachi & Subramanian, 2018). Being a member of a marginalised racial or ethnic group has an impact on a person's position, opportunities, and life trajectory in countries where racial prejudice and exclusion are prevalent (Kawachi & Subramanian, 2018). Health outcomes and status are usually markedly lower for disadvantaged racial and ethnic groups than for more privileged groups or the general populace (Solar & Irwin, 2010). For example, African-Americans in the United States have much lower life expectancies than Whites, and African-American women are twice as likely as White women to give birth to underweight children (Ghislandi et al., 2019).

2.4.1(b) intermediary determinants of social determinants of health

These intermediary determinants are the result of the social determinants of health inequities, which are connected to a number of individual-level variables, including physiological factors and health-related behaviours (Solar & Irwin, 2010). The structure of social stratification determines the intermediary factors, which in turn determine the differences in exposure to and susceptibility to bad health situations (Solar & Irwin, 2010). The outermost level of the models emphasises genetic and biological processes, regulating the influence of socioeconomic variables on health (Marmot & Bell, 2016). The four primary types of intermediary determinants of health are material circumstances, psychological circumstances, behavioural and/or biological factors, as well as the health system (Solar & Irwin, 2010).

2.4.1(b)(i) Material circumstances

This comprises factors related to the built environment, like housing (both the dwelling itself and its location), consumption potential, or the ability to afford warm clothing, healthier food, and other necessities, as well as the actual working and residential settings. These conditions might either contain health hazards or opportunities for health, depending on their quality (Solar & Irwin, 2010). The major intermediary factor is likely to be differences in material conditions of living. Particularly if we take into account external conditions, the material standards of living are likely directly significant for the health status of marginalised groups as well as for individuals in lower socioeconomic situations (Hernández & Swope, 2019). Aspects of the material socioeconomic environment are measured through housing quality. Housing's design and internal characteristics, such as dampness, temperature, and indoor contamination, have an immediate effect on health. (Hernández & Swope, 2019).

2.4.1(b)(ii) Psychological circumstances

This comprises psychosocial stressors, difficult living situations, such as heavy debt, and (lack of) social support, as well as coping mechanisms and other factors. Various social groupings are subjected to varying degrees of hazardous, terrible, and challenging day-to-day encounters and circumstances. This helps explain how social inequalities in health have existed across time (Solar & Irwin, 2010). For instance, negative long-term stress may also be a part of the causal chain behind many somatic disorders, and stress may be a causal factor and a trigger that leads to many forms of illness (Wilkinson, 2020).

2.4.1(b)(iii) Behavioural and biological factors

This involves factors like smoking, eating habits, drinking alcohol, and not exercising, all of which can either preserve and improve your health or harm it (like obesity) (Solar & Irwin, 2010). Social variations in lifestyle or behaviour have also been linked to social inequalities in health. Such variations can be seen in nutrition, exercise, and alcohol and tobacco use. This suggests that despite divergent opinions on their significance, lifestyle variations may contribute to social inequalities in health (Solar & Irwin, 2010).

2.4.1(b)(iv) Health care system

The health system can effectively address disparities in exposure and susceptibility by fostering intersectoral activity to enhance health status in addition to enhancing equitable access to care. One example is that food supplements are available through the health system. Other examples are transportation laws and other efforts to make sure that people can get health care no matter where they live (Solar & Irwin, 2010). The health system has three main responsibilities when it comes to addressing inequity: (1) ensuring that resources are distributed among areas according to how much they need them; (2) fairly addressing the health care needs of various social groups; and (3) taking the lead in promoting a broader and more strategic approach to developing healthy public policies at both the national and local levels to promote equity in health and social justice (Smith et al., 2016).

2.4.2 Related questionnaires for measuring social determinants of health (SDH)

Interprofessional health care providers in various settings are beginning to appreciate the need for assessing and addressing SDH (outpatient, inpatient, and community-based) (Pai et al., 2016). A recent systematic review reported that a total of 38 screening tools were used to assess SDH (O'Brien, 2019). But most of these screening tools only look at one aspect of SDH such as food insecurity (Baer et al., 2015), housing (Byrne et al., 2016), health literacy (Chung & Nahm, 2015), social support (Littlewood et al., 2015), and abuse (Usta & Farver, 2010). Four screening tools, on the other hand, look at multiple aspect of SDH (O'Brien, 2019). Furthermore, a simple measure of SDH called the social determinants of health, the Steps to Better Health Questionnaire (STBH-Q), was recently published in Australia (Oster et al., 2022). The STBH-Q was designed to evaluate multiple determinants of SDH at the individual level.

Table 2.2: Summary of related questionnaires for measuring social determinants of health

Questionnaire	Author	Items	Determinants	Reliability
Steps to Better Health Questionnaire (STBH-Q)	Oster et al. (2022)	16	Access; Employment; Finance and Education; Safety; Physical and Mental health; and Family and Childhood.	Cronbach's alpha: 0.561 – 0.827
Child Poverty Tool and Resource Guide (CPTRG)	Beaune et al. (2014)	7	Poverty; Food insecurity; Social support; and Trauma exposure.	NR
IHELP	Colvin et al. (2016)	13	Poverty; Food insecurity; Housing; Education; and Trauma exposure.	NR
Questionnaire Literacy Screen (QLS)	Sullivan et al. (1995)	11	Education; Employment; Transportation; and Social support.	NR
WE CARE	Garg et al. (2015)	12	Education; Employment, Housing, Food insecurity; and Poverty.	NR

NR = not reported

2.4.3 Environmental determinants of health (EDH)

The environment in which people live and work can have a direct impact on their health (WHO, 2014). We all live in the environment, and we all engage in development in an effort to make life better for ourselves there. Therefore, the links between urban planning and public health still need to be emphasized (Northridge & Freeman, 2011). There is an increase in the severity of the global population health catastrophe we are currently experiencing, which affects both industrialised and developing nations (Northridge et al., 2003). Out of a total worldwide population of close to 6 billion people, the United Nations Human Settlements Programme (UN-HABITAT) estimates that roughly 1 billion people currently reside in slum-like settings. The world's population is projected to grow by roughly 2 billion people by

2030, with slum dwellers predicted to make up half of this growth (Northridge et al., 2003).

Environmental variables are responsible for 36% of the disease burden in children and approximately 24% of the worldwide disease burden and 23% of mortality (Haines et al., 2012). South Asia and sub-Saharan Africa bear the heaviest burden. Malaria, lower respiratory tract infections, work-related accidents, injuries from traffic accidents, and waterborne diseases are the main health burdens associated with poor environments (Haines et al., 2012). Environmental factors like weather, deforestation, the management of water resources, and the location and type of buildings have an impact on the occurrence of malaria. Neglecting this environmental illness burden has left behind a legacy of poor health, to which the health effects of new threats like climate change will be added (Haines et al., 2012). Also, most of the one million people who die every year around the world because of cooking stoves that don't work right or open flames with biomass or coal are women and children (Gasana et al., 2012).

Environmental health is defined as the area of public health that deals with all the physical, biological, and chemical factors that affect a person's health that are observable to them, as well as all the associated elements that have an impact on behaviour through the built and natural environments (Northridge & Freeman, 2011). There is a substantial amount of research relating the built and natural environment with health and wellbeing (Bambra et al., 2010; Renalds et al., 2010), and it includes both objective and subjective aspects of the physical environment in which people live, work, and play (Frank & Engelke, 2005). As a result, the built environment and the natural environment are increasingly being encouraged to be taken into account by public health and planning experts (Bambra et al., 2010).

Numerous factors in the natural and built environment have an impact on our health. Numerous health risks can arise from indoor, outdoor, and work surroundings, including the danger of physical injury from moving cars or unsafe housing and working places, as well as pollution of the air we inhale, the water we drink, and the food we consume (Fasihi et al., 2022). The natural environment includes physical exposures (such as noise and radiation), anthropogenic changes (such as climate change and vector breeding grounds), exposure to pollutants and chemicals (such as air, water, soil, and food products), associated behaviours, and a safe work environment. Housing, land use, infrastructure, transportation, and public spaces are all part of the built environment (Prüss-Ustün et al., 2017).

2.4.3(a) Natural environment

The single most natural environmental threat to human health is air pollution. Every year, exposure to poor air quality kills almost 7 million people around the world (Bone, 2013). Motorized vehicles pose a risk to human health because they cause air and noise pollution, traffic accidents, and other environmental problems. In terms of air pollution, since transportation emissions are emitted close to the ground, where human exposure is higher, they could have an impact on human health that is disproportionately severe, similar to that of indoor air pollutants (Tran et al., 2020). Also, in cities, traffic noise is the biggest source of noise, making up 80% of all sources of noise in the community (Gilani & Mir, 2021; Tran et al., 2020).

Waterborne illnesses are an additional environmental health issue, accounting for 1.5 million annual fatalities (WHO, 2016). About 842 000 deaths annually, or more than half of that total, are caused by contaminated water sources and a lack of hygienic conditions. Flooding caused by groundwater, overflow from the land, sewers, and drains on the surface of the land are the outcomes of heavy rainfall. Although their events are unpredictable, they have the potential to seriously affect local populations as well as health and other services (Newson et al., 2022). Additionally, pesticides may have an effect on water sources. Acute poisoning, which is thought to be the main risk from pesticides in underdeveloped nations, is estimated to result in 3 million severe episodes and 220,000 fatalities annually (Newson et al., 2022).

Another of the major determinant of environmental health is having adequate access to a healthy food supply (Ward et al., 2013). In developed countries, food insecurity is linked to obesity and illnesses caused by obesity (Lindberg et al., 2015). This is mostly because more people are eating foods high in fat and/or sugar because they are often cheaper, easier to find, advertised more, and easier to make than healthier foods (Lindberg et al., 2015). Poverty (Beebout, 2017), rising food prices (Harrison et al., 2007), higher number of unhealthy food in socially disadvantaged areas (Pollard et al., 2014), as well as other financial obligations (Kirkpatrick & Tarasuk, 2007), employment status (Fiese et al., 2011), rurality (Pollard et al., 2014), lower educational attainment (McKinnon et al., 2014), and poor access to good transport system (Widener & Shannon, 2014), are all well-established factors resulting in the consequences of food insecurity.

Lastly, another fundamental determinant of environmental health is extreme weather (Curtis et al., 2017; Ebi et al., 2021). Extreme weather events have an impact on human health by affecting the built, social, and institutional infrastructures that support health and health care, as well as increasing demand for health service operations (Curtis et al., 2017). The effects of extreme weather and climate events depend on a number of factors, such as the physical risk (such as wind and rain), the degree of exposure to the hazard, the susceptibility of individuals and groups, and the ability to manage, handle, and recover from extreme events (Ebi et al., 2021). High temperatures are becoming a bigger problem for sports and physical activities since they can have a negative impact on those who are doing outdoor activities (Orr & Inoue, 2019). Extreme occurrences and disasters can also intensify or compound existing mental health issues or result in new mental health consequences that can be short-term, long-term, or acute (Colbert et al., 2022). Destruction of homes, companies, and communities can have significant socioeconomic effects that might cause financial pressure and community tension, which can raise the risk of domestic or community-based violence (Colbert et al., 2022). However, many people who undergo extreme situations show resilience and suffer little to mental distress (Bonanno, 2004).

2.4.3(b) Built environment

The term "built environment" refers to all structures, areas, and things that have been made or altered by humans. The physical and social situations both inside and outside, as well as health and quality of life, are all impacted by the built environment (Lopez, 2012). It covers aspects like urban planning, transportation systems, land-use policies, and laws that have an impact on suburban, rural, and urban populations (Hoehner et al., 2005; Lin & Moudon, 2010). A substantial amount of research has emerged in the last ten years that outlines the pathways and mechanisms through which the built environment affects health (Talukder et al., 2015).

Depending on where they are in a city, people may be exposed to health factors linked to the built environment differently. Policies (influencing structural and social characteristics) implemented in accordance with administrative and political interests may result in uneven distribution of resources, opportunities, and capacities among neighbourhoods (Gelormino et al., 2015). When each pathway's influence changes depending on a person's or an entire group's social standing, health inequities may be exacerbated (Gelormino et al., 2015).

The quantity of vegetation in people's residential areas demonstrates a favourable link (higher in urban areas) with the residents' reported good wellbeing; the relationship between green space and health may be slightly stronger for lower socioeconomic groups (Gelormino et al., 2015). Also, a previous study found that people with a secondary school certificate who live in large cities benefit more from having green spaces nearby, and access to green spaces benefits those with primary or no education at a middle level (greater than higher, lower in secondary) (Maas et al., 2006).

The built environment creates chances for everyday physical exercise (Ewing et al., 2014; Hamidi et al., 2018); convenience of car use; and reduced rate of traffic accidents (Hamidi et al., 2018; Mohamed et al., 2014). More factors affecting active mobility and physical exercise involve perceptions of availability, maintenance, size, accessibility, aesthetic features, and safety (Jansen et al., 2018). A good perceived quality of outdoor spaces has a relevant effect on active behaviour in adults (Ball et al., 2008; Ding et al., 2011), even though social factors typically explain significant variations (Cerin et al., 2017). According to Gelormino et al. (2015), people in disadvantaged neighbourhoods are less likely to participate in physical activities than those in more affluent neighbourhoods because they lack access to safe and pleasant green spaces.

Regardless of individual characteristics, the socioeconomic and environmental situation of communities may be influenced by segregation and a lack of opportunity to access equitable medical services: in nations with a significant private aspect of medical care, underprivileged neighbourhoods may struggle to attract primary and specialised health care providers (Caldwell et al., 2017). Furthermore, these neighbourhood environmental and social factors have been shown to have an impact on mental health (Ehsan & De Silva, 2015), leading to unhealthy behaviours motivated by fear (such as reduced social interaction and physical inactivity), which worsen the social and economic conditions in disadvantaged areas (Mair et al., 2015). Weak social capital increases the likelihood of getting sick because individualism and a lack of control, as well as weak communication networks, make it difficult to engage in preventative measures and make prompt, effective interventions (Hanslmaier et al., 2018).

2.4.4 Related questionnaires for measuring environmental determinants of health (EDH)

To date, there are no published studies that have used instruments to evaluate populations using a wide range of environmental health determinants. There are few communities profiling tools that have been tested for validity and reliability (Cortés et al., 2021). The majority of environmental assessment instruments currently in use evaluate particular risk factors, such as cardiovascular health (Chow et al., 2010) and physical activity (Sabo et al., 2020).

Table 2.3: Summary of related questionnaires for measuring environmental determinants of health

Questionnaire	Author	Items	Determinants	Reliability
Environmental Health Risk Perception Questionnaire.	Cortés et al. (2021)	27	Perception of community risks; Perception of personal risks; and Trust on public information sources.	Cronbach's alpha: 0.69 – 0.78
Environmental Profile of a Community's Health (EPOCH).	Chow et al. (2010)	38	Community observation walk; Tobacco store assessment; Grocery store assessment; and Restaurant assessment.	ICC: 0.49 – 0.97
Urban traffic-related determinants of health questionnaire (UTDHQ).	Nadrian et al. (2014)	40	Physical Environment; Social Environment; Public Services Delivery and Accessibility; Family Circumstances; Public Policy; Substance Use; Public Welfare Services; and Air Quality.	Cronbach's alpha: 0.70 – 0.83 ICC: 0.70 – 0.83
The Irvine–Minnesota Inventory to Measure Built Environments.	Day et al. (2006)	162	Accessibility; Pleasurability; Perceived safety from traffic; and Perceived safety from crime.	NR
Neighbourhood Environment Walkability Scale (NEWS).	Cerin et al. (2006)	68	Residential density; Proximity to non-residential land uses; Ease of access to non-residential uses; Street connectivity; Walking/cycling facilities; Aesthetics; Pedestrian traffic safety; and Crime safety.	ICC: 0.02 – 0.49
Physical environment for physical activity scale.	Sabo et al. (2020)	5	Availability of exercise facilities; and Quality of exercise facilities.	Cronbach's alpha: 0.743 – 0.771 ICC: 0.774 – 0.895

NR = not reported

2.4.5 Individual potentials (IP)

According to Bircher and Wehkamp (2011), everyone wants to have control over their lives and their own future. However, people always have close contact with their families and friends in their social network, even though this relationship changes significantly as people age. While most adults think they are in charge, new-born babies are completely reliant on their care givers. The degree of dependence is intensified by illness and the frailty of aging. As such, each person must adapt to the demands and difficulties that are specific to their age and culture at each stage of this evolution. The points mentioned imply that an individual's potential to manage their short-, medium-, and long-term needs can be used to describe their state of health (Bircher & Kuruvilla, 2014; Bircher & Wehkamp, 2011). The concept of "potential" seems suitable because it encompasses all potential future abilities to meet these needs (Bircher & Wehkamp, 2011). Certainly, a person in good health has a lot more prospects for handling all kinds of obstacles than someone who is ill or in poor condition. Also, because it is connected to the inherent constitution, including the genetic background and prior personal integrity that determine health, each person's potential also has a great deal to do with his or her past (Bircher & Kuruvilla, 2014; Bircher & Wehkamp, 2011). Therefore, humans rely on both their biologically given and personally acquired potentials to process and meet the demands of life (Bircher, 2020; Bircher & Kuruvilla, 2014).

Potentials that are both biologically derived and personally developed are not separated into body and mind. Many facets of personally acquired potential also reside in the body, even though biologically given potential is represented in a person's physical constitution. People who were physically active as children will have more athletic musculoskeletal systems than people who spent most of their youth reading or playing on computers. Anatomical and physiological variations show differences in personally acquired potentials in this and numerous other examples (Bircher, 2020; Bircher & Kuruvilla, 2014).

The Meikirch model (Bircher, 2020; Bircher & Kuruvilla, 2014) incorporates the potential for people to believe they are well despite having medical issues, highlighting the significance of the interaction between biologically given and personally acquired potentials for a person's wellbeing. For instance, even though they may have a chronic illness and accompanying physical limitations, people with rheumatoid arthritis and related physical impairments may believe they are healthy if their condition is under medical control and they have the potential to function sufficiently to lead fulfilling lives. This also applies to other scenarios where people have typical health issues.

According to a prior study, 87% of participants rated their health as "excellent" or "very good." Even though 36% of respondents had headaches, 37% had backaches, 35% had trouble sleeping, and 23% had other serious conditions in the past four weeks, this percentage stayed the same (Herrmann et al., 2015). This demonstrates how the capacity approach contends that people's capacities to reach well-being depend on what they can do and accomplish and, consequently, what kind of life they are actually able to lead. This means that the goal of human welfare systems should be to promote an individual's functional capabilities rather than end-state necessities like health, enjoyment, or fulfilling their desires. Some examples of functional abilities are being able to get health care and take part in social, economic, and political activities (Bircher, 2020).

In another scenario, Bircher and Kuruvilla (2014) claims that comparing the outcomes of two people who were just diagnosed with Type 1 diabetes will show how their capabilities, approaches, and potentials differ from one another. Social and environmental determinants would make it easier for someone to manage the disease if they lived in a high-income country with access to good health care and social supports. Even if someone from a low-income nation has the same potential as someone from a high-income country, they may not be able to purchase insulin or have access to the necessary health care and social services. Residents of high-income nations may therefore possess stronger capabilities.

2.4.5(a) Biologically given potential

The biological potential signifies the basic substructure of our life. Due to the genetic makeup and the condition of the pregnancy, it has a limited value at the time of birth. The genes themselves as well as how their epigenetic regulation changes throughout pregnancy are both included in the genetic component. This potential starts to decline soon after birth and eventually reaches zero at the time of death. Every somatic disorder, trauma, or defect reduces our biologically given potentials, whether temporarily or permanently (Bircher & Kuruvilla, 2014).

Somatic medicine has thus far concentrated on using drugs, surgery, radiation, genetic tools, and rehabilitative techniques to address biologically given potential issues. When possible, scientific techniques were used for this aim (Bircher, 2020). Due to the fact that many diseases that previously had no treatment options are now treatable, medicine has, in certain areas, greatly improved health. Medical research is also attempting to create new, cutting-edge therapies. However, a number of therapeutic choices have greatly improved in recent years, while many new medications are becoming overly expensive. Despite the growing expertise, the actual benefit of treatments still falls below expectations (Bircher, 2020). Recently, for several conditions, digital self-monitoring (self-tracking) is currently employed to enhance personal feedback. This is an excellent opportunity to enhance chronic disease self-management, but further research is required (Bartels et al., 2019; Morton et al., 2017).

When people assess their own health, they draw on information with significant predictive power (Schnittker & Bacak, 2014). According to the results of previous studies, self-perceived health is still a good indicator of the likelihood of developing a chronic disease (Mavaddat et al., 2014), recovering from an ailment (Latham & Peek, 2013), losing function (Chakravarty et al., 2012), and utilising medical services (Russo & Elixhauser, 2011). This is true even when more objective health indicators are taken into account (Garbarski, 2016).

According to earlier studies, people's assessments of their health depend on more than just their physical condition. People who don't suffer from any particular health issues often don't rank their wellbeing as outstanding; many just say they're "good," as opposed to "very good" or "excellent" (Kraja et al., 2013). Also, ratings that are favourable represent a broader understanding of health, whereas ratings that are unfavourable are primarily tied to physical issues (Kraja et al., 2013). The robustness of the phrase "self-perceived health" appears to outweigh any difficulties associated with the semantics and translation (Schnittker & Bacak, 2014).

2.4.5(b) Personally acquired potential

This is the sum of a person's physical, intellectual, and social resources put together. In utero, it begins to develop. The potential that one has individually gained increases quickly as the brain and other organ systems develop. Schools and communities play a critical role in fostering personal development and the growth of knowledge and skills for kids, teenagers, and families. The development of personal potential may slow down in adulthood, but it can continue to grow as long as a person desires to, is able to actively encourage their development, and lives in a social environment that supports their health (Bircher & Kuruvilla, 2014). People can increase their wellbeing and live longer by developing pleasant emotions, involvement, connections, meaning, and achievement (Seppälä, 2016).

Unfortunately, the personally acquired potential mostly continues to be a blind spot and is frequently simply disregarded in modern scientific medicine. A patient's personality is thought to be a private concern. A person who grows up and lives in decent conditions typically experiences a normal maturation of their personal potential that roughly matches their age (Bircher, 2020). Also, it's interesting to note that positive psychology provides a variety of methods for decreasing symptoms, enhancing individual resilience, and promoting personality development (Lin et al., 2016; Stahl et al., 2015). Chronic diseases that call for ongoing, attentive management, such as hypertension, diabetes mellitus, asthma, and many others, may necessitate extra attention to the personal given potential. This calls for sufficient knowledge and a mindset capable of handling such a major responsibility. It's conceivable that frequent, highly dependable interactions with a nurse, a psychologist, or a doctor may be necessary (Coventry et al., 2015; Orom et al., 2018).

In his salutogenic model, Antonovsky (1987), researched elements that promote health, and he created the notion of "sense of coherence" (SOC) to clarify why some people get sick when under stress while others stay well. According to the definition of SOC, it is "a global orientation that conveys the degree to which a person has a pervasive, durable, yet dynamic feeling of confidence" (Antonovsky, 1987). SOC typically expresses a person's worldview and consists of three elements: manageability (the degree to which a human has the resources required to meet the demands posed by these stimuli), comprehensibility (the degree to which stimuli from one's external and internal environments are structured, understandable, and reliable), and meaningfulness (the degree to which these demands are tasks needed for investment and participation) (Antonovsky, 1987).

People who have a high SOC frequently view their circumstances as manageable, meaningful, and understandable (Cassidy, 2017). Strong SOC means that a person has the tools (such as ego identification and social support) to handle different sorts of stressful life events. By the end of young adulthood, SOC has essentially stabilised, and subsequent significant life experiences have little to no impact on it, either positively or negatively (Cassidy, 2017). Furthermore, while other studies (Geue et al., 2014) claimed that men have a greater SOC than women, other researchers (Henchoz et al., 2015) concluded that there are no appreciable variations in SOC between men and women.

2.4.6 Related questionnaires for measuring individual potentials

To date, there are no published studies that have used instruments to evaluate individual potentials in terms of their biological and personal basis. But for the biologically given potential and the personally acquired potential, all related measurements were based on how the person felt about their own health and sense of coherence (Bircher, 2020).

Table 2.4: Summary of related questionnaires for measuring individual potentials

Questionnaire	Author	Items	Determinants	Reliability
Self-rated health.	Lundberg and Manderbacka (1996)	1	Perceived health (good, bad, or something in between). Other factors assessed: Functional abilities; Diseases; Aches; Psychological wellbeing; and Common illness.	Kappa: 0.85 – 0.90
Self-rated Health in Different Ethnic Groups.	Chandola and Jenkinson (2000)	1	Perceived health (fair - excellent). Other factors assessed: Hypertension; Cardiovascular disease and diabetes; and Limiting health.	NR
The short form Sense of Coherence Scale.	Holmefur et al. (2015)	13	Comprehensibility; Manageability; and Meaningfulness.	Item correlation: 0.81 – 0.99

NR = not reported

2.4.7 Demands of life

The phrase "need" refers to the existence of a certain need or preference, which is frequently motivated by a deficiency or shortage, with such preferences ranging significantly from person to person (Vansteenkiste et al., 2020). The three basic kinds of life need that affect humans are physiological, psychosocial, and environmental needs (Bircher & Kuruvilla, 2014). Individuals process and respond to these demands using their biologically predetermined and personally acquired potentials, as well as the social and environmental factors that may help or impede this process. These elements must exist in the short-, medium-, and long-terms, as well as in the present, for one to meet the appropriate demands of life (Bircher, 2020; Bircher & Kuruvilla, 2014).

However, every healthy individual must be able to meet the demands that life imposes on them as a result of their own unique and natural processes. These include work on personality development, social integration, and the connection to the environment, in addition to the maintenance of the physical body. A person is healthy if they are able to achieve these needs. There is sickness if these requirements cannot be adequately met (Bircher, 2020). For instance, a person's long-term future is put in jeopardy by a minor carcinoma that exists in the body. The discovery does not, however, make him or her sick. Most people with back or head discomfort claim to be in good health. This implies that a pathology or complaint is not a requirement for health (Bircher, 2020).

2.4.7(a) Physiological demands

For humans, physiological demands can take many different forms as input, output, and reproduction-related activities. Important examples are the intake of oxygen, nutrients, and water; excretion; fertilisation; pregnancy and childbirth; and the preservation of internal situations within physiological bounds (Bircher & Kuruvilla, 2014). To address physiological needs that change with time and environment, humans must deal with a variety of conditions. For instance, conventional farming could be the primary source of food in low-income countries, whereas industrialised agriculture could be the primary source in high-income countries. Both food sources have external mechanisms for distribution and storage, like neighbourhood stores or supermarkets (Bircher & Kuruvilla, 2014).

The potential susceptibility marker for a variety of physical and psychological health issues, including cardiovascular diseases (Lovallo, 2011), anxiety and depressive disorders (Dieleman et al., 2015), and disruptive behavioural disorders (Portnoy & Farrington, 2015), to mention a few, results from an abnormal physiological stress response. There is currently no agreement on which factors should be considered physiological determinants because research in this regard differs greatly. Several studies (McEwen, 2012, 2017, 2022) detail a variety of potential physiological stress response factors, including personal, social, environmental, and drug use behaviours.

According to Basakci Calik et al. (2022), people who perform repetitive tasks for long periods of time with little rest or while adopting fixed or poor postures are at risk of acquiring repetitive strain injury. These have been widely observed and experienced in workplaces and educational settings (Day & Nielsen, 2017). They frequently result from exhaustion, muscle pain, and repetitive strain (Day & Nielsen, 2017). According to previous studies, IT users' primary physical medical issues and the leading causes of missed workdays are eye discomfort and musculoskeletal pain (Babu et al., 2015; Lin et al., 2020; Raja & Bhasin, 2014).

2.4.7(b) Psychosocial demands

The personal growth and social integration of individuals, including their involvement in social, cultural, and political life, are related to psychosocial needs (Bircher & Kuruvilla, 2014). New-borns, who must connect to their caregivers, are instantly aware of the connection between personal growth and social interaction. This supports healthy brain growth and functioning (Perry et al., 2017). Every person has to deal with many social factors that affect their health over the course of their lives. Expectations and roles vary from place to place, depending on a person's job, relationships, social responsibilities, goals, and the economic and political environments (Bircher & Kuruvilla, 2014).

The notion of psychosocial factors influencing psychological well-being is supported by a number of theories. The psycho-educational method, in general, provides a crucial framework for the growth and assessment of psychological and educational components including social skills, compassion, identity, anxiety, and emotional control, among others (Castañeda Fernández, 2016; Mendizabal, 2019; Morales-Rodríguez et al., 2020). The following higher education competencies are listed in more detailed frameworks, like EuroPsy, for the creation of standards for high-quality professional education in psychology: sufficient levels of compassion or anxiety, morally sound behaviours, emotional regulation, conflict resolution, and study habit preferences (Mendizabal, 2019). According to some recent theories, psychosocial factors can be divided into two traits on a continuum. Self-esteem, social skills, and empathy are examples of positive traits, while anxiety symptoms are examples of negative traits (Santana Cabrera & Tapia Chiu, 2018; Yucra Serpa, 2017).

In addition, the psychosocial workplace is regarded as one of the most significant workplace challenges in both modern and future cultures (Leka & Houdmont, 2010; Leka et al., 2011; Parent-Thirion et al., 2016). For instance, a considerable number of workers in the European Union (EU) claim having been exposed to psychological stress at work, with potentially serious repercussions for employees, workplaces, and communities. Musculoskeletal conditions, cardiovascular disorders, mental health issues, stress, burnout, a diminished quality of life, absences due to illness, high labour turnover, and a decline in motivation and productivity are some of these effects.

2.4.7(c) Environmental demands

Different stimulating environments may exist at various points throughout the life course, yet this field has not been thoroughly explored in diverse age groups across the stages of life, i.e., in life span samples (Richards & Hatch, 2011). Subsequent cognitive functioning may be affected in one of two ways by these environmental factors. It is possible that people who grow up in an environment that is inspiring and diverse will perform cognitively better in later life (Schmitter-Edgecombe & Parsey, 2014), but it is also reported that persistent overstimulation and high commitment may lead to many immediate demands on ones' cognition that these increased levels of involvement may result in significant daily forgetfulness (Cox & Deary, 2022).

It is still unclear whether self-reported feelings of being busy are the result of a relationship between individual perception and specific environmental characteristics, a personality trait that appears to equate demand towards any environment, a decreased ability to cope with daily tasks resulting in a higher feeling of demand from the environment, or a combination of these factors (O'Conor et al., 2019). It is also plausible that there could be people who, by normative criteria, are objectively highly busy but who are sufficiently organised that they might disprove this claim (O'Conor et al., 2019). However, it was found that the daily memory challenge of remembering to take prescriptions was best predicted by self-reported busyness (Gadallah et al., 2015).

The workplace and busy times can be a major source of events that lead to inadequate sleep and a poor diet (Loft & Cameron, 2014; Pinho et al., 2018a). Working individuals frequently encounter responsibilities and emotions associated with their jobs that may interfere with the processes necessary for relaxing and initiating sleep (Loft & Cameron, 2014). Furthermore, it was revealed that among individuals from metropolitan areas in five European nations, barriers to healthy eating are related to time restraints, taste preferences, and monetary costs (Pinho et al., 2018a).

2.4.8 Related questionnaires for measuring demands of life

There haven't been any published studies that have employed instruments to assess the demands of life including the physiological, psychological, and environmental needs as a whole. However, there are available instruments related to these factors separately.

Table 2.5: Summary of related questionnaires for measuring demands of life

Questionnaire	Author	Items	Determinants	Reliability
Physiological Arousal Questionnaire (PAQ)	Dieleman et al. (2010)	7	Perceived state of physiological arousal.	Cronbach's alpha: 0.64.
Perceived physiological vulnerability to IT use (PPVITU)	Lin et al. (2020)	17	Visual discomfort; Head discomfort; Musculoskeletal discomfort (limb pain); and Musculoskeletal discomfort (neck, shoulder, and back pain).	Cronbach's alpha: 0.824 – 0.886.
Copenhagen Psychosocial Questionnaire (COPSOQ)	Burr et al. (2019)	127	Demands at work; Work organisation and job content; Interpersonal relations and leadership; Work-Individual interface; Social capital; Offensive behaviours; and Health and well-being.	Cronbach's alpha: 0.64 – 0.87.
Ryff's Psychological Well-Being Scale	Diaz et al. (2006)	39	Self-acceptance; Positive relationships; Autonomy; Environmental mastery; Personal growth; and Purpose in life.	Cronbach's alpha: 0.72 – 0.94.
The Martin and Park Environmental Demands (MPED) Questionnaire	Martin and Park (2003)	11	Busyness and Routine.	Cronbach's alpha: 0.74 – 0.88.

In summary, considering that many factors besides clinical treatment have an impact on health, there are various and recent initiatives targeted at creating better holistic ways to promote health and sustainable development. The Meikirch Model of Health can help with these continuing initiatives. However, the lack of relevant questionnaires that can be completed by both patients and healthcare providers as a self-report measure is a significant obstacle to the application of the Meikirch model. Therefore, it is crucial to create reliable measures for assessing the components of the Meikirch model (social determinants, environmental determinants, individual potentials and demands of life). The use of the model in practise would be substantially facilitated by the availability of these measures.

2.5 Quality of life (QOL)

Historically, quality of life (QOL) has emerged from three main philosophical approaches (Brock, 1993): The first method outlines aspects of the good life that must conform to normative values derived from various religious, philosophical, or other traditions. For instance, we can consider that helping others is an essential component of living a happy life because our religious beliefs demand it. The second philosophy relates to the ability to satisfy desires. It is assumed that people will choose the things that will improve their quality of life the most, given the limitations imposed by the resources they have at the moment. According to this tradition, a society's QOL is measured by its members' ability to fulfil their needs. The third philosophy relates to individual experiences. It is assumed that a person's life is pleasant and desirable if they feel that way. In this concept, the importance of elements like subjective happiness, enjoyment, satisfaction, and subjective wellbeing is essential.

In the last few decades, scientists have come up with two precise approaches to evaluate the QOL: objective or social indicators and the measurement of subjective well-being (SWB) (Baldwin et al., 2002; Bognar, 2005). The social indicators of QOL emphasise objective measurement. The social indicators movement was expanding at the same time that economists were debating whether economic growth was always beneficial. In contrast, subjective QOL research is interested in how people perceive their lives. The basic presumption is that hedonic thoughts or cognitive pleasures can be used to define people's perceptions of well-being. The field is founded on the premise that it is reasonable to evaluate a person's feelings regarding life in relation to their own standards in order to directly comprehend how they perceive their experiential quality of well-being (Baldwin et al., 2002; Joyce et al., 2013).

Subjective QOL is a crucial self-reported measure of a country's level of development and the success of effective interventions for particular cohorts (Chaturvedi & Muliyala, 2016). QOL, in contrast to other conventional health outcomes like death, incidence, prevalence, or severity of disease, is an individual's perception of their own health, including their perception of their physical, psychological, social, and environmental circumstances (Sears et al., 2011; Skevington et al., 2004). The World Health Organization defines QOL as "people's perception of their place within life in connection to their objectives, aspirations, standards, and worries and in the perspective of the values and cultural structures in which people live" (Skevington et al., 2004). As such, many treatments involving children, and adolescents, especially those with acute and chronic impairments, have QOL promotion as their main goal. Numerous studies have confirmed that a person's health and QOL are closely related (Gazibara et al., 2018; Milic et al., 2020; Pekmezovic et al., 2011).

Positive values including joy, achievement, income, wellness, and satisfactions are associated with QOL (Nordenfelt, 2013b). The term “QOL” has gained recognition in the field of medicine, with increasing life expectancy and enhancing QOL as the two key objectives of the Healthy People 2000 initiative (Nordenfelt, 2013b). According to various studies, young adults perceive health related QOL differently than older adults. In particular, young adults evaluate their health using behavioural and psychological aspects, whereas older people place more value on their physical health (Mikolajczyk et al., 2008; Schnittker, 2005). University students were shown to have a significant prevalence of mental health issues, particularly depressive symptoms (Ediz et al., 2017; Mikolajczyk et al., 2008; Peltzer & Pengpid, 2015). Additionally, studies have revealed that adolescents and young adults are three times more likely than children and older individuals to experience symptoms of depression (Hardeveld et al., 2010; Satyanarayana et al., 2009). Also, it was found that three out of every four mental health problems in adults occurred before the age of 24 (Kessler et al., 2005).

2.6 Related questionnaires for measuring QOL

Several attempts have been made to validate the QOL instrument in various contexts and health conditions, such as those with disabilities or special health care needs, across various age groups and locations around the world to date. Therefore, we present a summary of available short-form QOL instruments for youth that are relevant to this study.

Table 2.6: Summary of related questionnaires for measuring youth quality of life

Questionnaire	Author	Items	Determinants	Reliability
Youth Quality of Life Instrument-Research Version (YQOL-R)	Patrick et al. (2002)	41	Self; Relationship; Environment; and General quality of life.	Cronbach's alpha: 0.77 – 0.96.
Youth Quality of Life—Short Form (YQOL-SF)	Hoang et al. (2021)	14	Belief in self and family; and Environment and relationships.	Cronbach's alpha: 0.910 – 0.911.
The Brazilian-Portuguese version of the Youth Quality of Life Instrument-Research (YQOL-R)	Salum et al. (2012)	41	Self; Relationship; Environment; and General quality of life.	Cronbach's alpha: 0.779 – 0.885.

2.7 Healthy diet

Food and eating are essential to humans. People make about 200 food decisions every day (Wansink & Sobal, 2007), and food preferences account for about one-third of our daily desires (Hofmann et al., 2012). Even if we are not actively consuming food, thinking about it and craving it play an important role in our lives. People have evolved to like eating because it is necessary for survival (Mela & Rogers, 2013). Eating serves not only a biological purpose, but it also serves as a central cultural and social activity that most people enjoy at individual or group level (Cornil & Chandon, 2016). However, due to its potential for negative health effects, food is no longer just a source of delight and pleasure today; rather, it is a growing source of concern (de Ridder et al., 2017). The primary cause of such alarm is the rising epidemic of overweight caused by our obesogenic environment with an abundance of readily available, inexpensive, and high-calorie meals (de Ridder et al., 2017; Elinder & Jansson, 2009). Today, a significant section of the population, especially children and adolescents, are overweight, which has serious repercussions in terms of a higher chance of developing chronic diseases (Swinburn et al., 2019).

The idea of what comprises a healthy diet is always expanding to take into account new knowledge about the effects that various foods, important nutrients, and other food components have on health and disease (Cena & Calder, 2020). Intake of certain minerals, food groups, or general eating practises are all supported by a substantial and rising body of research as having a good impact on health and helping to prevent many non-communicable diseases (NCDs) (Cena & Calder, 2020; Eastwood et al., 2013). A healthy diet entails one that is well-balanced, with a good number of starchy foods such as potatoes, bread, and pasta; a good quantity of fruit, vegetables, and dairy products; a reasonable quantity of fish or meat; and not excessive sugar and fat. A healthy diet also emphasises the importance of drinking a lot of water and getting an amount of energy that corresponds to what the body requires (Eastwood, 2013; Eastwood et al., 2013; Gordon & Jin, 2017; Payne, 2001).

A healthier diet is out of reach for the many people due to several barriers (de Ridder et al., 2017; Temple & Steyn, 2011). For instance, the tasty nature of many less healthful foods is largely responsible for their appeal. Despite having a generally low nutritional content, fast food is often a quick and convenient way to eat. People have habits, and they frequently resist changing long-held eating habits, even when their regular diet puts them at risk for chronic diseases as a result of their lifestyle (de Ridder et al., 2017). A previous study in Malaysia found that 14.1% of adolescents skip all three meals each day, with breakfast being the meal that is most commonly skipped (44.3% miss breakfast at least once per week), which therefore triggers symptoms of anxiety and depression (Tajik et al., 2016). In the same way, a previous study in Nigeria revealed that very few students skipped lunch and dinner, but the majority (73%) often skipped breakfast, which could affect the students' level of focus and concentration at lectures (Arisukwu et al., 2019).

Furthermore, several psychological and social factors may affect healthy eating behaviour, with belief in one's own ability to commit to a healthy diet being the most important social cognitive predictor of eating healthily (de Ridder et al., 2017). The terms "self-efficacy" or "perceived behavioural control" are frequently used to describe this (de Ridder et al., 2017). People may feel that there are obstacles that make it harder for them to maintain a healthy diet. The inability to cook healthy food due to a lack of skills, the scarcity or high cost of healthier foods, or the effort and time it takes to prepare healthy meals are some examples of these barriers (Glasson et al., 2011). As such, numerous studies (Fitzgerald et al., 2013; Lee et al., 2019; Stok et al., 2015), have demonstrated an association between higher levels of self-efficacy and higher intakes of healthy foods in a wide range of samples. Additionally, several studies have revealed a consistent relationship between self-efficacy and fruit and vegetable intake (Guillaumie et al., 2010; McDermott et al., 2015).

2.8 Related questionnaires for measuring healthy diet

Even though there are a lot of short dietary assessment tools, most of them focus on just one nutrient or food group or take longer to complete because they have more questions. The summary below is a simplified screening instrument designed for health diet behaviour assessments and counselling relevant to this study.

Table 2.7: Summary of related questionnaires for measuring healthy diet

Questionnaire	Author	Items	Determinants	Reliability
The brief Starting The Conversation (STC) tool	Paxton et al. (2011)	8	Dietary assessment.	Item total correlation: 0.39 – 0.59.
Brief Dietary Assessment to Guide Counselling for Cardiovascular Disease Risk Reduction	Jilcott et al. (2007)	54	Fruits; Vegetables; Fruits and vegetables; Fibre; Total fat; and Saturated fat.	Item total correlation: 0.57 – 0.60.
Malay Mindful Eating Questionnaire (MEQ-M)	Abdul Basir et al. (2021)	28	Environment disinhibition; Emotional response; Taste awareness; Emotion awareness; Portion disinhibition; External cues of food; and External cues of place.	Cronbach's alpha: 0.54 – 0.70.

2.9 Physical activity

Traditional definitions of physical activity include any movement of the body caused by the contraction of skeletal muscles and resulting in a higher energy expenditure than when the body is at rest. Exercise, on the other hand, is a structured, repeated, and planned activity done with the goal of improving or maintaining one or more aspects of physical fitness (Caspersen et al., 1985; Hills et al., 2015). Physical activity and exercise, in turn, can be measured in terms of intensity (how difficult?), duration (how long?), repetition (how frequently?) and method (or type), which includes walking, cycling, running, and swimming (Chen & David R Bassett, 2005; Staudenmayer et al., 2012). The recent recommended guideline for appropriate physical activity is that preschool-aged children (ages 3 to 5 years old) should engage in physical exercise throughout the day. Children and adolescents between the ages of 6 and 17 years old should engage in 60 minutes or more of vigorous activity each day. Adults should engage in 75 to 150 minutes per week of strenuous exercise, or an equivalent combination of moderate and vigorous exercise, for a minimum of 150 to 300 minutes per week of moderate to vigorous intensity (Piercy et al., 2018).

Physical activity has a wide range of health benefits, including a decreased risk of a number of diseases and improved functional ability (Powell et al., 2011; Warburton & Bredin, 2016). Many studies have found compelling evidence that regular physical activity lowers the risk of premature death, coronary heart disease, hypertension, stroke, type 2 diabetes, some cancers, obesity, falls, depression, and cognitive decline (Cunningham et al., 2020; Powell et al., 2011). There is also pretty strong scientific evidence that physical activity helps older people keep their ability to function, helps them lose and maintain a healthy weight, improves the quality of their sleep, and lowers their risk of osteoporosis and hip fractures (Cunningham et al., 2020).

Regular physical activity involvement is also related to improvements in psychosocial wellbeing, such as decreases in stress, anxiety, and depressive symptoms (Rebar et al., 2015; Rosenbaum et al., 2014). Remarkably, psychosocial wellbeing has the possibility to make a major impact on the management and prevention of all chronic diseases, such as cardiovascular disease, hypertension, obesity, and depression. Previous research by Prakash et al. (2015) has reported an inverse relationship between physical activity and the relative risk of cognitive deterioration.

The large and progressive lifestyle changes that have occurred in both the developed and developing worlds over the past centuries and decades, respectively, have sparked more recent interest in the connection between physical activity and health. Global estimates of positive physical activity behaviour have generally indicated a downward trend (An et al., 2016; Brownson et al., 2005; Ding, 2018). Increases in noncommunicable diseases (NCDs) have consequently increased as a result of populations' declines in physical activity and the resulting effect of a more recently observed rise in sedentary behaviours (Andersen et al., 2016; Bauer et al., 2014; Lee et al., 2012). Even in developing countries, NCDs are thought to be the main cause of death and illness because they cause about 60% of all deaths and 44% of early deaths (Daar et al., 2007; Horton, 2013). Yet, the prevalence of physical inactivity is so serious that the issue has been referred to as a pandemic and the most significant health concern in the twenty-first century (Kohl et al., 2012; Reis et al., 2016). Over 53.8 billion USD were lost by health care systems worldwide in 2013 as a result of insufficient physical activity (Ding et al., 2016).

According to past studies, people's perceptions of the advantages and obstacles of physical activity shift as they age (Han et al., 2016; Shin et al., 2018). Time constraints, for instance, were reported as a barrier by 27.4% of participants in the 60–64 age group, 16.1% of participants in the 65–69 age group, and 7.1% of participants in the 70–plus age group (Booth et al., 2002; Shin et al., 2018). For older individuals, lack of companionship (such as friends) was reported as the main obstacle to physical activity, whereas for midlife adults, a lack of motivation was revealed as the most significant obstacle (Shin et al., 2018). Older adults reported benefits of physical activity were better health (physical and mental) and making friends from all racial/ethnic groups (Gothe & Kendall, 2016; Mathews et al., 2010), whereas young adults reported benefits were better physical performance, a more positive psychological outlook, and improved performance (Lovell et al., 2010; Roberts et al., 2015).

2.10 Related questionnaires for measuring physical activity

The International Physical Activity Questionnaire (IPAQ) is one of the most common tools of physical activity assessment and relies on participants' recall abilities (Craig et al., 2003). The IPAQ had already been tested and validated in various places around the world, including Malaysia (Shamsuddin et al., 2015) and Nigeria (Oyeyemi et al., 2014).

Table 2.8: Summary of related questionnaires for measuring physical activity

Questionnaire	Author	Items	Determinants	Reliability
International Physical Activity Questionnaire Short Version (IPAQ-S)	Craig et al. (2003)	7	Vigorous activity; Moderate activity; Walking; and Sitting time.	Item total correlation: 0.32 – 0.88.
Malay Language Version of the International Physical Activity Questionnaire (IPAQ-M)	Shamsuddin et al. (2015)	12	Vigorous activity; Moderate activity; Walking; Sitting time; and Sleeping time.	Item total correlation: 0.55 – 0.71.
International Physical Activity Questionnaire (Hausa IPAQ-LF) in Nigeria	Oyeyemi et al. (2014)	31	Occupation; Active transport; Domestic; Leisure; Sitting; Walking; Moderate; and Vigorous.	Intra-class correlation coefficient (ICC): 0.50 – 0.82.

2.11 Relationship between Social determinants of health and QOL

It is widely accepted that people with less education will have fewer job options and have lower economic potential (Braveman et al., 2011; Braveman & Gottlieb, 2014). In addition, socioeconomic position has a significant impact on one's living situation and place of residence; in recent years, a lot of effort has been made to emphasise the significance of health and where we live, work, and play (Thornton et al., 2016; Woolf & Braveman, 2011). As a result, a large number of residents in lower socioeconomic groups reside in areas with poor infrastructure, unsafe environments, a lack of health and medical resources, and limited access to health insurance, all of which have a negative impact on their quality of life (Hege et al., 2018).

Obesity and its comorbidities, inadequate physical activity, limited access to nutritious foods, and mental well-being are just a few of the social determinants of health that have been linked to health-related disparities and quality of life outcomes (Braveman et al., 2010; Gundersen & Ziliak, 2015; Meyer et al., 2014; Muntaner et al., 2013). In addition, Dhand et al. (2022) recently noted that in the rural patient population, social determinants of health like education, occupation, income, social support, lifestyle, medical history, and access to healthcare were correlated with a various quality-of-life indicators, including those that had to do with physical and overall health.

2.12 Relationship between Environmental determinants of health and QOL

The built environment can improve people's health and quality of life in three ways: by creating pathways that encourage physical activity participation, social cohesion in the community, and equal access to nutritious food (Kent & Thompson, 2014). According to an earlier study, spacious, green, and natural spaces, as well as urban planning that encourages social contact and safety, were the major factors influencing happiness in neighbourhoods (Pfeiffer & Cloutier, 2016). Additionally, Mouratidis (2021) summarised that the quality of life for people of all ages can be improved by encouraging active and public transportation while limiting the use of cars as much as possible, making sure that everyone has easy, equal access to facilities and services, and developing or directing technology and new ways to move to make everyone feel more welcome.

The findings of a previous study (Welch et al., 2013) revealed that, using the World Health Organization health-related quality of life questionnaire (WHOQOL), people who lived near highways had lower scores in the physical, environmental, psychological, and social domains. The WHOQOL domain scores were also linked to being more sensitive to loud sounds in people who stayed near highways compared to people who stayed in quieter areas. The neighbourhood is another important environmental element that is part of the built environment and has a significant impact on older people's quality of life (Buffel et al., 2012; Hatcher et al., 2019). Among the perceived qualities of the neighbourhood, traffic safety was positively correlated with both the physical and mental aspects of quality of life. Having favourable opinions of neighbourhood safety and qualities are also linked to a lower prevalence of mental illness in older people (Engel et al., 2016; Friedman et al., 2012).

2.13 Relationship between Individual potentials and QOL

Several studies have looked at how chronic conditions and their symptoms affect individuals' self-rated health (Rothrock et al., 2010; Sprangers et al., 2000). However, the results have been different depending on the diseases studied and the type of study population. Those with chronic conditions like depression, rheumatoid arthritis, neurological disease, and cancer were significantly more likely to rate their own health poorly and consequently report a poor quality of life. From a demographic standpoint, chronic diseases, with the exception of depression, did not significantly influence self-rated health among the middle-aged, but they severely influenced self-rated health among the elderly, particularly among women (Molarius & Janson, 2002). Additionally, having knowledge of a significant illness that could be fatal, such as cancer or coronary disease, may have a greater effect on a person's quality of life (Ocampo, 2010).

Results from cross-sectional research on different populations show that patients with a higher sense of coherence, including those with heart conditions, cancer, HIV infection, severe injuries, manière's disease, and those receiving respiratory support, have a greater quality of life score. The results demonstrated that regardless of the measurement method, the higher the sense of coherence, the better the reported overall quality of life (Eriksson & Lindström, 2007). In a previous study, Nabors et al. (2018) reported that family sense of coherence was strongly and positively related to quality of life in families with at least one member suffering from a serious illness. Also, research with young asthmatic children and their parents found that the children's sense of coherence and self-esteem were linked to how well they coped with their asthma and had a good quality of life (Vinson, 2002).

2.14 Relationship between Demands of life and QOL

There is increasing agreement that mental health services should be given according to need with the aim of enhancing subjective quality of life (Lasalvia et al., 2007; Lasalvia et al., 2000). This goal can be reached if the patients with the greatest needs also have the lowest quality of life and if addressing their needs results in an increase in their perceived quality of life (Lasalvia et al., 2007). In a prior study, Slade et al. (2004) found that patient rated unmet need was the only baseline predictor of follow-up quality of life, which accounted for 58% of the variance in follow-up quality of life.

In the UK700 trial (Fahy et al., 1999), unmet needs were found to be a better predictor of how a patient felt about their quality of life than any other clinical or social factor. Unmet needs were discovered to have a significant negative correlation with the underlying quality of life (Slade et al., 2004). This demonstrates that satisfying needs leads to a rise in quality of life that lasts only as long as needs are satisfied. Moreover, a more recurrent result has shown the association between subjective quality of life and life satisfaction across a variety of life domains (Hansson, 2006).

2.15 Relationship between Healthy diet and QOL

A recent systematic review (Wu et al., 2019) found that there is a strong relationship between a healthy diet and quality of life. This shows that a lot of researchers have looked into how a healthy diet affects the quality of life. A prior cross-sectional study demonstrated a positive relationship between a healthy diet (where higher scores indicated more adherent dietary practices) and higher health-related quality of life scores (Bolton et al., 2016), and a prior prospective cohort, measuring diet quality in a similar manner, demonstrated a relationship between improved diet quality and favourable mental health outcomes (Jacka et al., 2011). Furthermore, there was a dose-response association between the quality of the diet and health-related quality of life, with low diet quality being related to lower health-related quality of life (Wu et al., 2019). This was because diets with a relatively low nutrient density can result in nutrient deficiencies, which in turn are related to mental health issues (O'neil et al., 2014).

The results of a prior study (Regan et al., 2022) revealed a strong positive correlation between diet diversity and health-related quality of life, a strong positive correlation between the fruit and vegetable segment of healthy eating and health-related quality of life, and a strong positive correlation between healthy eating and diet diversity. However, no significant correlation was found between healthy eating and health-related quality of life. Another study found a strong and significant correlation between good eating habits and a better quality of life in terms of physical and mental health, as well as lower disability (Hadgkiss et al., 2015).

2.16 Relationship between Physical activity and QOL

Many studies have shown that physical activity improves the quality of life in various ways (Ho et al., 2019; Omorou et al., 2013; Puciato et al., 2017; Vagetti et al., 2014). Sports activities and exercise were significantly associated with the majority of quality-of-life domains, including general quality of life, social relationships, physical and mental health, and the environmental domain (Mourady et al., 2017). Moreover, Arizabaleta et al. (2010) found increases in health-related quality of life after a three-month aerobic exercise programme in the physical domain summary, bodily pain domain, physical function domain, and overall health domain.

In a previous study (Joseph et al., 2014) that looked at how exercise self-efficacy, physical self-esteem, and positive affect mediated the relationship between physical activity and quality of life in young adults, the strongest mediating effects came from physical self-esteem and positive affect. Furthermore, exercise self-efficacy was found to be significantly associated with quality of life. As a result, as people age, they can give more importance to their perceptions of their physical attributes.

Krzepota et al. (2018) prior research discovered a substantial relationship between the level and type of physical exercise they engaged in and their quality of life in the physical health domain among pregnant women in their second trimester. The women who gave this domain of their quality of life a higher rating reported higher energy expenditures related to vigorous exercise, occupational activity, and sport or exercise activity. Also, greater ratings of overall quality of life and general health were seen in third-trimester pregnant women who engaged in more energy-intensive sports or exercise activities. The study also found a positive relationship between quality of life and the amount of energy used during vigorous activity and the social and psychological relationship domains of quality of life.

2.17 Relationship between Social determinants of health and Environmental determinants of health

Several studies have reported a positive association between social well-being and the built environment, including neighbourhood social capital (Boessen et al., 2018; Cabrera & Najarian, 2015), neighbourhood sense of community (Lee et al., 2017; Wood et al., 2010), and neighbour ties (Cabrera & Najarian, 2015; Hipp & Perrin, 2009). For instance, according to the findings of a prior study (Mouratidis, 2018), people who live in compact communities report much higher levels of satisfaction with their personal interactions than those who live in low-density suburban neighbourhoods. Higher densities, closer proximity to the city centre, and a mix of land uses are all found to improve social well-being in general.

According to a study by Balducci and Checchi (2009), friends and neighbours may be triggers for subjective well-being, and this link may be influenced by local chances for social interaction and volunteerism as well as the accessibility of stores and gathering places. The availability of so-called "third spaces," which are more prevalent in compact neighbourhoods (e.g., community centres, restaurants, cafés, malls, and parks), has been hypothesised to improve quality of life (Jeffres et al., 2009). Leyden et al. (2011) discovery that neighbourhood amenities have a favourable effect on urban quality of life supports this as well. More options for social activities and gatherings are, according to Leyden et al. (2011), what makes local amenities important for quality of life and social well-being.

2.18 Relationship between Social determinants of health and Individual potentials

The experience of mental and physical health in late adulthood may be influenced by the presence or absence of appropriate social factors. In fact, a lack of strong social bonds is related to higher mortality, greater levels of depression, and worsening general health (Alcaraz et al., 2019; Yu et al., 2020). Strong social connections, however, offer health advantages, such as fewer physical and mental health-related issues (Shankar et al., 2017; Taylor et al., 2018). In a previous study, Ermer and Proulx (2019) found that social connectedness factors were differentially related to well-being. People who were more closely connected to their social networks and had larger social networks reported better self-rated health, and people who received more emotional and practical support from family and friends reported better emotional well-being.

Several studies have shown that a person's sense of coherence is largely associated with their social and personality factors (Eriksson et al., 2007; Marsh et al., 2007). An earlier study's (Volanen et al., 2004) results showed that psycho-social resources, not socioeconomic conditions, were related to a sense of coherence in both men and women. These resources included the nature of the partner relationship, the strength of one's social network, the standard of one's employment, and one's upbringing. Although gender differences were negligible, males living alone were more likely than women living alone to report having a low sense of coherence.

2.19 Relationship between Social determinants of health and Demands of life

According to many studies (Fratiglioni & Wang, 2007; Opdebeeck et al., 2016), a protective lifestyle characteristic that seems to be prevalent is high mental demands. High mental demands throughout life, such as schooling, a challenging workplace, and mentally taxing hobbies, may encourage better psychosocial functioning in old age and postpone the onset of dementia (Harandi et al., 2017). The findings of a study by Rodriguez et al. (2017) showed that, regardless of age or educational level, the level of cognitive functioning is much worse in socially isolated people than in non-isolated people. Perceived social support can also reduce the negative physiological side effects of illness and promote self-care in the elderly (Harandi et al., 2017).

Social support was reported to be a significant predictor of all health outcome variables, including health status, physical symptoms, stress-related psychological symptoms, depression, role performance, living adaptability, psychological adjustment, coping behaviours, health beliefs, health-promoting behaviours, quality of life, and self-actualization (Harandi et al., 2017; Yalcin, 2015). Individuals who enjoy more effective communication skills and have stronger social support and favourable ethnic social ties are less likely to experience depression and other mental health issues (Harandi et al., 2017). It was further demonstrated that social support differs based on sex by showing that women are more likely than men to talk about their emotional issues with people outside of the family. Because of the social expectations placed on them about how they should behave in terms of gender roles, it may be more difficult for males to accept their anxieties, phobias, and depressions. Males may avoid soliciting assistance in situations of need because they fear losing their standing and dignity since their inability to handle stress may be seen as a weakness (Harandi et al., 2017).

2.20 Relationship between Environmental determinants of health and Individual potentials

According to past studies (Goldstein et al., 2019; Pratt et al., 2020), the perceived neighbourhood environment has a distinctive impact health and may be a more accurate determinant of a person's health than objective neighbourhood factors. Similar findings indicated that self-rated health and mental health symptoms were all related to perceived neighbourhood cohesion and local issues (Poortinga et al., 2008).

Furthermore, there was a strong and positive correlation between perceived disorder and reported neighbourhood disorder (Hinkle & Yang, 2014).

After accounting for baseline health, it was found that among adults, perceived neighbourhood challenges such as noise, traffic, crime, garbage and trash, bright lights, and public transportation were associated with a higher risk of overall functional loss. This finding suggests a causal relationship between perceived neighbourhood quality and improved physical wellbeing (Wen et al., 2006). Also, significant independent predictors of decreased self-rated health after adjusting for socioeconomic class included repetitive labour, high psychological demands, job uncertainty, and high ergonomic musculoskeletal system exposures (Wadsworth et al., 2010).

2.21 Relationship between Environmental determinants of health and Demands of life

There is evidence linking human health and how natural settings are perceived by our senses (Panagopoulos et al., 2016). Environmental factors are becoming more important, such as proximity to green spaces, peaceful neighbourhoods, appealing street scenes, and clean air (Panagopoulos et al., 2016). The quantity and quality of green spaces have an impact on how people behave, how they choose to spend their free time, how they learn about the environment, and how they may unwind and manage their stress on a daily basis (La Rosa et al., 2018).

Living in low-quality built environments is associated with psychosocial stress, which may put one at a higher risk for mental health in general (Cooper & Baglioni, 2018). Poorly built urban environments can subject locals to annoyances and stressors on a regular basis, putting them under more social pressure and raising their risk of psychosocial stress (Cooper & Baglioni, 2018). Moreover, social pressures may be amplified in densely populated urban settings. Social pressure and its effects on mental health may be made worse by the close proximity of individuals in metropolitan neighbourhoods located in deteriorating built environments (Galea et al., 2005; Generaal et al., 2019).

2.22 Relationship between Individual potentials and Demands of life

The pathogenesis of physical disease is typically shown to be influenced by stressful situations that result in negative emotional states (such as depression and anxiety), which have direct effects on biological processes or behavioural patterns that affect disease risk (Cohen et al., 2007; Crosswell & Lockwood, 2020). Since they are most likely to create long-term or permanent alterations in the emotional, physiological, and behavioural responses that affect susceptibility to and the course of disease, chronic stress exposures are regarded as the most harmful (Crosswell & Lockwood, 2020). For instance, the way stress affects the control of immunological and inflammatory processes may have an impact on depression, infections, autoimmune, and heart diseases, as well as certain malignancies (Slavich, 2020).

Moreover, resilience is a predictor of psychological well-being (Sabouripour et al., 2021). According to Gurung et al. (2019), student well-being was significantly predicted by resilience. Similarly, Acharya et al. (2016) found that living away from the protective family setting helps hostel residents develop stronger coping mechanisms as they learn to rely on themselves. While some issues can be resolved through communication, others require situational adaptability in order to maintain psychological health. Furthermore, Dasti et al. (2018) came to the conclusion that the lack of elements that build resilience will have an effect on mental health in the long run. This is because resilience is a key factor that predicts and improves mental health in the population.

2.23 General information on the qualitative and quantitative research methods employed in the present study

The literature pertaining to the qualitative and quantitative research methods used in this study is summarized in this section.

2.23.1 Qualitative interview

In a psychometric study, a "qualitative interview" is a research technique in which researchers employ open-ended questions to collect comprehensive, in-depth information about people's experiences and viewpoints regarding a psychometric test (Potter & Hepburn, 2005). This allows researchers to examine test-takers' subjective interpretations and lived experiences regarding the test's format, content, and instructions, potentially revealing biases or areas where the test may not accurately reflect the skills or experiences of particular populations. Participants in these interviews are responding to questions orally, and an effort is made to document their responses (perhaps with notes, but more usually with recordings and transcriptions) (King, 1994; Potter & Hepburn, 2005). These interviews have been referred to as open-ended, conversational in nature, lively, subjective, and occasionally (confusingly) semi-structured (Potter & Hepburn, 2005). This type of interview is typically dictated by a list of subjects or questions, albeit the sequence in which they are asked may change. Additionally, interviewers may deviate from the list and employ a range of follow-up questions (or remarks, responses, or other kinds of input) (Potter & Hepburn, 2005).

2.23.2 Content validity process

Content validity refers to the accuracy with which a measurement tool captures the construct under assessment, and it serves as crucial evidence to support the validity of a measurement tool such as a study questionnaire. We must methodically carry out content validation using recommended procedures and evidence, as it is essential to establishing total validity (Cook & Beckman, 2006; Yusoff, 2019a). The terms "elements of a measurement instrument" refer to any component of the measuring process, such as instructions, response forms, and items from the questionnaire, that may have an impact on the data collected (Cook & Beckman, 2006; Yusoff, 2019a). The notion, component, domain, or factor that is the subject of the measurement is referred to as the construct (Cook & Beckman, 2006; Yusoff, 2019a). The assessment's goal relates to the anticipated capabilities of the measurement instrument; for instance, in this study, the social determinants of health questionnaire (SDH-Q) is designed to evaluate students' perceived SDH levels.

An assessment tool's accuracy is determined by how closely its elements correspond to the dimensions of the desired construct, whereas its relevance is determined by how well its elements fit the intended constructs as well as evaluation purposes (Sireci & Faulkner-Bond, 2014). Although there are two components to content validity—relevance and representation of an assessment tool—one frequently used method to determine content validity is the examination of instrument relevance (Davis, 1992; Yusoff, 2019a). Several studies (Hadie et al., 2017; Lau et al., 2018; Marzuki et al., 2018; Ozair et al., 2017) used the content validity index (CVI) to establish that an assessment tool was valid by applying six steps: (i) they designed a content validation form, (ii) chose a professional reviewing panel, (iii) performed content validation, (iv) evaluated subdomains and items, (v) assigned each item a score, and then (vi) computed the CVI.

In addition, the CVI can be established either through face-to-face interactions or via a non-face-to-face approach (Yusoff, 2019a). While the non-face-to-face approach offers cost savings, challenges such as response rate and time constraints may arise. However, systematic follow-up measures can enhance efficiency in addressing these challenges (Yusoff, 2019a).

2.23.3 Face validity process

Response process validity, also referred to as face validity, is the extent to which test takers or study participants are convinced that the questions and test content are pertinent to the circumstances in which the test is being given (Artino Jr et al., 2014; Yusoff, 2019b). Face validity testing is usually conducted after content validity has been established (Holden, 2010). The extent to which participants consider a measurement instrument's questions acceptable for the intended construct and evaluation aims is another way that other researchers characterize face validity (Hardesty & Bearden, 2004; Hughes, 2018). Face validity is a statistical indicator of how participants in an investigation survey think when they answer questions on the measurement tool (Yusoff, 2019b). Researchers typically assess these using the evaluation tool's terminology and instruction clarity, as well as the participants' ability to understand the content after a demonstration or training course (Hughes, 2018; Yusoff, 2019b).

Assessing the response validity process, systematically quantified based on evidence and best practices, enhances the validity of an assessment tool (Yusoff, 2019b). This can be achieved through the calculation of the face validity index (FVI) (Yusoff, 2019b). The FVI shows how valid the response process is, and many studies (Hadie et al., 2017; Lau et al., 2018; Marzuki et al., 2018; Ozair et al., 2017) have used it to validate assessment tools using a six-step process: (i) creating a response process validation form; (ii) choosing participants for the reviewing panel; (iii) conducting face validation; (iv) evaluating subdomains and items; (v) giving scores to each item; and finally (vi) computing the FVI. Moreover, the face validation process can be carried out using the non-face-to-face approach, similar to the content validity process, due to its practicality, adaptability, and cost-effectiveness in data collection, as well as its ability to mitigate response bias.

2.23.4 Exploratory Factor Analysis (EFA)

EFA is a commonly used statistical method to assess measurement models. created in its inception to evaluate hypotheses of intelligence by psychologists (Kline, 2023; Watkins, 2018). A group of techniques known as EFA encompasses centroid, principal components, and principal (common) factor analysis techniques, which vary in the statistical standards they employ to identify factors (Kline, 2023; Watkins, 2018). A priori assumptions on how many components or the factor-indicator link are not necessary for this method (Kline, 2023; Watkins, 2018). For instance, EFA evaluates unconstrained factor models, meaning that all items are permitted to load on all factors (Watkins, 2018). One technique to perform EFA similar to confirmatory mode is to give the computer instructions to extract a predetermined number of factors based on theory. However, the key idea is the fact that applying EFA does not necessitate a set of unique hypotheses (Kline, 2023).

Moreover, in EFA, unrestricted factor models typically lack identification, and it is difficult to replicate results with an independent data set. Put simply, no specific EFA model possesses a singular, definitive set of parameter estimates (Kline, 2013). This is because there exist countless ways to configure an EFA solution. Researchers strive to select an EFA rotation method that enhances clarity in factor interpretation; among the available options are Varimax, Quartimax, Equamax, Direct Oblimin, and Promax, among others (Kline, 2023; Watkins, 2018). When a factor in EFA accounts for maximum variance in non-overlapping sets of indicators, the solution exhibits a fundamental structure and is deemed parsimonious (Kline, 2023; Thompson, 2004; Watkins, 2018).

2.23.5 Confirmatory Factor Analysis (CFA)

Confirmatory factor analysis (CFA) is a statistical method that evaluates the degree of alignment between a proposed measurement model and actual data. This method, a form of multivariate analysis grounded in theoretical assumptions, examines the associations between latent constructs (factors) and observable variables (items) (Brown, 2015; Kline, 2013; Kline, 2023). In CFA, researchers construct a model that posits specific relationships between latent factors and observed variables, determining factors such as the number of factors, the variables associated with each factor, and the structure of relationships (factor loadings) between factors and observed variables (Brown, 2015; Kline, 2023). Furthermore, the model incorporates error terms to explain the variance in each observed variable that the factors fail to explain (Brown, 2015; Kline, 2023).

A frequently raised issue in CFA is the minimum number of indicators required for each factor. For models with two or more factors, at least two indicators per factor are recommended to achieve model identification. However, factors with only two indicators are more likely to have poor loadings, particularly in studies with small sample sizes (Brown, 2015; Kline, 2023). In addition, estimating measurement error correlations for such factors can be problematic, increasing the risk of specification errors (Kline, 2023). Kenny (1979) popular guideline remains useful here: “Two might be fine, three is better, four is best, and anything more is gravy.”

CFA results provide several parameters (Kline, 2023), including factor variances and covariances, item loadings on their respective factors, and measurement error for each item. When the proposed model is reasonable and appropriate, two key patterns are expected: (1) indicators assigned to the same factor should show relatively high standardized loadings (e.g., > 0.70), which indicate convergent validity; and (2) estimated correlations between factors should not be excessively high (e.g., < 0.90), demonstrating discriminant validity. For instance, if the correlation between factors A and B is 0.95, it would suggest that the indicators are not measuring two distinct constructs (Kline, 2023). If the CFA results do not align with the hypothesized model, researchers may need to respecify the measurement model through model modification indices procedures (Kline, 2023).

2.23.6 Reliability and validity testing

The most common models for assessing reliability and shared amount of variance in psychometric analysis are internal consistency, average variance extracted (AVE), discriminant validity, and test-retest. Internal consistency refers to the degree to which responses are consistent across the items of a measure. It estimates how effectively a collection of items captures the intended latent variable and its reliability (Kline, 2023). A low level of internal consistency suggests that the items' content is so varied that the total score is not the most useful unit of analysis. The coefficient most frequently reported in the literature is Cronbach's alpha (Kline, 2023). However, Cronbach's alpha may undervalue reliability, and composite reliability (CR) provides a more accurate estimate when residual covariances are included in the model (Raykov & Marcoulides, 2016).

The AVE estimate, standing for Average Variance Extracted, represents the average proportion of variance in observable variables that is theoretically attributed to a latent construct. For instance, a latent construct correlates with its theoretically associated observable variables, items 1 and 2, with the strength of this correlation referred to as factor loading (Kline, 2023). The variance in each observable variable that is accounted for by the latent construct, also termed shared variance, is determined by taking the square root of these correlations. The estimated AVE is the average of this shared variance across all observable variables that are conceptually linked to a latent construct (Farrell, 2010).

Discriminant validity refers to a set of variables presumed to measure different constructs (Kline, 2023). For instance, if the estimated correlation between factors A and B is very high, it is difficult to assert that the indicators measure two distinct constructs, A and B (Kline, 2023). Lastly, test-retest reliability testing reflect the variation in measurements taken by an instrument on the same subject under the same conditions at different points in time (Koo & Li, 2016). This is generally indicative of reliability in situations where raters are not involved or the rater effect is negligible, such as with self-reported survey instruments (Koo & Li, 2016).

2.23.7 Structural equation modelling

Structural equation modelling (SEM), which integrates factor analysis and multiple regression analysis, examines the structural relationship between measurable variables and latent constructs (Kline, 2023). Kline (2023) also recognizes path analysis, a technique within SEM, as a causal model. According to Brown (2015) view, SEM models comprise two main components: the measurement model, which defines the number of factors, the correlation between multiple indicators and their respective factors, and the relationships between indicator residuals (i.e., a CFA model); and the structural model, which describes the relationships between the factors (e.g., direct, or indirect effects, or no relationship).

Software tools for SEM require researchers to specify in advance which variables are expected to influence others and the directions of these effects (Kline, 2023). These a priori specifications represent the researcher's hypotheses and together form the model to be tested. In this way, SEM is fundamentally confirmatory, as the analysis begins with a proposed model and asks whether the data support it (Kline, 2023). However, it is common for data to diverge from the hypothesized model, requiring researchers to either reject the model or revise the underlying assumptions. In a purely confirmatory approach, a single model is tested and accepted or rejected based on its fit with the data (Jöreskog, 2005). Nonetheless, in practice, model testing is rarely so limited in this scope.

A second, less restrictive context involves the testing of alternative models, which applies when more than one a priori model can be proposed (Jöreskog, 2005). In such cases, there must be adequate theoretical or empirical justification for specifying multiple models. The model that best fits the data is retained, while the others are rejected (Kline, 2023). A third and more common context is model generation, which occurs when an initial model fails to fit the data and is then modified by the researcher. The revised model is retested with the same data (Jöreskog, 2005). The aim of this process is to identify a model that is theoretically sound, reasonably parsimonious, and demonstrates an acceptable fit to the data.

The two main aspects of SEM variables are latent and observable variables. Measured scores are considered observed variables and serve as indicators of the underlying construct (Kline, 2023). Latent variables are explanatory variables that represent a continuum related to hypothetical entities or factors but are not directly observable. Latent variables are continuous, while observed variables can be continuous, ordinal, or categorical (Kline, 2023). In SEM, the aim of model estimation is to minimize the residuals that result from the difference between the variances or covariances predicted by the model and those observed in the sample (Kline, 2023).

The extent to which the model fits the data is indicated by the difference between the sample and model variance/covariance (Byrne, 2013; Kline, 2023).

2.23.8 Measurement and structural invariance testing

Establishing measures that are valid and reliable is crucial in social science research to ensure that measurements are comparable across groups (Yuan & Chan, 2016). This concept is vital whether the focus is on identifying differences or tracking changes among groups (Yuan & Chan, 2016). From simple mean difference tests to complex evaluations of whether theoretical constructs remain invariant across groups, it has been argued that equivalent measurements are a logical prerequisite (Millsap, 2012; Vandenberg & Lance, 2000). Without measurement invariance, observed or estimated differences between groups may likely reflect differences in population characteristics rather than differences in the intended attribute (Yuan & Chan, 2016).

Measurement invariance refers to the quality of indicating that a measurement model functions consistently across different groups or conditions (Kline, 2023). Ensuring that comparisons between groups (such as various cultures, genders, and time points) are valid and unbiased by differences in how constructs are measured across these groups is crucial (Kline, 2023). Measurement invariance (or equivalence) refers to whether the scores obtained from a particular construct hold the same meaning across different conditions (Kline, 2023). These conditions may include consistency of measurement across populations, time points, or methods of test administration. Invariance across populations relates to the concept of construct bias, which occurs when a test measures something different in one group (e.g., Nigerian students) than in another (e.g., Malaysian students). If there is no evidence of construct bias, then the measurement is invariant across groups.

Structural invariance/scaler invariance demonstrates the ability to confidently compare constructs, coefficients, and latent means across units of analysis (Meredith, 1993; Millsap, 2012; Steenkamp & Baumgartner, 1998; Vandenberg & Lance, 2000). When configural and metric invariance are established, the latent construct can be meaningfully interpreted across units of analysis, and structural relationships, such as unstandardized regression coefficients or covariances, can be reliably compared (Meredith, 1993; Millsap, 2012; Steenkamp & Baumgartner, 1998; Vandenberg & Lance, 2000). Thus, achieving structural invariance reflects the invariance in factor variances, factor covariances, and factor means across groups or over time, and requires first establishing the measurement invariances (i.e., configural, weak, strong, and strict) (Davidov et al., 2014; Meitinger et al., 2020).

The structural/scalar invariance, the highest level of invariance, is frequently very challenging for researchers to achieve (Davidov et al., 2012; Meitinger et al., 2020). Consequently, it frequently happens that there is no meaningful way to compare the latent means of constructs (Meredith, 1993; Millsap, 2012). The inability to apply methods like multilevel analyses or a ranking of nations based on the mean values of the dimensions with confidence has implications for future analyses as well (Meitinger et al., 2020).

The following set of hierarchical models can undergo an iterative process of model refinement based on equality constraints to assess their invariance (Kline, 2023). By estimating the same model without imposing any equality constraints across groups, the configural invariance hypothesis (Hform) is evaluated, and the least restrictive model adheres to it. If Hform is rejected, it indicates that invariance is not upheld at any level, whether at the measurement or structural level. Subsequently, examine each factor loading estimated without constraints across the groups to assess the construct-level metric invariance hypothesis, denoted as $H\Lambda$. Assess the less stringent hypothesis, $H\lambda$, by relaxing some but not all of the equality constraints on factor loadings if $H\Lambda$ is rejected. If every iteration of $H\lambda$ is rejected, the process should be terminated. Examining the equivalence of structural model parameters becomes relevant when there is evidence supporting at least some degree of measurement invariance (i.e., $H\ddot{Y}$ or $H\lambda$ is retained). Assessments of moderation, or interaction effects, are essentially examinations for equal direct effects. Specifically, group membership moderates these direct effects if there are noticeable variations in the magnitudes or directions of the structural model's direct effects between the groups.

2.23.9 Multigroup comparison

Behavioral researchers often seek to compare the relationships between two or more constructs (e.g., attitudes, beliefs, emotions) across different groups (e.g., countries or genders). For example, Brandt et al. (2021) investigated how people's feelings of threat relate to political beliefs across 56 countries, while Bastian et al. (2014) explored how the social value of positive emotions influences life satisfaction across 47 countries. SEM, also known as "structural relations," represents the cutting-edge method for analyzing these relationships. SEM permits researchers to test complex path models, including mediation, within a single analysis, rather than conducting several path analyses.

To examine and compare structural relations across multiple groups, researchers can apply multigroup structural equation modeling (multigroup SEM) (Perez Alonso et al., 2024). When analyzing many groups, it is likely for many structural relationships to vary across them. For instance, the association between social determinants of health and individual potentials may differ between countries, depending on their unique contexts and historical backgrounds. However, identifying similarities and differences across groups can be challenging, as it requires a large number of pairwise comparisons (Perez Alonso et al., 2024). For example, analyzing 10 groups would involve 45 pairwise comparisons, while the 56 groups would require as many as 1,540 comparisons (Brandt et al., 2021).

Multi-group comparisons have become increasingly popular across various fields of study due to their ability to identify differences within subgroups that may be overlooked when the entire population is analysed (Matthews et al., 2018). In marketing, for example, these comparisons provide broader insights into consumer behaviour, enabling marketers to design effective strategies and deliver greater value (Cheah et al., 2023). The assumption of homogeneity often falls short in real-world scenarios, as individuals, groups, or organizations may likely differ in their perceptions and evaluations of latent constructs (Sarstedt et al., 2011). According to Becker et al. (2023) and Hair et al. (2019), neglecting population heterogeneity can significantly skew results and lead to incorrect management conclusions when analysing aggregated data. These arguments make it readily apparent why group comparisons are important and necessary.

Multigroup analysis is a widely used method for group comparisons (Cheah et al., 2023). It encompasses advanced techniques commonly applied when researchers aim to explore differences of continuous variables or categorical variables, such as gender or country, between categorized variables through dichotomization or cluster analysis (Hair et al., 2019). By conducting multigroup analysis within partial least squares structural equation modelling, researchers can examine significant differences in the structural paths across different groups (Matthews et al., 2018).

2.24 Conceptual framework

The Meikirch model (Bircher & Kuruvilla, 2014) of holistic health served as the foundation for the conceptual framework of the study. A human being must be able to meet the demands of life in order to be healthy. Each person has biologically given as well as personally acquired potentials for this, both of which are highly correlated with their social and environmental surroundings (Bircher, 2020; Bircher & Kuruvilla, 2014). The resulting complex adaptive system enables the person to emerge with a personal identity and to continue to develop it until death. As a result, the conceptual framework investigates the inter-relationship between the subjective measures of social determinants of health, environmental determinants of health, individual potentials and life demands, and their influence on perceived quality of life. Furthermore, a healthy diet and physical activity were included in the model because of their strong association with quality of life. Figure 2.1 presents the conceptual framework of the study.

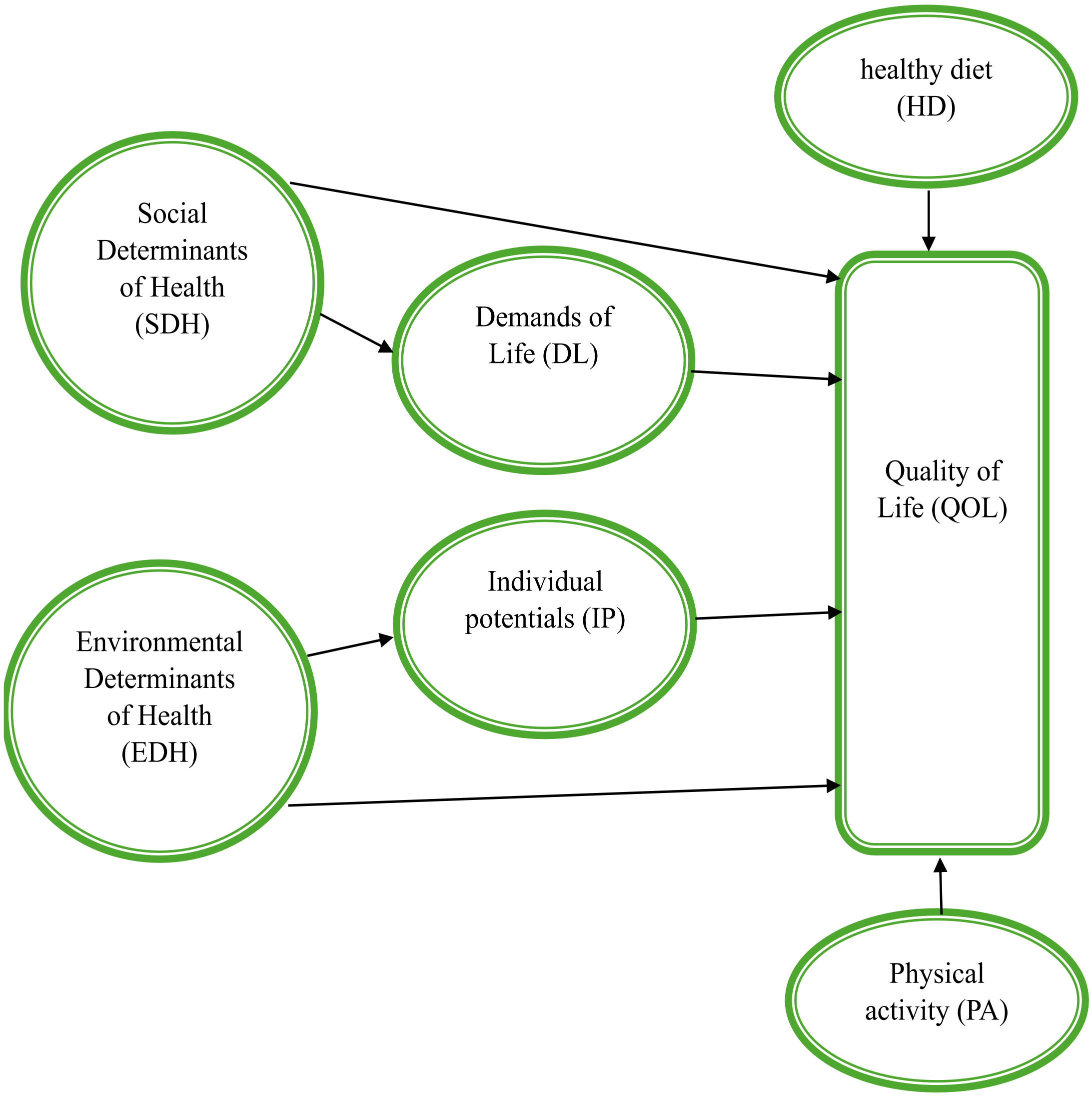

Figure 2.1: Conceptual Framework

Note: DL = demands of life, IP = individual potential, BGP = biologically given potential, PAP = personally acquired potential, QOL = Quality of life.

2.25 Summary of the Literature Review

This chapter has provided a thorough discussion of several definitions of holistic health in relation to historical and contemporary problems. Additionally, we have covered the various components that contribute to holistic health, such as social and environmental determinants of health, individual potentials, life demands, a healthy diet, and physical activity, as well as the related assessment questionnaires for each of these components and how they interact to affect quality of life, as well as the overview of the qualitative and quantitative research methods employed in the present study.

CHAPTER 3

RESEARCH METHOD FOR PHASE I: QUESTIONNAIRE DEVELOPMENT

3.1 Introduction

This study used an exploratory mixed-methods approach to examine its hypotheses. We initially employed qualitative methods to gather pertinent information, which preceded the quantitative phase where we formulated questionnaires. This integration methodology, as opposed to employing independent quantitative and qualitative techniques, facilitated a more thorough and cohesive utilization of data.

In this chapter, we delve into the research methods utilized in Phase 1. During this phase, the researchers focused on generating new items for a newly developed holistic health questionnaire, including social determinants of health (SDH), environmental determinants of health (EDH), demands of life (DL), and individual potentials (IP). The processes involved in this phase included an extensive literature review to identify relevant theories, consultations with experts (from public health, psychology, and questionnaire development), and interviews with the study's target population. Subsequently, we determined the response process validity of the newly generated items using content validity process and face validity process. This phase was conducted over a period from January 2023 to July 2023.

3.2 Development of new questionnaires based on literature search

The initial literature search led to the conclusion that the Meikirch model is currently considered one of the most robust health models, encompassing essential factors that determine holistic health (Bircher, 2020). According to the Meikirch model, health is constituted by four dimensions: SDH, EDH, DL, and IP. The EDH includes two main factors: the natural environment and the physical environment. The DL consists of three components: physiological demands, psychosocial demands, and environmental demands. The IP comprises two components: personally acquired potential and biologically given potential. However, a significant limitation of the Meikirch model is the current unavailability of valid and reliable instruments to assess these dimensions (SDH, EDH, DL, and IP) (Bircher, 2020).

3.2.1 Social determinants of health questionnaire (SDH-Q)

The items SDH-Q were developed based on the conceptual framework developed by World Health Organization Commission on Social Determinants of Health (CSDH) (Solar & Irwin, 2010; WHO CSDH, 2008). The SDH were structured into two main categories: structural determinants of SDH and intermediary determinants of SDH (WHO CSDH, 2008). The items under structural determinants of SDH were designed to assess a variety of factors that create or reinforce social stratification in society and define individuals' socioeconomic positions, such as income, education, occupation, social class, gender, race or ethnicity, and material circumstances. These factors are typically inherited or result from government policies. Conversely, the items under intermediary determinants of SDH were created to evaluate factors such as psychological circumstances, behavioural and/or biological factors, and the healthcare system (Solar & Irwin, 2010).

3.2.2 Environmental determinants of health questionnaire (EDH-Q)

The items for the EDH-Q were generated based on the conceptual model of "Social Determinants of Health and Environmental Health Promotion" developed by Schulz and Northridge (Schulz & Northridge, 2004). The perceived natural environment includes factors such as exposure to extreme weather conditions, the quality and accessibility of drinking water and food, air pollution levels, and the safety of the work environment (Schulz & Northridge, 2004). The perceived built environment involves assessing aspects like housing, land use, infrastructure, transportation, public spaces, schools, and healthcare facilities (Schulz & Northridge, 2004). Previous studies have shown that perceived environmental health refers to individuals' subjective evaluations or opinions regarding the quality, safety, and impact of their immediate surroundings on their overall well-being (Castaldo et al., 2018; Castilla et al., 2017; Gabriel et al., 2021). Individuals' assessments of environmental cleanliness, safety, and risk exposure can directly influence their physical health. Additionally, perceptions of poor air quality, contaminated water sources, and exposure to pollutants or toxins can exacerbate respiratory issues, cardiovascular conditions, and other health problems, thereby affecting the overall quality of life (Bircher, 2020; Castaldo et al., 2018).

3.2.3 Demands of life questionnaire (DL-Q)

Building on the Meikirch model (Bircher, 2020; Bircher & Kuruvilla, 2014), this study proposes that the DL-Q consists of three hypothesized constructs: physiological demands, psychosocial demands, and environmental demands. For the physiological demands, items were generated based on the stress-disease model (Van Heeringen, 2012), commonly used by psychologists and medical professionals to explain how biological predispositions (diathesis) and environmental stressors contribute to the development of certain physiological conditions or disorders. Additional information was sourced from the Physiological Arousal Questionnaire (Dieleman et al., 2010) and the Perceived Physiological Vulnerability to IT Usage Questionnaire (Lin et al., 2020).

For the psychosocial demands, items were developed using the theory guiding the six dimensions of psychosocial well-being by Ryff and Singer (1996). These dimensions include self-acceptance, positive relations with others, autonomy, environmental mastery, purpose in life, and personal growth, emphasizing the interconnectedness of different aspects of life on overall well-being (Ryff & Singer, 1996). Additional information was obtained from the Copenhagen Psychosocial Questionnaire (Burr et al., 2019).

Regarding environmental demands, items were derived from Bronfenbrenner's Ecological Systems Theory (Hertler et al., 2018), which posits that an individual's development is shaped by interconnected systems ranging from the immediate microsystem to the broader macrosystem. In this context, environmental demands encompass expectations and pressures from social spheres such as family, peers, school, and other important relationships (Elliott & Davis, 2020; Hertler et al., 2018). Further information was gathered from the Martin and Park Environmental Demands Questionnaire (Martin & Park, 2003).

3.2.4 Individual potentials questionnaire (IP-Q)

Based on the Meikirch model (Bircher, 2020; Bircher & Kuruvilla, 2014), the present study creates the IP-Q, which posits two hypothetical constructs: biologically given potential and personally acquired potential. For the biologically given potential, the items were generated based on the Health Belief Model (HBM) construct of perceived severity (Champion & Skinner, 2008; Green et al., 2020; Sulat et al., 2018). According to this model, evaluations of potential medical and clinical outcomes (such as mortality, impairment, and discomfort), as well as potential social repercussions (such as effects on employment, family dynamics, and social connections), shape perceptions of the severity of illness or the consequences of not treating it. Perceived threat encompasses both susceptibility and severity (Abraham & Sheeran, 2015; Ritchie et al., 2021). Further insights were obtained from longitudinal studies, indicating that self-perceived health serves as a predictor for the onset of chronic diseases (Allen et al., 2016; Froehlich-Grobe et al., 2016; Shields & Shooshtari, 2001), recovery from illnesses (Latham & Peek, 2013), and deterioration in functional abilities (Assari et al., 2016; Barry et al., 2020; Rnic et al., 2023).

For the personally acquired potential, the items were developed based on the HBM construct of perceived benefits (Champion & Skinner, 2008; Green et al., 2020). This construct suggests that even when individuals recognize their susceptibility to and the severity of a health threat, they are unlikely to adopt a recommended health action unless they perceive it as beneficial in mitigating the threat. Additional information was drawn from Antonovsky's salutogenic model (Antonovsky, 1987), which emphasizes the sense of coherence as a key factor in effective stress management. This model describes a universal perspective in which individuals believe that the stimuli they encounter from both internal and external environments are structured, predictable, and understandable (comprehensibility); that resources are available to meet the demands posed by these stimuli (manageability); and that these demands are meaningful, worthwhile, and deserving of their effort and engagement (meaningfulness) (Dantas, 2007; Eriksson & Lindström, 2005).

3.3 Soliciting professional input

A total of eight professionals (4 from Nigeria and 4 from Malaysia) were approached to solicit their contribution of items related to holistic health, including the SDH, EDH, DL, and IP. The professionals involved four from public health, two from psychology, and two with expertise in psychometric testing. They were briefed about the research aims and objectives, and the definition of the scales and the objective of measurement were explained to these professionals. Also, all the generated items from the literature search were presented to professionals. The experts were encouraged to list any additional items or information relevant to the scales that were not identified in the literature and to provide suggestions to the researchers.

3.4 Interview with the target population

We then used a qualitative method to collect more information on SDH, EDH, DL, and IP from the viewpoints of the participants. We aimed to capture insights on holistic health among Nigerian and Malaysian undergraduate students, which remained undocumented in published resources. The researchers invited a few students from the target population to review and give their input on the study's questionnaire items using an interview script (Appendix A). The main researcher with the assistance of the main supervisor conducted in-depth individual interviews with the participants to gather additional information not found in the literature. We obtained consent beforehand and informed the participants about the tape recording of the interviews. The draft of the interview guide was based on literature and expert opinions. We applied probing questions to encourage participants to elaborate on the issues and maintain focus on their perceptions of achieving holistic health. We also assured participants that their participation was voluntary and they could withdraw from the study at any time without penalty.

3.4.1 Study location

The interviews were conducted at Federal University Dutse (FUD), Nigeria and Universiti Sains Malaysia (USM), health campus, Malaysia

3.4.2 Study design

The interviews employed a qualitative approach, utilizing a semi-structured scale, to delve into students' perceptions regarding holistic health concerning SDH, EDH, DL, and IP.

3.4.3 Reference population

The study includes undergraduate students from the college of medicine and allied medical science at FUD, Nigeria and the health campus of USM, Malaysia.

3.4.4 Target population

The study includes undergraduate students from the college of medicine and allied medical science at FUD, Nigeria and the health campus of USM, Malaysia. Students who are considered active students during data collection.

3.4.5 Sample size

There is no specific sample size estimation needed for this part. According to existing recommendations, for the qualitative part that requires interviewing the participants, there is no fixed number that can ensure the number of interviews is enough to reach data saturation (Guest et al., 2006). Data saturation is reached when there is enough information to replicate the study (O'reilly & Parker, 2013). Hence, we conduct a total of 24 interviews (12 with the Nigerian target population and 12 with the Malaysian target population) to ensure we obtain consistent and rich information from the participants.

3.4.6 Sampling method

We used the purposive sampling approach to select participants from different classes and programs in order to have a representative sample that reflects our target population.

3.4.7 Interview process

We selected an in-depth interview as the preferred qualitative technique. Originally, the interview's content was based on a topic guide derived from literature reviews, and the ideas of eight professionals in the fields of public health, psychology, psychometrics, and questionnaire development served as the basis for the interview's content. We then condensed the guide into a set of open-ended questions. The following four areas were the focus of the interview:

Interview subsection: Social determinants of health (SDH): (1) Briefly describe your understanding of SDH. (2) List the factors that you think can influence the SDH. (3) What improvements do you suggest can be made to these SDHs? Environmental determinants of health (EDH): (1) Briefly describe your understanding of EDH. (2) List the factors that you think can influence the EDH. (3) What improvements do you suggest can be made to these EDHs? Demands of life (DL): (1) Briefly describe your understanding of DL. (2) List the factors that you think can influence the DL. (3) What improvements do you suggest can be made to these DLs? Individual potentials (IP): (1) Briefly describe your understanding of IP. (2) List the factors that you think can influence the IP. (3) What improvements do you suggest can be made to these IPs?

Initially, a list of student representatives was obtained from the Dean of Student Affairs, and we invited the participants by phone call and verbally encouraging them to participate in the study. Next, both parties agreed to schedule a fresh interview session at an appropriate time and date. The researcher requested their meeting in the library section, setting aside a quiet area for the interview. The interview was conducted in the isolation room, which was intended for private meetings and was a calm, empty space. This was the motivation for booking the isolation room, which was empty on the day of data collection. The researcher utilized his own voice recorder, and each room had a table and chair in a typical arrangement.

Each interview occurred in English, lasted between 60 and 90 minutes, and was audio recorded with the respondent's permission. The interviewee meets the researcher and gives a brief introduction before the recording begins. According to the interview outline the researcher had put together before the study started, the interview started with a relevant and interesting topic on the holistic health dimensions. Throughout the session, additional detailed questions were added to gain more insight or clarification on the information that the participants supplied. The final question asked before the session ended was, "Would you like to add more information?" Finally, the researcher further expressed his gratitude to the respondent for participating in the interview.

3.4.8 Guidelines for interviews

A literature search and recommendations from experts in the relevant field were utilized in developing the study interview guide, which included conceptual questions about the variables to be measured that the researchers needed to investigate. Before the study began, items were enumerated and categorized into a few key areas that needed to cover different aspects of holistic health. Also, prior to being utilized in the larger study, the interview guide was initially tested and enhanced on four participants—two from Malaysia and two from Nigeria—through a pilot study. This contributes to improving the data's quality (Gillham, 2005; Potter & Hepburn, 2005). In order to enhance the interview guide and interview method, participants were invited to provide comments at the conclusion of each session. As a result, changes were made appropriately.

3.4.9 Qualitative data analysis

Subsequently, the audio recordings and supplementary notes made during the interviews were used to manually transcribe each interview. A different researcher individually examined the transcripts for authenticity as part of quality control. The initial content analysis used a quantitative technique to determine the number of instances (frequency and percentages) of phrases or terms essential to the pre-established ideas of holistic health. We then used the repetitions of interested statements to identify shared concepts. The interview responses were then coded according to the predetermined ideas, and aggregation quotes were used to apply concept categorizations. The encoded data was organized using Microsoft Word (365), and descriptive data analysis was carried out using Microsoft Excel (365).

The researcher analyzed the interview scripts by employing an inductive methodology, with thematic codes to identify trends in the scripts (Bowen, 2009). To create a transcript for a word processing file, the material was manually and verbatim transcribed from recorded audio into a Word document. To make data analysis easier, field notes, participant profiles, and interview transcripts were all arranged properly in supplementary files. Following transcription, the data was coded and examined. According to Corbin and Strauss (2014), the coding process includes drawing conclusions and creating ideas from information. These procedures were carried out right away following every in-depth interview. With recurrent actions of hearing and reviewing the transcribed interviews, the transcription process not only helped the researcher get acquainted with the information at hand, but it additionally permitted the researcher to comprehend the topic more (Barbour, 2013).

Once we transcribed the complete data, we initiated data coding. Barbour (2013) posit that the application of codes, described as keywords used to classify or arrange text, is a crucial component of qualitative research. After interpreting and categorizing the codes, we mapped them to reveal trends and relationships. Subsequently, the data underwent further analysis, leading to the creation of themes and sub-themes. This led to the finalisation of the resulting themes and sub-themes.

Four key factors needed to be considered to determine the validity of the qualitative results: subjectivity, respondent validation, rigor, and credibility. The goal was to accurately capture the participants' experiences and ensure the researcher's trust in their data (Polit & Beck, 2010; Speziale et al., 2011). We implemented measures to maintain this level of rigor throughout the investigation and participant feedback process. We used interview questioning and a summary at the end of each session to validate respondents' answers. The validity of the findings was scrutinized with regard to subjectivity. At times, we sought guidance from qualitative specialists to streamline this process. Thus, we incorporated all four factors into the investigation to enhance the validity of the findings.

3.4.10 Development and listing of items

The purpose of the qualitative interview and literature search was to gain an understanding of holistic health and identify potential components for the newly established scales. The information acquired during the literature search helped to clarify the domain identification for every scale of interest. Based on the aforementioned problem, the recommendations provided by the stated conceptual frameworks, and a literature search, the following primary domains were determined and accepted: (1) The SDH domains were (a) structural determinants of SDH and (b) intermediary determinants of SDH; (2) The EDH domains were (a) natural EDH and (b) built EDH; (3) The DL domains were (a) physiological demands, (b) psychosocial demands, and (c) environmental demands; and (4) The IP domains were (a) biologically given potentials and (b) personally acquired potentials.

3.5 Response rating

In the present study, the response ratings for the newly established scales (SDH, EDH, DL, and IP) were based on the Vagias (2006) Likert response ratings. For the SDH, the structural determinants were assessed using a Likert option ranging from 1 (totally unsatisfied) to 5 (totally satisfied), while the intermediary determinants were assessed using a Likert option ranging from 1 (very poor) to 5 (very good). For EDH, both the natural and built environment domains were assessed using five rating options ranging from 1 (strongly disagree) to 5 (strongly agree). For DL, both the physiological, psychosocial, and environmental demand domains were evaluated using a five-point rating ranging from 1 (not at all) to 5 (almost every day). For the IP, the items were assessed using four rating options, ranging from 1 (none) to 4 (severe) for biologically given potential domain and from 1 (not at all) to 4 (very often) for personally acquired potential domain.

3.6 Response process validity

In this section, we illustrate the process of content validity and face validity of the newly developed scales (SDH, EDH, DL, and IP) to answer objective 2 of the study.

3.6.1 Content validity process

A total of 12 experts (i.e., 6 from Nigeria and 6 from Malaysia) in the fields of health psychology (2 experts each), public health (2 experts each), and questionnaire development (2 experts each) were invited to assess the relevance of each item to its respective domain. Using a Google Form (Appendix B), these experts rated each item's relevance on a scale of four options: (1) not relevant, (2) somewhat relevant, (3) quite relevant, and (4) highly relevant. The Item Content Validity Index (I-CVI) and Scale Content Validity Index (S-CVI) were calculated according to recommended guidelines (Lynn, 1986; Polit & Beck, 2006; Polit et al., 2007).

In this study, a non-face-to-face method was employed, utilizing a Google form distributed to the experts along with clear instructions to facilitate the content validation process. Experts were tasked with rating each questionnaire item based on four criteria: (i) not relevant to the measured domain, (ii) somewhat relevant to the measured domain, (iii) relevant to the measured domain, and (iv) highly relevant to the measured domain.

Relevance ratings were recoded as either 1 (indicating the item is quite relevant or highly relevant) or 0 (indicating the item is not relevant or somewhat relevant). The I-CVIs were calculated by the proportion of experts who rated items as 1 for relevance. The S-CVIs were calculated by averaging the I-CVIs for all items within each domain. Finally, the Scale Content Validity Index for Universal Agreement (S-CVI/UA) was calculated by determining the proportion of items on the scale that received a rating of 1 from all experts. Table 3.1 outlines the recommended number of professionals and its implications for establishing an acceptable cut-off score for the CVI. Since the current study relied on ratings from six experts independently from Nigeria and Malaysia, a cutoff of ≥ 0.83 was selected to determine the CVI.

Table 3.1: The number of professionals and how that affects the required CVI values

Professionals	Recommended CVI scores	Source
2 professionals	≥ 0.80	Davis (1992)
3 – 5 professionals	1.00	Polit and Beck (2006); Polit et al. (2007)
6 professionals	≥ 0.83	Polit and Beck (2006); Polit et al. (2007)
6 – 8 professionals	≥ 0.83	Lynn (1986)
9 professionals	≥ 0.78	Lynn (1986)

3.6.2 Face validity process

A total of 20 students (i.e., 10 from Nigeria and 10 from Malaysia) were selected using a purposive sampling to select two students from each study year at the College of Medicine and Allied Medical Sciences, FUD and USM, health campus. This is to ensure equal representations from each year of study. These students assessed the clarity and comprehensibility of each item via a Google Form (Appendix C), rating them on a four-point scale: (1) not clear and understandable, (2) somewhat clear and understandable, (3) clear and understandable, and (4) very clear and understandable. Following recommended guidelines (Marzuki et al., 2018; Yusoff, 2019b), we calculated the Item Face Validity Index (I-FVI) and Scale Face Validity Index (S-FVI).

To facilitate the face validation procedure, we distributed a Google form to the students, accompanied by explicit instructions. Participants were instructed to evaluate each questionnaire item based on four criteria: (i) lack of clarity and understanding in relation to the measured domain; (ii) partial clarity and understanding in relation to the measured domain; (iii) clarity and understanding in relation to the measured domain; and (iv) high clarity and understanding in relation to the measured domain.

We recoded the relevance ratings as 1 (the item is clear and understandable, or very clear and understandable) or 0 (the item is not clear and understandable, or somewhat clear and understandable). The I-FVIs were calculated by determining the proportion of students who rated each item as 1. S-FVIs were obtained by averaging the I-FVIs for all items within each domain. Lastly, we calculated the Scale Face Validity Index for Universal Agreement (S-FVI/UA) by determining the proportion of items on the scale that received a rating of 1 from all students. Table 3.2 outlines the recommended number of participants and its implications for establishing an acceptable cut-off score for the FVI. Since the current study relied on ratings from 10 students independently from Nigeria and Malaysia, a cutoff of ≥ 0.83 was selected to determine the FVI.

Table 3.2: The number of participants and how that affects the FVI acceptable cut-off values

Method	Participants	Recommended FVI scores	Source
Face to face survey	30 medical students	≥ 0.80	Hadie et al. (2017)
Face to face survey	30 paramedics	≥ 0.83	Ozair et al. (2017)
Face to face survey	30 parents of pre-school children	≥ 0.80	Lau et al. (2017)
Face to face survey	30 parents of pre-school children	≥ 0.80	Lau et al. (2018)
Online survey	10 users of medical apps	≥ 0.83	Marzuki et al. (2018)
Online survey	32 medical students	≥ 0.80	Chin et al. (2018)
Online survey	32 medical students	≥ 0.80	Mahadi et al. (2018)

CHAPTER 4

RESULTS OF PHASE 1

4.1 Introduction

This chapter presents the results of the study obtained in phase I, which is questionnaire development and response process validity among experts and undergraduate students from Nigeria and Malaysia. The chapter is organized into seven main sections: (1) questionnaire development and item generation; (2) presentation of the holistic health questionnaires; (3) content validity results of Nigerian experts; (4) content validity results of Malaysian experts; (5) face validity results of Nigerian undergraduate students; (6) face validity results of Malaysian undergraduate students; and (7) summary.

4.2 Questionnaire development and items generation

The newly developed questionnaires encompass social determinants of health (SDH), environmental determinants of health (EDH), demands of life (DL), and individual potential (IP). The constructs and items for each questionnaire were derived from a literature review, expert input from Nigeria and Malaysia, and in-depth interviews conducted with undergraduate students from the College of Medicine and Allied Medical Sciences at FUD, Nigeria, and the Health Campus at USM, Malaysia.

The initial section of the study scales collects demographic information, including age, gender, ethnicity, field of study, year of study, frequency of exercise, and duration of exercise. We included details about the students' physical activity levels to give insight into their lifestyles. After completing the questionnaire development process, the SDH scale comprised 20 items, the EDH scale included 18 items, the DL scale also contained 18 items, and the IP scale consisted of 14 items. Table 4.1 below shows the number of constructs and items for each questionnaire.

Table 4.1: Summary of the number of constructs and items in the newly developed holistic health questionnaires

Questionnaire	Construct	Number of items
Social determinants of health		20
	Structural determinants of SDH	10
	Intermediary determinants of SDH	10
Environmental determinants of health		18
	Natural environment	8
	Built environment	10
Demands of life		18
	Physiological demands	6
	Psychosocial demands	6
	Environmental demands	6
Individual potential		14
	Biologically given potential	6
	Personally acquired potential	8

4.3 Holistic health questionnaires

In this section, we present the finalized items and constructs of the newly developed holistic health questionnaires, following extensive literature reviews, experts' input, and interviews. Table 4.2 details the items and constructs of the SDH questionnaire. Table 4.3 details the items and constructs of the EDH questionnaire. Table 4.4 details the items and constructs of the DL questionnaire. Table 4.5 details the items and constructs of the IP questionnaire. For the complete versions of the study questionnaires, including instructions and rating options, refer to Appendix D.

Table 4.2: The items and constructs of the social determinants of health questionnaire (SDHQ)

	Structural determinants
1	How satisfied are you with your gender?
2	In terms of all the opportunities in your community, how would you evaluate gender equality?
3	How satisfied are you with your ethnic background?
4	In terms of all the opportunities in your community, how would you evaluate ethnic equality?
5	How satisfied are you with your present financial income?
6	How do you rate your financial opportunities in the future?
7	How satisfied are you with your present education?
8	How do you rate your employment opportunity in the future?
9	How satisfied are you with your present standard of living?
10	How do you rate the government's effort towards improving your standard of living?
	Intermediary determinants
11	How do you rate the state of your current housing or accommodations?
12	How do you rate the availability of healthy food or safe water in your neighbourhood?
13	How do you rate the support you received from your family members?
14	How do you rate the support you received from your friends?
15	How do you rate the state of your mental health?
16	How do you rate the state of your physical health?
17	How would you rate your good lifestyle habits, such as healthy eating?
18	How do you rate the quality of the health system services in your community?
19	How do you rate your access to health services when needed?
20	How do you rate the affordability of health services in your community?

Table 4.3: The items and constructs of the environmental determinants of health questionnaire (EDHQ)

	Natural environment
1	The weather is always favourable
2	There is assistance available during extreme weather
3	There is always safe drinking water available
4	I always have access to clean drinking water
5	Fresh, healthy foods are always available
6	I can always afford fresh, healthy foods
7	There is always fresh air without any sign of pollution
8	The workplaces are very safe
	Built environment
9	There is appropriate land use protection for residential purposes in my neighbourhood
10	There is appropriate land use protection for industrial purposes in my neighbourhood
11	Transportation systems, either public or private, are always convenient
12	There are sufficient locations to make purchases, including markets or shops
13	There are sufficient banks or other places for cash transactions
14	There are sufficient healthcare facilities in my neighbourhood
15	In my neighbourhood, waste products are properly disposed
16	Public places like parks, museums, or libraries are available for use
17	The quality of the living environment is good in my neighbourhood
18	The quality of the school environment is good in my neighbourhood

Table 4.4: The items and constructs of the demands of life questionnaire (DLQ)

	Physiological demands
1	How frequently do you experience respiratory issues, such as difficulty in breathing?
2	How frequently do you have problems digesting and eliminating food or water?
3	How often do you feel pain in your eyes either during or after your regular activities?
4	How frequently do you have headaches when engaging in daily activities?
5	How frequently do your hands and/or legs hurt during or after performing daily activities?
6	How often does your neck, shoulder, or back hurt while performing your daily activities?
	Psychosocial demands
7	How frequently do you feel good about yourself considering your past and/or present circumstances?
8	How often do you feel satisfied with your interactions with colleagues (e.g., their support of you, and/or your support towards them)?
9	How often do you feel confident in your ability to make the right decisions for yourself?
10	How frequently do you handle unforeseen circumstances in your environment calmly?
11	How often do you think your life goals are on track?
12	How frequently do you consider your life's progress?
	Environmental demands
13	On average, how often are you busy?
14	How frequently do you feel like you have too much to do each day?
15	How frequently do you miss classes because you're too busy?
16	How frequently do you rush to get to school in the mornings?
17	How frequently do you wake up in the morning or fall asleep at your scheduled time?
18	How often do you eat all your meals on time?

Table 4.5: The items and constructs of the individual potential questionnaire (IPQ)

	Biologically given potential
1	Do you have any chronic health conditions that you developed as a child?
2	During your early childhood, did you have any challenges because of your health condition?
3	Do you have any health issues right now?
4	Do you have any chronic conditions right now?
5	Do you have any long-standing chronic conditions that have been present for at least six months?
6	Do you have any chronic conditions that are limiting your daily activities?
	Personally acquired potential
7	Do you believe that you can accomplish your life goals regardless of the circumstances?
8	Do you feel that the changes in the past have made your situation unpleasant?
9	When you are in an unfamiliar situation, does it affect your normal activities?
10	How well do you solve your issues when faced with a challenge?
11	Do you believe that your state of happiness may be affected by pain or health issues?
12	How often do you experience regret over your past?
13	How often do you feel bad about your future?
14	How often do you feel in control of the conditions in your life?

4.4 Content validity among Nigerian experts

All six invited experts from Nigeria provided responses, resulting in a 100% response rate. Therefore, we established the content validity of the SDHQ, EDHQ, DLQ, and IPQ using the I-CVs and S-CVIs. For SDHQ, the I-CVIs ranged from 0.83 to 1, and the S-CVIs were 0.93 and 0.95 (as displayed in Table 4.6).

Table 4.6: Summary of CVI for the SDHQ (Nigerian experts)

Constructs	Items	I-CVI	S-CVI/Ave	S-CVI/UA
Structural determinants of SDH	10	0.83 – 1.00	0.93	0.50
Intermediary determinants of SDH	10	0.83 – 1.00	0.95	0.73

For the EDHQ, all items received uniform ratings of 1.00 I-CVIs. Similarly, the S-CVIs were 1.00 for both the natural environment and the built environment domains, respectively (as displayed in Table 4.7).

Table 4.7: Summary of CVI for the EDHQ (Nigerian experts)

Constructs	Items	I-CVI	S-CVI/Ave	S-CVI/UA
Natural environment	8	1.00	1.00	1.00
Built environment	10	1.00	1.00	1.00

For DLQ, the I-CVIs ranged from 0.83 to 1, and the S-CVIs ranged from 0.97 to 1.00 (as displayed in Table 4.8).

Table 4.8: Summary of CVI for the DLQ (Nigerian experts)

Constructs	Items	I-CVI	S-CVI/Ave	S-CVI/UA
Physiological demands	6	1.00	1.00	1.00
Psychosocial demands	6	0.83 – 1.00	0.97	0.83
Environmental demands	6	1.00	1.00	1.00

For IPQ, the I-CVIs ranged from 0.83 to 1, and the S-CVIs ranged from 0.98 to 1.00 (as displayed in Table 4.9).

Table 4.9: Summary of CVI for the IPQ (Nigerian experts)

Constructs	Items	I-CVI	S-CVI/Ave	S-CVI/UA
Biologically given potential	6	1.00	1.00	1.00
Personally acquired potential	8	0.83 – 1.00	0.98	0.88

4.5 Content validity among Malaysian experts

All six invited experts from Malaysia provided responses, resulting in a 100% response rate. For SDHQ, the I-CVIs ranged from 0.83 to 1, and the S-CVIs were 0.97 and 0.98 (as displayed in Table 4.10).

Table 4.10: Summary of CVI for the SDHQ (Malaysian experts)

Constructs	Items	I-CVI	S-CVI/Ave	S-CVI/UA
Structural determinants of SDH	10	0.83 – 1.00	0.97	0.40
Intermediary determinants of SDH	10	0.83 – 1.00	0.98	0.90

For the EDHQ, the I-CVIs ranged from 0.83 to 1, and the S-CVIs were 1.00 and 0.95 (as displayed in Table 4.11).

Table 4.11: Summary of CVI for the EDHQ (Malaysian experts)

Constructs	Items	I-CVI	S-CVI/Ave	S-CVI/UA
Natural environment	8	1.00	1.00	1.00
Built environment	10	0.83 – 1.00	0.95	0.70

For DLQ, the I-CVIs ranged from 0.83 to 1, and the S-CVIs ranged from 0.83 to 1.00 (as displayed in Table 4.12).

Table 4.12: Summary of CVI for the DLQ (Malaysian experts)

Constructs	Items	I-CVI	S-CVI/Ave	S-CVI/UA
Physiological demands	6	1.00	1.00	1.00
Psychosocial demands	6	1.00	1.00	1.00
Environmental demands	6	0.83 – 1.00	0.97	0.83

For IPQ, the I-CVIs ranged from 0.83 to 1, and the S-CVIs ranged from 0.98 to 1.00 (as displayed in Table 4.13).

Table 4.13: Summary of CVI for the IPQ (Malaysian experts)

Constructs	Items	I-CVI	S-CVI/Ave	S-CVI/UA
Biologically given potential	6	1.00	1.00	1.00
Personally acquired potential	8	0.83 – 1.00	0.98	0.88

4.6 Face validity among Nigerian undergraduate students

All 10 selected undergraduate students from Nigeria provided responses, resulting in a 100% response rate. Therefore, we established the face validity of the SDHQ, EDHQ, DLQ, and IPQ using the I-FVs and S-FVIs. For SDHQ, the I-FVIs ranged from 0.90 to 1, and the S-FVIs were 0.98 and 1.00 (as displayed in Table 4.14).

Table 4.14: Summary of FVI for the SDHQ (Nigerian students)

Constructs	Items	I-FVI	S-FVI/Ave	S-FVI/UA
Structural determinants of SDH	10	0.90 – 1.00	0.98	0.80
Intermediary determinants of SDH	10	1.00	1.00	1.00

For EDHQ, the I-FVIs ranged from 0.90 to 1, and the S-FVIs were 0.99 and 1.00 (as displayed in Table 4.15).

Table 4.15: Summary of FVI for the EDHQ (Nigerian students)

Constructs	Items	I-FVI	S-FVI/Ave	S-FVI/UA
Natural environment	8	0.90 – 1.00	0.99	0.88
Built environment	10	1.00	1.00	1.00

For DLQ, the I-FVIs were all equal to 1.00, and similarly, the S-FVIs were all equal to 1.00 (as displayed in Table 4.16).

Table 4.16: Summary of FVI for the DLQ (Nigerian students)

Constructs	Items	I-FVI	S-FVI/Ave	S-FVI/UA
Physiological demands	6	1.00	1.00	1.00
Psychosocial demands	6	1.00	1.00	1.00
Environmental demands	6	1.00	1.00	1.00

For IPQ, the I-FVIs were all equal to 1.00, and similarly, the S-FVIs were all equal to 1.00 (as displayed in Table 4.17).

Table 4.17: Summary of FVI for the IPQ (Nigerian students)

Constructs	Items	I-FVI	S-FVI/Ave	S-FVI/UA
Biologically given potential	6	1.00	1.00	1.00
Personally acquired potential	8	1.00	1.00	1.00

4.7 Face validity among Malaysian undergraduate students

All 10 selected undergraduate students from Malaysia provided responses, resulting in a 100% response rate. For SDHQ, the I-FVIs were all equal to 1.00 and the S-FVIs were 1.00 (as displayed in Table 4.18).

Table 4.18: Summary of FVI for the SDHQ (Malaysian students)

Constructs	Items	I-FVI	S-FVI/Ave	S-FVI/UA
Structural determinants of SDH	10	1.00	1.00	1.00
Intermediary determinants of SDH	10	1.00	1.00	1.00

For EDHQ, the I-FVIs ranged from 0.90 to 1.00, and the S-FVIs ranged from 0.99 to 1.00 (as displayed in Table 4.19).

Table 4.19: Summary of FVI for the EDHQ (Malaysian students)

Constructs	Items	I-FVI	S-FVI/Ave	S-FVI/UA
Natural environment	8	1.00	1.00	1.00
Built environment	10	0.90 - 1.00	0.99	0.90

For DLQ, the I-FVIs were all equal to 1.00, and similarly, the S-FVIs were all equal to 1.00 (as displayed in Table 4.20).

Table 4.20: Summary of FVI for the DLQ (Malaysian students)

Constructs	Items	I-FVI	S-FVI/Ave	S-FVI/UA
Physiological demands	6	1.00	1.00	1.00
Psychosocial demands	6	1.00	1.00	1.00
Environmental demands	6	1.00	1.00	1.00

For IPQ, the I-FVIs were all equal to 1.00, and similarly, the S-FVIs were all equal to 1.00 (as displayed in Table 4.21).

Table 4.21: Summary of FVI for the IPQ (Malaysian students)

Constructs	Items	I-FVI	S-FVI/Ave	S-FVI/UA
Biologically given potential	6	1.00	1.00	1.00
Personally acquired potential	8	1.00	1.00	1.00

4.8 Summary

In this chapter, we have presented the results of content and face validity based on ratings from experts and undergraduate students from Nigeria and Malaysia. The findings of all the CVI values satisfied the required cutoff of 0.83 (for six experts) (Polit et al., 2007). Also, the FVI values satisfied the required cutoff of 0.83 (for 10 raters) (Marzuki et al., 2018).

CHAPTER 5

RESEARCH METHOD FOR PHASES II AND III: VALIDATION STUDY AND STRUCTURAL RELATIONSHIP STUDY

5.1 Introduction

This chapter demonstrates the process involved in phases II and III, which is validation (exploratory and confirmatory) study to validate the questionnaires developed in phase I and examine their relationships with healthy diet, physical activity, and quality of life among the Nigerian and Malaysian samples (structural relationships, invariance, and multigroup comparison). We discussed the methods for the two phases together because the same method was applied for phases II and III; ultimately, this will prevent repetitions of information. The chapter covers the methods employed for EFA, CFA, reliability measures, including Cronbach's alpha, composite reliability, and test-retest for the newly developed scales, structural equation modelling (SEM), invariance test, and multigroup comparison of SEM models. It is divided into the following sections: study design, study location, study duration, study population and sample, sampling method, sample size determination, research measures, participant recruitment, data collection, data management, and statistical analyses conducted for Phases II and III.

5.2 Study design

The study addressed the Phases II and III research objectives (objectives 4 to 11) by using a cross-sectional design. In this phase, we obtained all the necessary parameters using the questionnaires developed in phase I.

5.3 Study population

5.3.1 Reference population

Malaysian and Nigerian medical and health sciences undergraduate university students.

5.3.2 Source population

All undergraduate students at the College of Medicine and Allied Medical Sciences, FUD, Nigeria and those from the Health Campus, USM, Malaysia, who are registered students during the data collection made up the source population. These participants were chosen because they are more likely to understand the fundamental concepts and constructs being assessed.

In Nigeria's public universities, students come from various regions across the country, reflecting the nation's rich cultural and ethnic diversity (Udo, 2023). Universities strive to maintain a balanced student body by admitting applicants from different states and regions to promote inclusivity and diversity (Udo, 2023). Consequently, the sample in this study represents diverse regional backgrounds. Similarly, Malaysian universities constitute multiculturalism (Koh & Harris, 2020). Koh and Harris (2020) argue that universities in Malaysia serve as critical spatiotemporal settings that foster youth engagement in "multicultural reflexivity." This concept refers to the ability to critically assess past encounters with racism and intercultural harmony, influencing one's current and future views and actions regarding multiculturalism.

5.3.3 Sampling frame

The study participants were those students taking lectures in 2023/2024 who met the study inclusion criteria.

5.4 Inclusion and exclusion criteria

Undergraduate students in the College of Medicine and Allied Medical Sciences, FUD and Health Campus, USM, who were in their first to final year, participants who were considered active students during data collection, participants who were present during data collection time, and participants who consented to participation. All foreign students were excluded.

5.5 Study participants

The study involves undergraduate students from the College of Medicine and Allied Medical Sciences, FUD, Nigeria and Health Campus, USM, Malaysia, who have volunteered and are eligible to participate.

5.6 Sampling method

The study employed a convenience sampling method to recruit participants from the College of Medicine and Allied Medical Sciences at FUD, Nigeria and Health Campus, USM. This approach was chosen for its accessibility, ease, and cost-effectiveness, making it suitable for exploratory studies, pilot studies, or preliminary investigations where the primary goal is to gain initial insights or generate hypotheses (Andrade, 2021).

5.7 Sample size

The sample size was calculated for each specific objective necessary to adequately represent the population of interest. The sample size determination for each objective related to the Phases II and III study is described below.

5.7.1 Sample size for objectives 4 and 6

For EFA, the minimum recommended sample size is between 100 and 250 (Kyriazos, 2018). In this study, we initially set the minimum sample size for EFA at 200. To account for missing values, we added 30%, resulting in an adjusted sample size of 286. Consequently, we rounded the sample size to a total of 300 for EFA in these objectives. Additionally, according to Tabachnick et al. (2013), an acceptable sample size for EFA is 300. Therefore, a total of 600 samples (i.e., 300 from FUD, Nigeria, and 300 from USM, health campus) were used for EFA in the present study. Additionally, the EFA was performed separately for the Nigerian and Malaysian students using a sample of 300 participants from each country.

For CFA, the recommended minimum sample size for seven or fewer constructs is 300 (Hair et al., 2006). In these objectives, we set the sample size for CFA at 300. To account for missing values, we added 30%, resulting in an adjusted sample size of 430. Therefore, a total of 860 samples (i.e., 430 from FUD, Nigeria, and 430 from USM, health campus) were used for CFA in the present study. Additionally, the CFA was performed separately for the Nigerian and Malaysian students using a sample of 430 participants from each country.

5.7.2 Sample size for objectives 5 and 7

The sample size estimation for internal consistency reliability was done using the sample size calculator by Arifin (2018). The parameters used were: Cronbach's alpha (Ho) = 0.70 (the lowest acceptable Cronbach's alpha value), Cronbach's alpha (H1) = 0.85 (the expected value of Cronbach's alpha), significance value (α) = 0.05, power of the study ($1 - \beta$) = 0.80, number of items = 20 (the highest number of items from the SDH questionnaire). The calculated sample size was 37, and after adding anticipated dropout rate of 30%, the adjusted sample size was 53. Therefore, the sample size was based on the estimated 300 samples from EFA above for each objective. This means that the 300 samples estimated in objectives 4 and 6 (EFA part) above was used to determine the internal consistency of the scales based on Cronbach's alpha. Sample size estimation for test-retest reliability was performed using the sample size calculator. The parameters used were: observations (n) = 2 (number of repeated observations), significance level (α) = 0.05, study power (1 – β) = 0.80, minimum acceptable reliability (Po) = 0.60, expected reliability (P1) = 0.80, and an anticipated dropout rate of 30%. The calculated sample size was 70. Therefore, a total of 140 participants (i.e., 70 from FUD, Nigeria and 70 from USM, health campus) were re-invited to complete the study questionnaires twice at a 7-day interval. For composite reliability, the sample size was based on the estimated 430 samples from objectives 4 and 6 above (CFA part).

5.7.3 Sample size for objectives 8 and 9

According to Kline (2023) the median sample size for studies utilizing structural equation modelling (SEM) is 200 cases, based on a review of studies. However, this number can vary depending on the model's complexity. Consequently, a minimum sample size of 200 was set for each of these objectives. Further estimation of the sample size was performed using a Monte Carlo simulation in Mplus 8. The estimated standardized path regression coefficient was set at 0.2, representing the lowest acceptable effect (Kline, 2023). The initial sample size for the simulation was 200, which achieved a minimum power of 53.8%. To enhance the study's power, the simulation was repeated with a larger sample size (see Table 5.1). The final sample size was determined to be 400, yielding a minimum power of 81.8%. After accounting for 30% of the missing values, the adjusted sample size was 570. Hence, a total of 1140 (i.e., 570 from FUD, Nigeria and 570 from USM, health campus) were recruited to answer these objectives.

Table 5.1: Computed sample size and related power for study for Nigerian and Malaysia samples

Sample size	Minimum power
200	53.8%
250	61.4%
300	70.6%
350	77.0%
400	81.8%

5.7.4 Sample size for objective 10

The sample size for the invariance testing was based on the 430 samples of CFA estimated above. Hence, a total of 860 samples (i.e., 430 from FUD, Nigeria, and 430 from USM, health campus) were used to answer this objective.

5.7.5 Sample size for objective 11

The sample size for the SEM multigroup comparison was based on the 570 samples of SEM estimated above. Hence, a total of 1140 samples (i.e., 570 from FUD, Nigeria, and 570 from USM, health campus) were used to answer this objective.

In summary, the total estimated sample size for the present study was 1300 from FUD, Nigeria (EFA: 300 + CFA: 430 + SEM: 570) and 1300 from USM, health campus (EFA: 300 + CFA: 430 + SEM: 570), amounting to a total of 2600.

5.8 Measurement scales

The questionnaires included socio-demographic characteristics and seven scales. The seven scales were (1) social determinants of health questionnaire (SDHQ), (2) environmental determinants of health questionnaire (EDHQ), (3) demands of life questionnaire (DLQ), (4) individual potentials questionnaire (IPQ), (5) short-form healthy eating assessment scale (SFHEA), (6) International Physical Activity Questionnaire (IPAQ), and (7) Youth Quality of Life Short-Form (YQOL-SF).

5.8.1 Socio-demographic information

The demographic section covered age, gender, ethnicity, field of study, year of study, frequency of exercise, and duration of exercise. The study presented the additional information about the students' physical activity levels to gain insights into their lifestyles.

5.8.2 Social determinants of health questionnaire (SDHQ)

The SDHQ consists of 20 items hypothesized to measure two underlying constructs: the structural determinants of SDH (10 items) and the intermediary determinants of SDH (10 items). The items related to structural determinants evaluate factors that create or reinforce social stratification in society and define individuals' socioeconomic positions using a Likert scale ranging from 1 (totally unsatisfied) to 5 (totally satisfied). On the other hand, the intermediary determinants assess psychosocial circumstances, the individual's environment, and the health care system using a Likert scale ranging from 1 (very poor) to 5 (very good).

5.8.3 Environmental determinants of health questionnaire (EDHQ)

The EDHQ consists of 18 items hypothesized to measure two underlying constructs: the natural environment (8 items) and the built environment (10 items), using a five-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). The perceived natural environment covers physical exposures, including extreme weather conditions, the quality and accessibility of drinking water and food, air pollution, and workplace safety. In contrast, the perceived built environment evaluates various factors such as housing, land use, infrastructure, transportation, public spaces, schools, and healthcare facilities.

5.8.4 Demands of life questionnaire (DLQ)

The DLQ consists of 18 items hypothesized to measure three underlying constructs: physiological demand (6 items), psychosocial demand (6 items), and environmental demand (6 items), using a five-point scale ranging from 1 (not at all) to 5 (very often). Physiological demands can take many forms for humans, including input, output, and reproduction-related activities. Psychosocial demands pertain to an individual's social integration and personal development, encompassing their involvement in political, cultural, and social activities. Environmental demands refer to self-reported feelings of being busy stemming from personality traits that seem to equate demand with any environment.

5.8.5 Individual potentials (IPQ)

The IPQ consists of 14 items hypothesized to measure two underlying constructs: the biologically given potential (6 items) and the personally acquired potential (8 items), using four rating options ranging from 1 (none) to 4 (severe) for biologically given potential and from 1 (not at all) to 4 (very often) for personally acquired potential. The biologically given potentials are designed to assess an individual's present health status and its potential impact on their daily functioning. The personally acquired potential items are designed to evaluate an individual's sense of coherence across past, present, and future contexts.

5.8.6 Short-form healthy eating assessment scale (SFHEA)

The SFHEA is an efficient tool for assessing dietary patterns, calculating a health benefit score, and initiating discussions about healthy eating to prevent chronic diseases (Paxton et al., 2011). The SFHEA includes 10 questions with Likert scale options ranging from 1 to 5. Scores from each item are summed to create a total score ranging from 10 to 50, where higher scores indicate a more healthful diet and lower scores highlight areas needing improvement. A score of 10–19 suggests a need for significant improvement; 20–29 indicates a fair diet; 30–39 indicates a good diet; and

40–50 reflects an excellent diet. The SFHEA items and the total score are moderately intercorrelated ($r = 0.39–0.59$, $p<0.05$) (Paxton et al., 2011).

5.8.7 International Physical Activity Questionnaire (IPAQ)

The IPAQ was used to evaluate the participants' intensity of physical activity and their daily sitting time (Craig et al., 2003). The total amount of physical activity was estimated in MET-minutes per week, along with the time spent sitting. Students reported their physical activity over the past seven days. The test-retest reliability was established with a Cronbach's alpha of 0.80 (Craig et al., 2003). In addition, the IPAQ has been tested and validated in Nigeria (Oyeyemi et al., 2014) and Malaysia (Shamsuddin et al., 2015).

Participants were encouraged to respond to each question, regardless of whether they considered themselves active. We obtained the total physical activity score by summing the product of 3.3 days and minutes spent walking or engaging in mild activities (Q1 and Q2), 4.0 days and minutes spent in moderate activities (Q3 and Q4), and 8.0 days and minutes spent in vigorous activities (Q5 and Q6) (Craig et al., 2003). We adjusted the total physical activity score (IPAQ score) for each participant in the SEM analysis by dividing it by a constant (1000) to rescale it. Due to the potential for total IPAQ scores exceeding 100, there was a risk of significant variability in physical activity variables, leading to the termination of the analysis in Mplus.

Also, it is recommended to convert all activities to minutes before calculating MET minutes, as using hours will lead to inaccurate results. Activity sessions shorter than 10 minutes are not counted, and sessions longer than 3 hours are truncated, meaning no activity bout can exceed 3 hours (180 minutes). Consequently, each category allows a maximum of 21 hours of activity per week (3 hours x 7 days).

5.8.8 Youth Quality of Life Short-Form (YQOL-SF)

The YQOL-SF is a two-factor scale, including factor 1 ("belief in self and family”) and factor 2 ("environment and relationships"), with a total of 14 items that provide a multidimensional assessment of quality of life among youths (Hoang et al., 2021). The CFA results showed that the two-factor model has acceptable fit indices (RMSE (90% CI = 0.111 (0.100–0.122); CFI = 0.908; SRMR = 0.046; p-value = <0.001) (Hoang et al., 2021). The response scale ranges from 0 = not at all to 10 = a great deal or completely. A higher score represents a higher quality of life, and a lower score represents a lower quality of life. Cronbach’s alpha value showed excellent internal consistency in both factors (0.911 and 0.910) (Hoang et al., 2021).

The scores are added together and then converted to a scale ranging from 0 to 100 using the formula below (Hoang et al., 2021). The overall quality of life (QOL) score is determined by averaging the transformed scores of all 14 items. A higher score indicates a better quality of life (Hoang et al., 2021).

$$\text{Transformed score} = \frac{actual\ score - loswest\ possible\ score}{possible\ score\ range} * 100$$

Note: transformed score = the score of each item after being transformed, actual score = the actual score obtained by each individual (0 – 10), lowest possible score = the minimum score that an individual can rate (0), possible range score = the possible range score for each item (= 10).

5.9 Data collection

We utilized the final validated versions of the questionnaires for data collection. Eligible participants were given a Google Form link or QR code to fill it out online voluntarily after reading and understanding the information given in the participant sheet. This process was ended after we obtained the required sample of 1300 responses from each country. Google Forms are widely used for research and surveys due to their practical, adaptable, and cost-effective nature, which also helps to minimize response bias (Nayak & Narayan, 2019). Hence, this study involved independent samples of 1300 enrolled in the College of Medicine and Allied Medical Sciences at FUD and another 1300 enrolled from Health Campus USM, Malaysia. The estimated time to complete the questionnaire was 40–60 minutes. We downloaded the complete questionnaires, each numbered ID and matric number, into an Excel spreadsheet, then transferred them to SPPS for data entry and storage.

5.10 Study flowchart

Figure 5.1 below illustrates the data collection process involved in Phases II and III of the study.

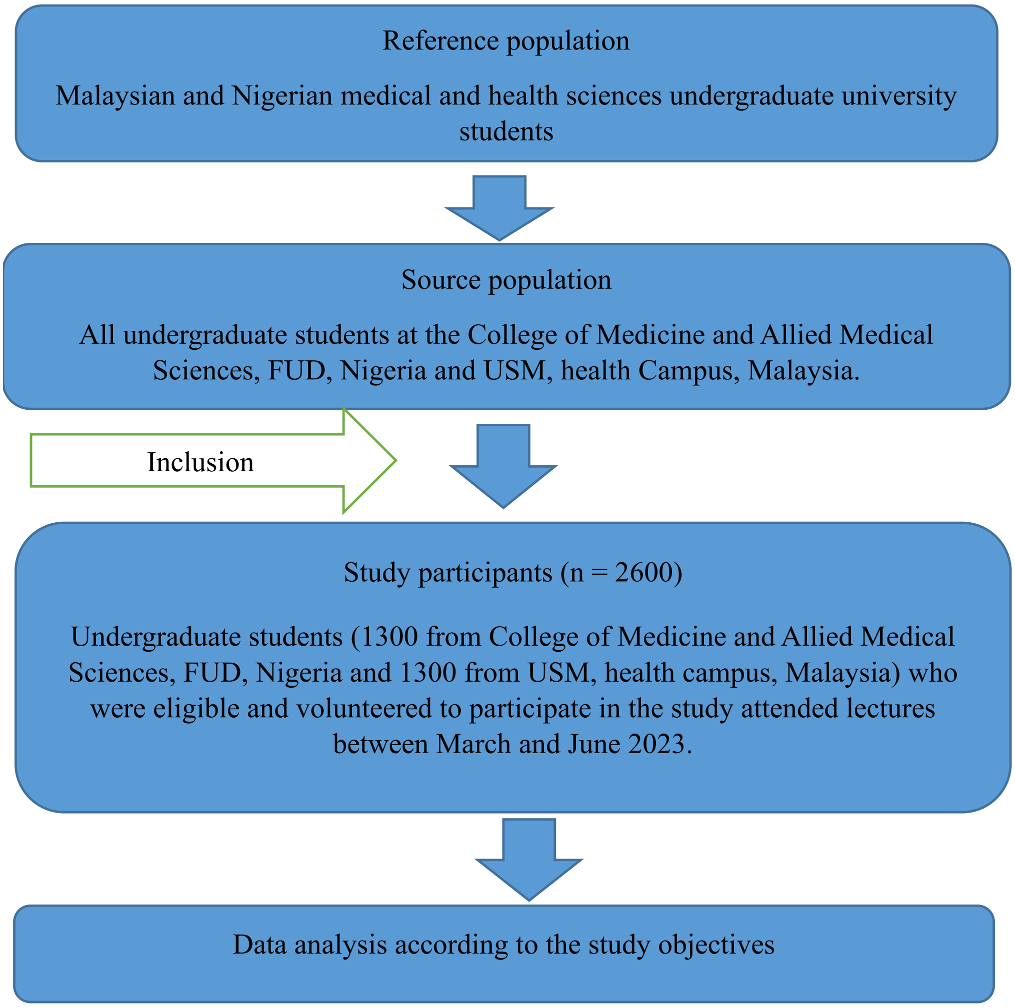

Figure 5. 1: Phases II and III study Flow Chart

5.11 Data management

The researcher coded each scale item and initially entered it into Microsoft Office Excel 2021 (Microsoft 365) for preliminary data exploration. The data were then transferred to the IBM package for Statistical Product and Service Solution (SPSS) version 29.0 for preliminary and descriptive analyses, including checking the univariate normality assumption and EFA. We used Mplus version 8 for multivariate analyses, which involved checking the assumption of multivariate normality, evaluating the CFA measurement models, and testing the hypothesized structural models.

5.12 Missing data

There were no missing items or scales in the present study with missing data, thus eliminating any issues related to missing data. This lack of missing data might be attributed to the use of Google Forms where researcher set all questions/items must be answered by respondents, which typically results in a higher response rate.

5.13 Data analysis

We first performed descriptive analysis for data exploration, frequencies, percentages, means, standard deviations, skewness, and kurtosis. We then performed inferential statistics in accordance with each specific objective.

5.13.1 For objectives 4 and 6

The statistical analyses were EFA and CFA.

The EFA was performed using principal axis factoring with Promax rotation was conducted to test the newly developed scales, which included SDH with 20 items, EDH with 18 items, DL with 18 items, and IP with 14 items, to identify the primary contributing factors. Promax rotation is utilized in EFA when a theoretical rationale for correlated factors is anticipated, allowing for better alignment of the hypothesized model with established theories or expectations (Tabachnick et al., 2013). Factors with eigenvalues greater than one were examined, and those with factor loadings greater than 0.40 were considered statistically significant and retained for further CFA (Brown, 2015; DeVon et al., 2007).

5.13.1(a) Assumption checking during EFA

5.13.1(a)(i) Positive definiteness

According to Brown (2015), principal component analysis is the framework outlined for utilizing to validate positive definiteness, with eigenvalues serving as a precise gauge of the explained variance extent. Consequently, for the data to demonstrate positive definiteness, all eigenvalues must exceed zero (Meyers et al., 2016).

5.13.1(a)(ii) Univariate normality

The univariate normality can be investigated using the histograms and box-whisker plots. However, this approach relies on eye-ball judgment (Park, 2015). A more objective approach is the use of the Kolmogorov-Smirnov test and the Shapiro-Wilk test, and a significant p-value greater than 0.05 indicates normally distributed data, whereas a significant p-value less than 0.05 indicates non-normally distributed data (Park, 2015). For the current study, both approaches were applied.

5.13.1(a)(iii) Multicollinearity

Multicollinearity in EFA refers to the high degree of correlation between two or more factors (Shrestha, 2021). High levels of multicollinearity in EFA can complicate the understanding of the factors and affect the stability and dependability of the resulting factor structure (Shrestha, 2021). Interpreting the interactions between variables and factors can become more challenging because of inflated factor loadings or ambiguous factor structures. According to Kline (2013), multicollinearity is considered satisfactory if the squared multiple correlation (tolerance) is greater than 1 and the variance inflation factor (VIF) is less than 10.

5.13.1(a)(iv) KMO

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy serves as a statistic in EFA to assess the suitability of the data for factor analysis (Kline, 2013).

The KMO metric quantifies the degree of relationship between variables in a dataset to determine their suitability for factor analysis (Kline, 2013). The KMO metric specifically assesses the percentage of variance among variables that could be attributed to underlying causes. Higher values suggest that the variables are better suited for factor analysis. The range is 0 to 1. Generally, researchers consider a KMO value greater than 0.5 as satisfactory, and values closer to 1 indicate more adequate sampling (Kline, 2013). A low KMO value implies that there may be problems with multicollinearity among the variables or that EFA is not appropriate for the data given the lack of strong relationships between the variables in the dataset (Kline, 2013). A value of 0.7 and above is considered a reasonable cut-off value (Hair et al., 2010; Stevens, 2002).

5.13.1(a)(v) Bartlet's test of sphericity

EFA uses a statistical test known as Bartlett's test of sphericity to determine whether the correlation matrix of the variables in a dataset differs significantly from an identity matrix, which would indicate that the variables are not unrelated (Kline, 2013). The sphericity assumption in EFA implies the presence of correlations between variables, enabling EFA (Kline, 2013). Bartlett's test evaluates the null hypothesis that the correlation matrix is an identity matrix, indicating that variables are uncorrelated. A significant test (p-value < 0.05) suggests that there were significant correlations among the items (Hair et al., 2010; Kline, 2023).

The CFA and average variance extraction (AVE) were conducted to further test the EFA models, which included SDHQ with 2 constructs and 20 items, EDHQ with 2 constructs and 18 items, DLQ with 3 constructs and 18 items, and IPQ with 2 constructs and 14 items.

Below is the equation for AVE:

$$AVE = \frac{\sum_{i=1}^{K} \lambda_i^2}{\sum_{i=1}^{K} \lambda_i^2 + \sum_{i}^{K} Var\ (e_i)}$$

Here, k represents the number of items, λi denotes the factor loading of item i, and Var (ei) signifies the variance for the measurement error of item i. The study employed a criterion of AVE > 0.5 as the cut-off value (Fornell & Larcker, 1981).

5.13.1(b) Assumption checking during CFA

5.13.1(b)(i) Estimate parameter

First, an assumption proof was executed to identify the type of estimator that would be used during the CFA analysis. When examining the measurement model in Mplus version 8, Maximum Likelihood (ML) was selected as the preferred estimator (Muthén & Muthén, 1998). ML is applied to numerical outcome measurements that satisfy the requirement of normality. In cases where the assumption of normality was not satisfied, the study employed maximum likelihood robustness (MLR). According to Yuan and Bentler (2000), MLR is the maximum likelihood parameter estimate that offers a stable standard error and is insensitive to normality violations of data. Moreover, missing at random (MAR) and missing completely at random (MCAR) variables can be accommodated by MLR (Wang & Wang, 2019).

5.13.1(b)(ii) Univariate normality

The degree of skewness and kurtosis is checked to determine whether the data have a symmetrical distribution. A unimodal distribution with a skew has a disproportionate form with respect to its mean. According to Kline (2013), a positive skew indicates that the majority of the scores are distributed below the mean, while a negative skew indicates the exact reverse. According to some research, a variable is considered highly skewed if its skew index (SI) is greater than 3.0. A distribution is referred to as platykurtic when, in comparison to a normal distribution, an excessive number of values occur on its extremities, giving the graph a flattening appearance

(Gerstman, 2014; Rossi, 2022). On the other hand, a distribution is considered leptokurtic if, in comparison to a normal distribution, it has a lower proportion of values in its extremities, resulting in a more pointed shape on its graph. A normal distribution that resembles a bell shape is called a mesokurtic (Daniel & Cross, 2018). Byrne (2013) states that a normalized kurtosis index of 3.0 indicates a positive kurtosis, whereas lower values indicate a negative kurtosis. Excessive kurtosis is defined as a kurtosis index (KI) of a particular value ranging from 8.0 to above 20.0. According to the standard guideline, moderate kurtosis is implied by a value of KI greater than 10.0, and extreme kurtosis is indicated by a value of KI greater than 20.0 (Kline, 2013). The univariate normality of each factor was also evaluated using the skewness and kurtosis values generated by the Mplus output during the CFA analysis.

5.13.1(b)(iii) Bivariate normality

If a pair of variables demonstrates a joint normal distribution, it indicates that each variable possesses a normal distribution for every value of the other variable. The skewness and kurtosis values from the Mplus output were used to check the bivariate normality between the variables (Kline, 2013).

5.13.1(b)(iv) Multivariate normality

In Mplus 8, we conducted two-sided tests of fit for multivariate kurtosis and multivariate skewness. A p-value below 0.05 indicated evidence of multivariate nonnormality in the dataset.

5.13.1(b)(v) Multicollinearity

Strong correlations among the independent variables within a given regression model indicate multicollinearity, which reduces the predictive capacity of independent variables in regression studies (Hair et al., 2010). In Mplus, detection of multicollinearity was automated during the analyses. Mplus would indicate whether this criterion was met for the model under examination based on the output. According to Muthén and Muthén (1998), the standard CFA model analyzed in the study did not incorporate any covariates. CFA solely applies to observed variables treated as ordinals. Consequently, the CFA model scrutinized in this study encountered no issues with multicollinearity. SEM analysis was performed to validate multicollinearity. Should multicollinearity be evident among the variables, the Mplus output would issue a warning message highlighting the concern. Consequently, a new specification and analysis of the model would be necessary.

5.13.1(b)(vi) Positive definiteness

Most estimation methods necessitate positive definiteness, a condition met when the determinant of the variance-covariance matrix is positive. Attempting data analysis with a non-positive-definite (NPD) matrix is likely to be futile (Kline, 2013). By employing the four scales in the initial models, this requirement was validated. If the tested model fulfilled this condition, it would be noted in the Mplus output.

5.13.1(b)(vii) Specifications of the Model

We defined the model and assessed its likelihood using sample data that included each of the model's observed variables (Kline, 2013). If a computer can theoretically compute a unique estimate for each model parameter, the model is considered identified (Kline, 2013). This necessitates a confirmatory test of the measurement model using CFA, along with a pretest to evaluate the construct items (O'Rourke et al., 2013). To assess how well the observed data fit a predetermined structure, the structure of the theoretical model applied to the sample data was examined. Since we cannot directly measure latent variables, we scale them by setting their metric or unit to be comparable to one of their indicators (Brown, 2015). We refer to the indicator that transfers its metric to the factor as a reference indicator or marker

(Brown, 2015). However, it is up to the researcher to decide which observed measurements to use as marker indicators. By definition, the latent variable receives a portion of the sample variation of a marker indicator (Brown, 2015). Additionally, another strategy is to fix the variance of the latent variable to 1. Despite standardizing the latent variables to 1, the model still fits as well as the unstandardized model (estimated using marker indicators) (Brown, 2015).

5.13.1(b)(viii) Identification of the model

The degree of freedom (DF) had to be greater than zero, and each latent variable—including the residual terms—had to have a scale assigned to it. These were the two fundamental conditions for model identification (Kline, 2013). When the sufficient condition for model identification is satisfied, a model is said to be overidentified if it has fewer freely estimated parameters than the total number of data points (DFM < 0) (Kline, 2013). Finding the goodness-of-fit between the sample data and the proposed measurement model is a step in the model-fitting process. The other two fit evaluation perspectives (localized strain and parameter estimates) provide more accurate information about the acceptability and efficiency of the output, but goodness-of-fit indices only provide a global descriptive summary of the model's capacity to generate the input covariance matrix (Brown, 2015).

According to Brown (2015), at least one index from each fit class (absolute and incremental) should be considered when assessing the fitness of the CFA model because each fit class offers unique information. After ensuring accurate specification, we examine the goodness-of-fit indices to begin evaluating the model's acceptability (Brown, 2015). If these indices are consistent with a good model fit, we will receive some initial (tentative) support for the model's appropriate specification (Brown, 2015).

Absolute fit indices, according to Kline (2013), absolute fit indices refer to the proportion of the covariances in the sample data matrix that the model can explain. The standardized root mean square residual (SRMR), root mean square error of approximation (RMSEA), and Chi-square goodness-of-fit (χ^2) make up the indices. Although it has several drawbacks, the Chi-square goodness-of-fit method provides a way to evaluate factor analysis models using more objective standards. According to Wang and Wang (2019), the χ^2 statistics were vulnerable to Type I error because they were very sensitive to large sample sizes and more likely to reject the null hypothesis of no difference. On the other hand, the limited sample size might not yield a well-fitting χ^2 distribution. Since the χ^2 value rises when variables have strongly skewed distributions and become kurtotic, the χ^2 statistics are also sensitive to multivariate non-normality (Wang and Wang, 2012). Wang and Wang (2019) further confirmed that when a model has more variables, the value of χ^2 frequently rises. As a result, additional model fit indices may be used instead of relying solely on the Chi-square goodness-of-fit χ^2 as the only test of fit index.

Given that the model chi-square sensitivity to the sample size, Normed chi-square (NC) = χ^2/df was introduced in place of applying the Chi-square goodness-of-fit χ^2 (Kline, 2013). However, there was no precise benchmark for justifying the recommended value of NC. It is not utilized in this study due to the sensitivity of chi-square goodness-of-fit to sample size and the fact that normed chi-square is ineffective for global fit assessment.

The best fit is defined as the root mean square error of approximation (RMSEA) with a value of zero (Kline, 2023). According to Byrne (2013), it quantifies the extent to which a theoretical model matches the population correctly. However, the number of samples and model degrees of freedom (more parsimony) have an impact on the RMSEA value. Increasing degrees of freedom or higher sample sizes result in a lower RMSEA value (Kline, 2023). As stated, RMSEA less than 0.05, based on Hair et al. (2010), could indicate whether the model fits the data well (closely). A value of less than 0.08 denotes a satisfactory fit (acceptable fit of closeness with the data), and if the value is higher than 0.1, the results reveal poor fit with the data. The "close" fit (CFit) measure, particularly supported by a non-significant outcome of the CFit statistic ($p > 0.05$), is a statistical assessment of the closeness of model fit using RMSEA (Brown, 2015). It is defined by values of the RMSEA less than 0.05. The residual-based model fit indices can be identified as root mean square residuals, or RMRs (Wang & Wang, 2019). SRMR, or the standardized form of RMR (SRMR), represents the mean value across all residuals that are standardized with a range of 0.00 to 1.00. A score below 0.05 indicates an accurately fitting model (Hair et al., 2010; Kline, 2023).

Incremental fit indices indicates the relative improvement in the proposed model's fit compared to the statistical baseline model, often called the null hypothesis model (Kline, 2023). Fit indices, such as the Tucker-Lewis Index (TLI) and Comparative Fit Index (CFI), are typically used to measure this incremental fit (Hair et al., 2010). By comparing the hypothesized model, which imposes a specific structure, with the less restricted nested baseline model, both indices assess the proportional gain in model fit (Byrne, 2013).

A well-fitting model is indicated by Comparative Fit Index (CFI) values close to 1.00, within a range from 0.00 to 1.00. Hair et al. (2010) suggested that a CFI value above 0.95 indicates a well-fitting model. The CFI score is influenced by the average size of the correlations in the data (Wang & Wang, 2019). Similarly, the Tucker-Lewis Index (TLI), a non-normed index with values ranging from 0.00 to 1.00, signifies a good fit when values are near 1.00 (Byrne, 2013). Hair et al. (2010) defined a satisfactory fit as TLI values greater than 0.95.

In this study, the TLI, CLI, RMSEA, and SRMR were utilized to assess the validity of the CFA model. This approach is consistent with Brown (2015) recommendation that the Standardized Root Mean Square Residual (SRMR), Root Mean Square Error of Approximation (RMSEA), Tucker-Lewis Index (TLI), and Comparative Fit Index (CLI) are among the most widely accepted global goodness-of-fit indicators. Table 5.2 below offers an overview of the fit index guidelines.

According to Hair et al. (2010), the values of fit indices can vary depending on factors such as the number of observed variables (V) and the number of observations per group (N). If the model shows a misfit, re-specification is necessary to modify the model and improve its fit. Factor loading, which ranges from -1.0 to 1.0, can be used to assess construct validity among item measures. In this study, factor loadings of 0.40 and above, with a significant p-value and modification index, were considered appropriate benchmarks for retaining or removing items from the measurement model, as suggested by Wang and Wang (2019).

Table 5.2: Characteristics of Various Fit Indices Demonstrating Goodness-Of-Fit in Different Model Scenarios

Fit Indices	Symbol	Cut off Value	Source
Absolute Fit Indices			
Chi-square statistics	χ^2	p-value > 0.05	Kline (2023)
Normed chi-square	χ^2/df	Between 1.0 to 5.0	Kline (2023)
Standardized Root Mean Square Error	SRMR	<0.08	Hair et al. (2010); Kline (2023)
Root Mean Square of Approximation	RMSEA	<0.05, model is good fit <0.08, reasonably fit, and <0.10 indicate poor fit	Hair et al. (2010)
Incremental Fit Measures			Hair et al. (2010); Kline (2023)
Comparative Fit Index	CFI	>0.95	
Tucker Lewis Index	TLI	>0.95	

Note: χ^2 = Chi-square, df = degree of freedom, SRMR = standardized root mean residual, RMSEA = root mean square error of approximation, CFI = comparative fit index, TLI = Tucker Lewis Index.

5.13.2 For objectives 5 and 7

For objectives 5 and 8, we determined the scales reliability based on Cronbach’s alpha, composite reliability (CR), and test-retest based on intra-class correlation coefficient (ICC) of the newly developed questionnaires (SDHQ, EDHQ, DLQ, and IPQ). Furthermore, in this study, we included both Cronbach's alpha and CR, as residual covariances were incorporated for all the models (SDH, EDH, DL, and IP). Using Mplus 8, CR was calculated following Raykov's approach, and cutoff values for CR were ≥ 0.60 (Raykov & Marcoulides, 2016). The Cronbach’s alpha was computed using the statistical product and service solution (SPSS) version 29, and the cutoff values for Cronbach’s alpha were ≥ 0.50 (Enders & Tofighi, 2007).

The equations for CR are as follows:

$$CR = \frac{(\sum_{i=1}^{n} \lambda_i)^2}{(\sum_{i=1}^{n} \lambda_i)^2 + (\sum_{i=1}^{n} ei)}$$

Where CR represents composite reliability, λi denotes the standardized factor loading, and ei signifies the measurement error of the item. The equation above shows the CR calculation without considering the correlated error term in the scale. When error covariance is included, the CR formula must use the Raykov and Marcoulides (2016) approach, as shown below:

$$CR = \frac{(\sum_{i=1}^{n} \lambda_i)^2}{(\sum_{i=1}^{n} \lambda_i)^2 + (\sum_{i=1}^{n} e_i) + 2\sum_i \sum_j \theta ij}$$

2∑i∑ Ɵ Ij = twice the sum of the covariances between the error terms (Raykov & Marcoulides, 2016).

Figure 5.2 illustrates the steps of validation from CFA until test-retest analysis.

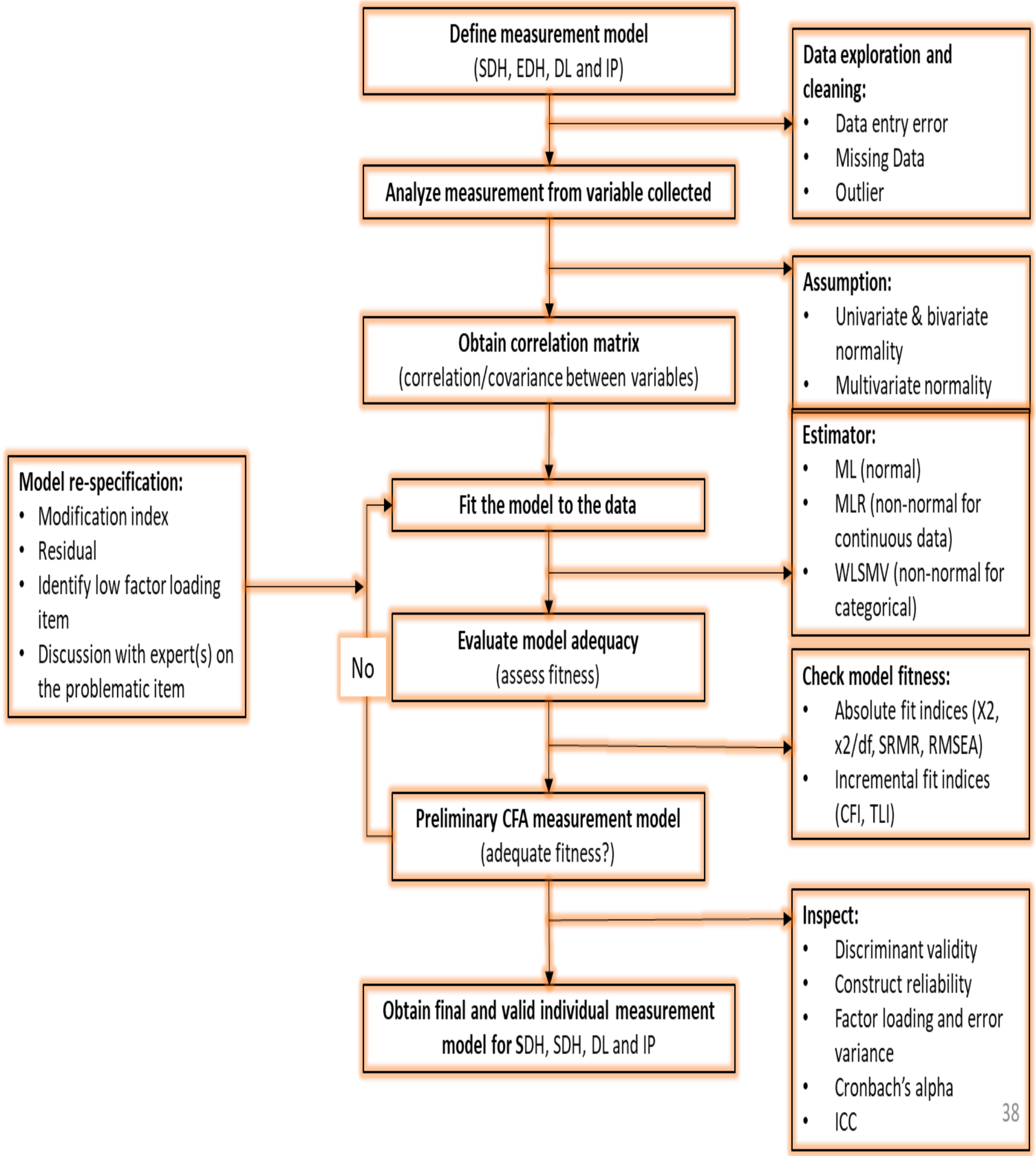

Figure 5.2: A statistical flow chart of various fit indices shows the goodness-of-fit across different CFA measurement model stages

5.13.3 For objectives 8 and 9

The structural equation modelling (SEM) was performed to determine the structural relationship between SDH, EDH, DL, IP, healthy diet, physical activity, and quality of life among the FUD, Nigeria, and USM, health campus students. The current study used the robust MLR estimator because it is resilient to non-normality.

The overall model fit test was conducted on the main hypothesis model as part of the model evaluation process to assess the validity of the model's structure. The goal was to evaluate the degree of difference between the observed sample variance/covariance matrix (S) and the model-estimated variance/covariance matrix (∑^) (Wang & Wang, 2019). A thorough examination and removal of non-significant variables were performed using factor loadings, path regressions, and R^2 values. Model fit indices were obtained to assess how close ∑^ was to S. Several fit indices are recommended to evaluate the relative fit of the data to the model. According to Hair et al. (2010), multiple indices of different types should be applied to provide adequate evidence of model fit. Criteria such as incremental fit indices like the CFI and TLI and absolute fit indices like SRMR and RMSEA were used to determine whether the model fit the data sufficiently. The subsequent SEM analysis was conducted using the fit index criteria listed in Table 5.2.

We examined all significant paths, standardized residuals, and modification indices (MI) to re-specify a misfit model. The model was then adjusted and retested using the same data set. However, model re-specification must be supported by empirical data or theoretical justification. According to Wang and Wang (2019), a high Modification Index (MI) suggests that the associated fixed parameter should be released to improve the model's fit. In Mplus, a default MI value of 10 was set to indicate a significant reduction in the corresponding χ^2. Since changes to one parameter can affect other aspects of the model, the parameter with the highest MI is released one at a time (Kline, 2023). Releasing a new parameter can potentially enhance the overall fit of the model, but the change must have theoretical validity and significance.

The final and valid structural model is established once the model fit indices are met. In this study, the significant path (β) was provided along with its 95%

confidence interval (CI), standard error (SE), and statistical significance value ($p < 0.05$). Figure 5.3 summarizes the procedures used to conduct the SEM analysis. After verifying the measurement models of SDH, EDH, DL, and IP, the study explores and evaluates potential associations between these measurement models using the structural model. SEM provides a method for balancing measurement error among observable variables in a model, offering a versatile and efficient way to investigate causal relationships between constructs and assess measurement suitability simultaneously (Wang & Wang, 2019). Since latent constructs are unobservable and lack a direct metric, SEM accounts for them in addition to observed indicator variables (Wang & Wang, 2019). To explore relationships based on theory-driven analysis, items from the same measurement models were compared to their corresponding latent constructs. When dealing with a large number of items on a scale, CFA and SEM often use item parceling. According to Little et al. (2002), this approach is also useful for handling non-normal data and creating a parsimonious model. In this study, item parceling was performed on all scales using the total score of each subscale.

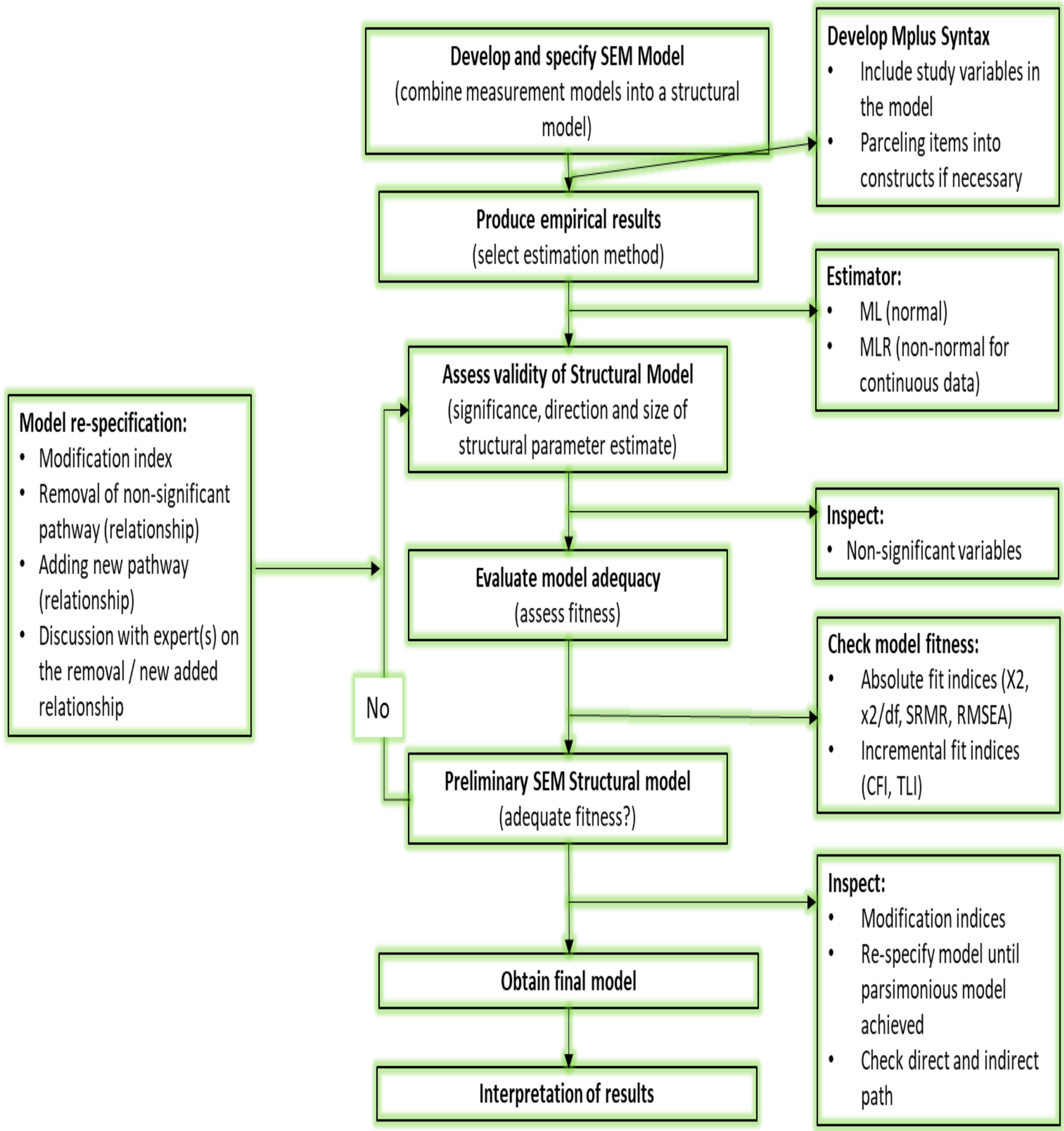

Figure 5.3: A statistical flow chart of various fit indices shows the goodness-of-fit across different SEM measurement model stages

5.13.4 For objective 10

The hierarchical test of measurement invariance was performed across the samples of Nigerian and Malaysian students to establish the measurement invariance of the newly developed scales (SDHQ, EDHQ, DLQ, and IPQ) by applying a progressive restrictive constraint on the model parameters, and the variations in the model fit indices were investigated. For this study, we applied the following recommended cut-off values (Cheung & Rensvold, 2002; Kimber et al., 2015; Kline, 2023; Wang & Wang, 2019) to determine the measurement and structural invariance: an absolute difference (Δ) of 0.01 or less for CFI (ΔCFI) and TLI (ΔTLI), and 0.015 for RMSEA (ΔRMSEA) and (ΔSRMR).

Firstly, we examined measurement invariance by testing and establishing the configural invariance model to compare it with the fit indices of other invariance models. In the configural invariance model, no equality restrictions were imposed on the model parameters across the countries (Nigeria and Malaysia).

Secondly, the weak or metric invariance model was specified and evaluated. In this model, equality constraints were applied to the factor loadings across the samples of Nigerian and Malaysian students to ensure consistency in the measurement scale and enable precise comparisons between them.

Thirdly, the strong invariance model was specified and assessed. In this model, we imposed equality constraints on both factor loadings and item intercepts across the samples of Nigerian and Malaysian students to ensure the comparability of scale factors between them.

Finally, the strict invariance model was specified and evaluated. This model applied equality constraints to factor loadings, item intercepts, and residual variances to confirm that the items' variance in regression equations remained consistent across the two samples of Nigerian and Malaysian students.

The structural invariance of the model parameters was also assessed by evaluating factor variance and covariance invariance, as well as factor means invariance. Factor variance and covariance invariance were tested to determine the similarity of factor correlations between the Nigerian and Malaysian university student samples. Conversely, factor means invariance was examined to identify any differences in factor means across the two groups. Overall, structural invariance analysis aimed to evaluate the extent to which Nigerian students at FUD and Malaysian students at USM differ, regardless of the measurement scale being used.

5.13.5 For objective 11

We conducted a multigroup SEM comparison to examine the similarities between the two SEM models derived from students at FUD in Nigeria and USM Health Campus. The significant path relationships identified in both models were tested using the combined sample to evaluate the fit of a single SEM model. Subsequently, the regression coefficients of the two groups were compared.

Table 5.3 below summarizes the statistical analyses conducted in Phases II and III according to the specific objectives.

Table 5.3: Summary of statistical analyses performed in Phases II and III

Specific objectives	Statistical analysis	Software
Objectives 4 and 6	EFA	SPSS 29.0
	CFA	Mplus 8.0
	AVE	Microsoft excel 2021
Objectives 5 and 7	Cronbach's alpha, ICC	SPSS 29.0
	CR	Mplus 8.0
Objectives 8 and 9	SEM	Mplus 8.0
Objective 10	Invariance analysis	Mplus 8.0
Objective 11	Multigroup SEM comparison	Mplus 8.0

Note: EFA = exploratory factor analysis, CFA = confirmatory factor analysis, AVE = average variance extracted, ICC = intra-class correlation coefficient, SEM = structural equation modelling.

5.14 Ethical considerations

5.14.1 Ethical approval

Prior to the study's commencement, the Human Research Ethics Committee, Ministry of Health, Jigawa State, Nigeria, granted ethical approval of the study [JGHREC/2023/151]. The approval date was March 13, 2023, to March 13, 2024 (Appendix E). Similarly, the Human Research Ethics Committee USM (HREC), granted ethical approval of the study [USM/JEPeM/22110695]. The approval date was April 2, 2023, to April 1, 2024 (Appendix F). Later, the HREC granted approval of an extension for the study to April 1, 2025 (Appendix G). We conducted the study in accordance with the Helsinki Declaration. After obtaining ethical approval, we secured permission from the Deans of the Faculty of Basic Medical and Allied Medical Sciences, FUD, PPSP, PPSK and PPSG before beginning the data collection process.

Additionally, permission was obtained from the authors of the three supplemental questionnaires on healthy diet, physical activity, and quality of life, as they indicated that no formal permission was required for their use. During data collection, participants who volunteered and agreed to participate were provided with a research information sheet upon opening the Google Form link. This sheet included essential details such as the study's objective, procedures, potential risks, and benefits. By clicking 'agree to participate' and completing the survey, participants were considered to have given their consent. They were assured that their personal information would remain confidential, be kept private, and be used solely for research purposes unless required by law.

5.14.2 Record-keeping and data privacy

The principal investigator (PI) was tasked with collecting all the completed and submitted Google Forms. The Google Form was designed and shared using the PI Gmail account. The data were downloaded in Microsoft Excel format and subsequently transferred to SPSS 29.0 for data cleaning, data coding, and preliminary exploration prior to conducting the intended statistical analyses. Participants were given the option to enter their matriculation number during the survey to prevent multiple responses from the same individual.

5.14.3 Declaration of conflicts of interest

The researchers affirm that they have no conflicts of interest.

5.15 Chapter summary

This chapter presented detailed descriptions of the research methods applied in the studies of phases II and III. The chapter covers aspects of the validation study to determine the validity and reliability of the newly developed questionnaires (SDHQ, EDHQ, DLQ, and IPQ) in phase I of this study and the structural relationship aspect, which is the SEM, invariance testing, and multigroup SEM comparison. In the subsequent chapters we presented the results obtained from phase II and phase III. However, we divided the results for each phase into separate chapters for easy understanding. Table 5.4 below presents the summary of the methods employed in phases II and III according to each study's objectives.

Table 5.4: Summary of research methods for phase II and phase III

No	Research objectives	Hypotheses	Sample size	Study participants	Statistical tests
		PHASE II			
1	To determine the construct validity of the of the newly developed questionnaires for assessing SDH, EDH, DL, and IP using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) among undergraduate students in FUD, Nigeria.	The newly developed questionnaires for assessing SDH, EDH, DL, and IP are valid by using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) among undergraduate students in FUD, Nigeria.	730 (300 for EFA and 430 for CFA).	Undergraduate students from the College of Medicine and Allied Medical Sciences, FUD, Nigeria.	EFA, CFA, and AVE
2	To determine the reliability of the newly developed questionnaires for assessing SDH, EDH, DL, and IP using Cronbach's alpha, composite reliability, and test re-test (ICC) among undergraduate students in FUD, Nigeria.	The newly developed questionnaires for assessing SDH, EDH, DL, and IP are reliable by using Cronbach's alpha, composite reliability, and test-retest (ICC) among undergraduate students in FUD, Nigeria.	300 (EFA sample)		Cronbach's alpha, ICC, and CR
3	To determine the construct validity of the of the newly developed questionnaires for assessing SDH, EDH, DL, and IP using EFA and CFA among undergraduate students in USM, health campus, Malaysia.	The newly developed questionnaires for assessing SDH, EDH, DL, and IP are valid by using EFA and CFA among undergraduate students in USM, health campus, Malaysia.	730 (300 for EFA and 430 for CFA).	Undergraduate students from the Health Campus, USM, Malaysia.	EFA, CFA, and AVE

Table 5.4 Continued

No	Research objectives	Hypotheses	Sample size	Study participants	Statistical tests
4	To determine the reliability of the newly developed questionnaires for assessing SDH, EDH, DL, and IP using Cronbach's alpha, composite reliability, and ICC among undergraduate students in USM, health campus, Malaysia.	The newly developed questionnaires for assessing SDH, EDH, DL, and IP are reliable by using Cronbach's alpha, composite reliability, and ICC among undergraduate students in USM health campus, Malaysia.	300 (EFA sample)		Cronbach's alpha, ICC, and CR
		PHASE III			
5	To determine the structural relationship between SDH, EDH, DL, IP, healthy diet (HD), physical activity (PA), and quality of life among undergraduate students in FUD, Nigeria.	There are significant structural relationships between SDH, EDH, DL, IP, healthy diet (HD), physical activity (PA), and quality of life among undergraduate students in FUD, Nigeria.	570	Undergraduate students from the College of Medicine and Allied Medical Sciences, FUD, Nigeria.	SEM
6	To determine the structural relationship between SDH, EDH, DL, IP, HD, PA, and quality of life among undergraduate students in USM, health campus, Malaysia.	There are significant structural relationships between SDH, EDH, DL, IP, HD, PA, and quality of life among undergraduate students in USM, health campus, Malaysia.	570	Undergraduate students from the Health Campus, USM, Malaysia.	SEM

Table 5.4 Continued

No	Research objectives	Hypotheses	Sample size	Study participants	Statistical tests
7	To determine the measurement and structural invariance of the newly developed questionnaires for assessing SDH, EDH, DL, and IP across the samples of Nigerian and Malaysian undergraduate students.	The newly developed questionnaires for assessing SDH, EDH, DL, and IP have adequate measurement and structural invariance across Nigerian and Malaysian samples.	860 (CFA samples of Nigerian and Malaysian students).	Undergraduate students from the College of Medicine and Allied Medical Sciences, FUD, Nigeria, and Undergraduate students from the Health Campus, USM, Malaysia.	Invariance analysis
8	To conduct an SEM multigroup comparison between samples of Nigerian and Malaysian undergraduate students.	The structural relationships between SDH, EDH, DL, IP, HD, PA, and quality of life are similar across Nigerian and Malaysian samples.	1140 (SEM samples of Nigerian and Malaysian students).	Undergraduate students from the College of Medicine and Allied Medical Sciences, FUD, Nigeria, and Undergraduate students from the Health Campus, USM, Malaysia.	Multigroup SEM comparison

Note: EFA = exploratory factor analysis, CFA = confirmatory factor analysis, AVE = average variance extracted, ICC = intra-class correlation coefficient, SEM = structural equation modelling.

CHAPTER 6

RESULTS OF PHASE II: EXPLORATORY AND CONFIRMATORY STUDY

6.1 Introduction

This chapter covers the results of phase II, which covers an exploratory and confirmatory study to validate the newly developed holistic health questionnaires among undergraduate students in FUD, Nigeria, and USM health campus, Malaysia. The chapter covers the study's objectives 4 to 7. Thus, we organize the results based on FUD, Nigeria samples, and USM health campus, Malaysia samples.

Nigerian based sample – (EFA, CFA, and reliability)

6.2 EFA Nigerian based sample

6.2.1 Preliminary data assessment

We examined the percentage of missing data for each item in each questionnaire. There were no items with missing values, and as a result, the questionnaires completion rate was 100%. Furthermore, the univariate normality of all the items was assessed using the Kolmogorov-Smirnov test, the Shapiro-Wilk test, boxplots, and histogram plots. The results of the Kolmogorov-Smirnov test and the Shapiro-Wilk test show that the scores of all the items were not normally distributed ($P < 0.05$). The results of the boxplot show that some items have outliers (see Appendix H). Lastly, the results of the histogram plot show that some items of the questionnaires were not normally distributed (see Appendix I).

6.2.2 Descriptive characteristics of the study participants

Table 6.1 presents the general characteristics of Nigerian study participants for the EFA sample. There were a total of 300 students (male 55.7%, female 44.3%), with a mean age of 21.1 (SD = 3.00). The mean frequency and duration of exercise per week were 4.1 (SD = 2.25) and 46.2 (SD = 37.42), respectively. The highest proportion of the students were Hausa (70.7%) and studied medicine (43.7%). Furthermore, most of the students were in Year 1 (43.7%).

Table 6.1: General Characteristics of the Participants in EFA (N = 300), Nigerian students

Variables	Mean (SD)	n (%)
Age	21.1 (3.00)	
Frequency of exercise/week	4.1 (2.25)	
Duration of exercise (min)	46.2 (37.42)	
Gender		
Male		167 (55.7)
Female		133 (44.3)
Ethnicity		
Hausa		212 (70.7)
Yoruba		31 (10.3)
Igbo		11 (3.7)
Others		46 (15.3)
Field of study		
Medicine		131 (43.7)
Human anatomy		109 (36.3)
Human physiology		60 (20.0)
Study year		
Year 1		131 (43.7)
Year 2		51 (17.0)
Year 3		5 (1.7)
Year 4		113 (37.7)

Note: SD = standard deviation, min = minutes.

6.2.3 Item's score distribution of the EFA sample

In this sub-section, we present the descriptive statistics for all the items in the holistic health questionnaires (SDH, EDH, DL, and IP) based on Nigerian sample. The following tables (Table 6.2–Table 6.5) provide the results in terms of mean, standard deviation, median, interquartile range, frequencies, and percentages. The minimum expected value for each scale is one, and the maximum value varies from four to five.

Table 6.2 presents the descriptive distribution of SDHQ items. The expected minimum and maximum scores were 20 and 100, respectively, with structural and intermediary determinants of SDH expected to range from 10 to 50 each. The mean (SD) score for the total SDHQ was 71.2 (13.40), with actual scores ranging from 30.0 to 99.0. For structural determinants of SDH, the mean (SD) was 36.2 (8.78), and for intermediary determinants, it was 35.0 (9.50). Item SDH1 (How satisfied are you with your gender?) had the highest rating of 5 (totally satisfied) by 64.3% of respondents, while item SDH10 (How do you rate the government's effort towards improving your standard of living?) received the highest rating of 1 (totally unsatisfied) by 21.7% of respondents.

Table 6.2: Score distribution of the SDHQ (N = 300), Nigerian students

Items	Mean (SD)	Median (IQR)	Score 1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)
SDH1	4.29(1.12)	5.00(1)	11(3.7)	19(6.3)	35(11.7)	42(14.0)	193(64.3)
SDH2	3.48(1.16)	4.00(1)	17(5.7)	44(14.7)	88(29.3)	81(27.0)	70(23.3)
SDH3	4.20(1.14)	5.00(1)	11(3.7)	23(7.7)	37(12.3)	54(18.0)	175(58.3)
SDH4	3.50(1.18)	4.00(1)	14(4.7)	54(18.0)	74(24.7)	84(28.0)	74(24.7)
SDH5	3.24(1.29)	3.00(2)	36(12.0)	54(18.0)	73(24.3)	77(25.7)	60(20.0)
SDH6	3.87(1.10)	4.00(2)	11(3.7)	26(8.7)	58(19.3)	100(33.3)	105(35.0)
SDH7	3.74(1.09)	4.00(2)	11(3.7)	31(10.3)	67(22.3)	106(35.3)	85(28.3)
SDH8	3.61(1.13)	4.00(2)	15(5.0)	35(11.7)	77(25.7)	97(32.3)	76(25.3)
SDH9	3.64(1.14)	4.00(2)	16(5.3)	34(11.3)	69(23.0)	103(34.3)	78(26.0)
SDH10	2.60(1.23)	2.00(1)	65(21.7)	89(29.7)	76(25.3)	42(14.0)	28(9.3)
SDH11	3.41(1.23)	4.00(1)	29(9.7)	44(14.7)	63(21.0)	104(34.7)	60(20.0)
SDH12	3.29(1.18)	3.00(2)	24(8.0)	56(18.7)	77(25.7)	94(31.3)	49(16.3)
SDH13	4.00(1.27)	5.00(2)	18(6.0)	34(11.3)	32(10.7)	62(20.7)	154(51.3)
SDH14	3.56(1.20)	4.00(1)	23(7.7)	39(13.0)	55 (18.3)	113(37.7)	70(23.3)
SDH15	3.92(1.24)	4.00(2)	17(5.7)	34(11.3)	39(13.0)	76(25.3)	134(44.7)
SDH16	3.89(1.22)	4.00(2)	16(5.3)	35(11.7)	38(12.7)	88(29.3)	123(41.0)
SDH17	3.63(1.19)	4.00(2)	17(5.7)	41(13.7)	62(20.7)	96(32.0)	84(28.0)
SDH18	3.13(1.08)	3.00(2)	25(8.3)	55(18.3)	106(35.3)	85(28.3)	29(9.7)
SDH19	3.19(1.10)	3.00(2)	23(7.7)	55(18.3)	95(31.7)	95(31.7)	32(10.7)
SDH20	3.03(1.11)	3.00(2)	28(9.3)	67(22.3)	102(34.0)	75(25.0)	28(9.3)

Note: SDH1 – SDH10 (1 = totally unsatisfied, 2 = unsatisfied, 3 = somewhat satisfied, 4 = satisfied, 5 = totally satisfied), SDH11 – SDH20 (1 = very poor, 2 = poor, 3 = somewhat good, 4 = good, 5 = very good), SD = standard deviation, IQR = interquartile range.

Table 6.3 presents the descriptive distribution of EDHQ items. The expected minimum and maximum scores were 18 and 90, respectively, with natural and built environments expected to range from 8 to 40 and 10 to 50, respectively. The mean (SD) score for the total EDHQ was 56.1 (15.55), with actual scores ranging from 18.0 to 90.0. For the natural environment, the mean (SD) was 24.2 (7.71), and for the built environment, it was 31.9 (9.35). Item EDH4 (I always have access to clean drinking water) had the highest rating of 5 (strongly agree) by 17.7% of respondents, while item EDH2 (There is assistance available during extreme weather) received the highest rating of 1 (strongly disagree) by 23.3% of respondents.

Table 6.3: Score distribution of the EDHQ (N = 300), Nigerian students

Items	Mean (SD)	Median (IQR)	Score 1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)
EDH1	2.52(1.11)	2.00(1)	64(21.3)	88(29.3)	89(29.7)	47(15.7)	12(4.0)
EDH2	2.47(1.13)	2.00(1)	70(23.3)	89(29.7)	84(28.0)	43(14.3)	14(4.7)
EDH3	3.06(1.22)	3.00(2)	44(14.7)	49(16.3)	86(28.7)	87(29.0)	34(11.3)
EDH4	3.37(1.25)	4.00(1)	38(12.7)	31(10.3)	67(22.3)	111(37.0)	53(17.7)
EDH5	3.33(1.24)	4.00(1)	37(12.3)	35(11.7)	72(24.0)	105(35.0)	51(17.0)
EDH6	3.29(1.26)	3.00(1)	40(13.3)	34(11.3)	77(25.7)	97(32.3)	52(17.3)
EDH7	2.89(1.30)	3.00(2)	60(20.0)	58(19.3)	71(23.7)	78(26.0)	33(11.0)
EDH8	3.25(1.16)	4.00(2)	32(10.7)	44(14.7)	73(24.3)	118(39.3)	33(11.0)
EDH9	3.23(1.19)	3.50(2)	37(12.3)	41(13.7)	72(24.0)	117(39.0)	33(11.0)
EDH10	3.08(1.14)	3.00(2)	34(11.3)	59(19.7)	79(26.3)	105(35.0)	23(7.7)
EDH11	3.06(1.21)	3.00(2)	43(14.3)	52(17.3)	78(26.0)	97(32.3)	30(10.0)
EDH12	3.46(1.16)	4.00(1)	28(9.3)	31(10.3)	65(21.7)	128(42.7)	48(16.0)
EDH13	3.38(1.15)	4.00(1)	30(10.0)	32(10.7)	71(23.7)	127(42.3)	40(13.3)
EDH14	3.09(1.17)	3.00(2)	35(11.7)	53(17.7)	95(31.7)	84(28.0)	33(11.0)
EDH15	2.89(1.23)	3.00(2)	53(17.7)	56(18.7)	88(29.3)	76(25.3)	27(9.0)
EDH16	3.08(1.28)	3.00(2)	49(16.3)	49(16.3)	66(22.0)	100(33.3)	36(12.0)
EDH17	3.3(1.11)	3.00(1)	29(9.7)	34(11.3)	88(29.3)	116(38.7)	33(11.0)
EDH18	3.36(1.15)	4.00(1)	29(9.7)	35(11.7)	77(25.7)	118(39.3)	41(13.7)

Note: 1 = strongly disagree, 2 = disagree, 3 = somewhat disagree, 4 = agree, 5 = strongly agree, SD = standard deviation, IQR = interquartile range.

Table 6.4 presents the descriptive distribution of DLQ items. The expected minimum and maximum scores were 18 and 90, respectively, with both the physiological, psychosocial, and environmental demands expected to range from 6 to 30 each. The mean (SD) score for the total DLQ was 63.0 (12.47), with actual scores ranging from 18.0 to 90.0. For the physiological demands, the mean (SD) was 22.6 (6.47), for the psychosocial demands, it was 23.2 (5.82), and for the environmental demands, it was 17.2 (6.65). Item DL1 (How frequently do you experience respiratory issues, such as difficulty breathing?) had the highest rating of 5 (almost every day) by 72.3% of respondents, while item DL13 (On average, how often are you busy?) received the highest rating of 1 (not at all) by 42.3% of respondents.

Table 6.4: Score distribution of the DLQ (N = 300), Nigerian students

Items	Mean (SD)	Median (IQR)	Score 1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)
DL1	4.39(1.15)	5.00(1)	15(5.0)	18(6.0)	19(6.3)	31(10.3)	217(72.3)
DL2	4.23(1.23)	5.00(1)	20(6.7)	17(5.7)	27(9.0)	45(15.0)	191(63.7)
DL3	3.90(1.38)	5.00(2)	32(10.7)	18(6.0)	54(18.0)	40(13.3)	156(52.0)
DL4	3.26(1.48)	3.00(3)	59(19.7)	31(10.3)	73(24.3)	48(16.0)	89(29.7)
DL5	3.44(1.51)	4.00(3)	57(19.0)	22(7.3)	63(21.0)	48(16.0)	110(36.7)
DL6	3.36(1.54)	4.00(3)	60(20.0)	33(11.0)	53(17.7)	47(15.7)	107(35.7)
DL7	3.76(1.34)	4.00(2)	26(8.7)	25(8.3)	80(26.7)	32(10.7)	137(45.7)
DL8	3.84(1.20)	4.00(2)	16(5.3)	19(6.3)	89(29.7)	49(16.3)	127(42.3)
DL9	4.01(1.19)	5.00(2)	16(5.3)	14(4.7)	71(23.7)	48(16.0)	151(50.3)
DL10	3.55(1.30)	4.00(2)	28(9.3)	34(11.3)	81(27.0)	58(19.3)	99(33.0)
DL11	3.85(1.28)	4.00(2)	23(7.7)	19(6.3)	74(24.7)	48(16.0)	136(45.3)
DL12	4.17(1.16)	5.00(2)	14(4.7)	11(3.7)	63(21.0)	33(11.0)	179(59.7)
DL13	2.29(1.46)	2.00(2)	127(42.3)	72(24.0)	38(12.7)	14(4.7)	49(16.3)
DL14	2.33(1.44)	2.00(2)	120(40.0)	70(23.3)	49(16.3)	13(4.3)	48(16.0)
DL15	3.45(1.44)	4.00(3)	36(12.0)	55(18.3)	56(18.7)	43(14.3)	110(36.7)
DL16	2.64(1.54)	2.00(3)	104(34.7)	51(17.0)	57(19.0)	25(8.3)	63(21.0)
DL17	3.30(1.45)	3.00(3)	41(13.7)	60(20.0)	67(22.3)	31(10.3)	101(33.7)
DL18	3.22(1.36)	3.00(3)	39(13.0)	55(18.3)	83(27.7)	46(15.3)	77(25.7)

Note: 1 = not at all, 2 = 1/month, 3 = 1-2 times/week, 4 = 3-4 times/week, 5 = almost every day, SD = standard deviation, IQR = interquartile range.

Table 6.5 presents the descriptive distribution of IPQ items. The expected minimum and maximum scores were 14 and 56, respectively, with biologically given potential and personally acquired potential expected to range from 6 to 24 and 8 to 32, respectively. The mean (SD) score for the total IPQ was 31.7 (6.23), with actual scores ranging from 14.0 to 56.0. For the biologically given potential, the mean (SD) was 9.4 (4.48), and for the personally acquired potential, it was 22.3 (6.14). Item IP7 (Do you believe that you can accomplish your life goals regardless of the circumstances?) had the highest rating of 4 (very often) by 52.3% of respondents, while item IP6 (Do you have any chronic conditions that are limiting your daily activities?) received the highest rating of 1 (not at all) by 69.7% of respondents.

Table 6.5: Score distribution of the IPQ (N = 300), Nigerian students

Items	Mean (SD)	Median (IQR)	Score 1 n (%)	2 n (%)	3 n (%)	4 n (%)
IP1	1.55(0.85)	1.00(1)	198(66.0)	46(15.3)	48(16.0)	8(2.7)
IP2	1.55(0.85)	1.00(1)	198(66.0)	46(15.3)	49(16.3)	7(2.3)
IP3	1.71(0.92)	1.00(1)	170(56.7)	61(20.3)	56(18.7)	13(4.3)
IP4	1.52(0.86)	1.00(1)	206(68.7)	44(14.7)	39(13.0)	11(3.7)
IP5	1.57(0.91)	1.00(1)	203(67.7)	35(11.7)	49(16.3)	13(4.3)
IP6	1.49(0.83)	1.00(1)	209(69.7)	44(14.7)	38(12.7)	9(3.0)
IP7	3.23(0.94)	4.00(1)	16(5.3)	57(19.0)	70(23.3)	157(52.3)
IP8	2.82(1.03)	3.00(2)	35(11.7)	86(28.7)	76(25.3)	103(34.3)
IP9	2.35(0.89)	2.00(1)	49(16.3)	130(43.3)	87(29.0)	34(11.3)
IP10	3.02(0.84)	3.00(2)	12(4.0)	68(22.7)	123(41.0)	97(32.3)
IP11	2.27(1.03)	2.00(1)	74(24.7)	125(41.7)	46(15.3)	55(18.3)
IP12	2.69(0.92)	3.00(1)	30(10.0)	98(32.7)	107(35.7)	65(21.7)
IP13	3.12(0.98)	3.00(2)	18(6.0)	72(24.0)	65(21.7)	145(48.3)
IP14	2.77(0.93)	3.00(1)	30(10.0)	82(27.3)	114(38.0)	74(24.7)

Note: IP1 – IP6 (1 = none, 2 = mild, 3 = moderate, 4 = severe), IP7 – IP14 (1 = not at all, 2 =rarely, 3 = often, 4 = very often), SD = standard deviation, IQR = interquartile range.

6.2.4 Model assumption checking

Before conducting the EFA, we assessed the data for adherence to assumptions regarding positive definiteness and multicollinearity. We confirmed positive definiteness by applying principal component analysis to the sample covariance matrix, thereby verifying that the covariance matrix was positive-definite. Additionally, we used the variance inflation factor (VIF) and tolerance (squared multiple correlation) to examine multicollinearity. Results indicated that tolerance exceeded 0.1 and VIF was below 10 for each item, suggesting that there was no multicollinearity issue.

6.2.5 EFA model of the holistic health questionnaires

Following assumption checking, which revealed that the assumptions were not met for all the items, principal axis factoring and Promax rotation were used in the

EFA process. Principal axis factoring can handle data with non-normal distributions (Costello & Osborne, 2019).

6.2.5(a) EFA results of the SDHQ

The initial EFA model of the SDHQ with 20 items yielded good sampling adequacy with an estimated Kaiser-Meyer-Olkin (KMO) value of 0.899, and the Bartlett's test of sphericity was significant ($p < 0.001$). Thus, the model is considered to have adequate validity. Three factors in the initial EFA model had eigenvalues greater than 1, but only two of the factors loaded well with all the items (Figure 6.1). Hence, the number of factors was set at two in the subsequent stage, which conforms with the SDHQ hypothesized structure. Using principal axis factoring with Promax rotation, two factors were extracted. The findings indicate that the two factors had factor loadings greater than 0.40 with no cross-loadings, a factor correlation of 0.178, communality of 0.311 to 0.774, and a cumulative percentage of 61.8%. As such, none of the items were deleted from the EFA (Table 6.6).

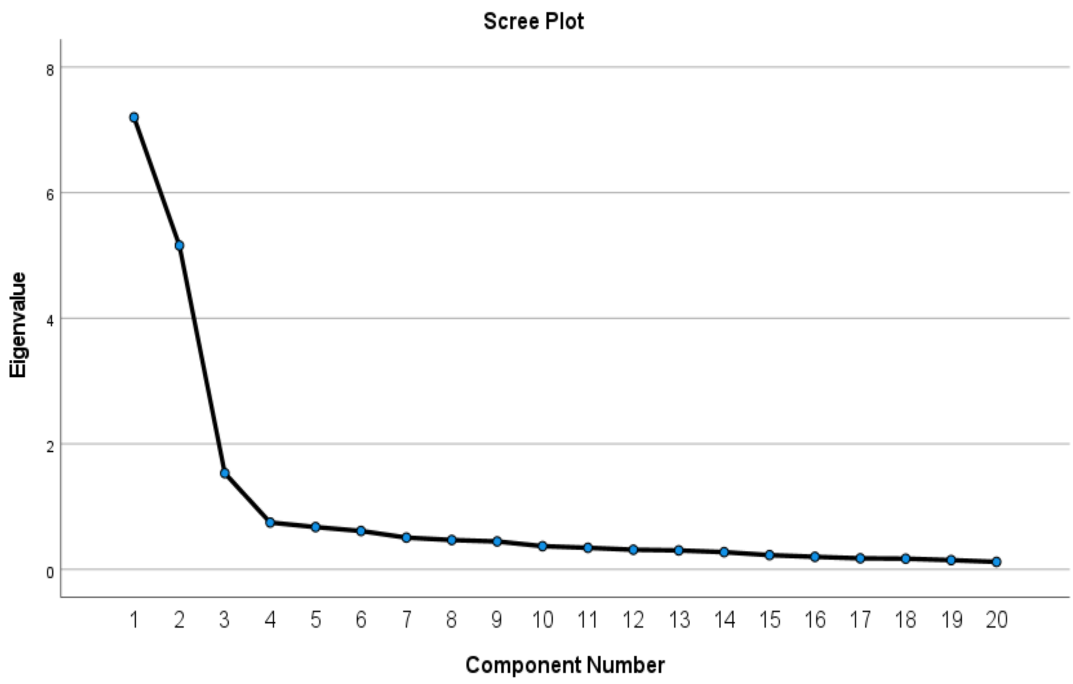

Figure 6.1: Scree Plot of the SDHQ constructs (Nigerian students)

Table 6.6: Exploratory Factor Analysis of the SDHQ (N = 300), Nigerian students

Items	Communality	Factor loading	
		1	2
SDH1	0.586	0.738	
SDH2	0.471	0.694	
SDH3	0.584	0.745	
SDH4	0.549	0.746	
SDH5	0.457	0.684	
SDH6	0.623	0.784	
SDH7	0.633	0.789	
SDH8	0.603	0.781	
SDH9	0.614	0.776	
SDH10	0.311	0.557	
SDH11	0.567		0.757
SDH12	0.613		0.789
SDH13	0.635		0.793
SDH14	0.609		0.784
SDH15	0.661		0.803
SDH16	0.774		0.869
SDH17	0.69		0.823
SDH18	0.553		0.751
SDH19	0.588		0.776
SDH20	0.414		0.757
Eigenvalue		7.20	5.16
Variance explained (%)		36.00	25.80
Cumulative variance (%)		36.00	61.80

Note: Factor correlation = 0.178.

6.2.5(b) EFA results of the EDHQ

The estimated KMO value of the EFA model of the initial EDHQ with 18 items was 0.937, and the Bartlett's test of sphericity was significant ($p < 0.001$). As a result, the model is considered to have sufficient validity. In the initial EFA model, three factors exhibited eigenvalues exceeding 1; however, the items demonstrated satisfactory factor loadings on only two of these factors (Figure 6.2). Thus, in accordance with the hypothesized structure of the EDHQ, the number of factors was fixed at two in the subsequent stage. Two factors were obtained with Promax rotation and Principal Axis Factoring. The results indicate that the two factors displayed factor loadings exceeding 0.40, with no instances of cross-loadings. The factor correlation was 0.671, communality of 0.344 to 0.705, and the cumulative percentage was 63.5%. Consequently, all items were retained in the final EFA, as shown in Table 6.7.

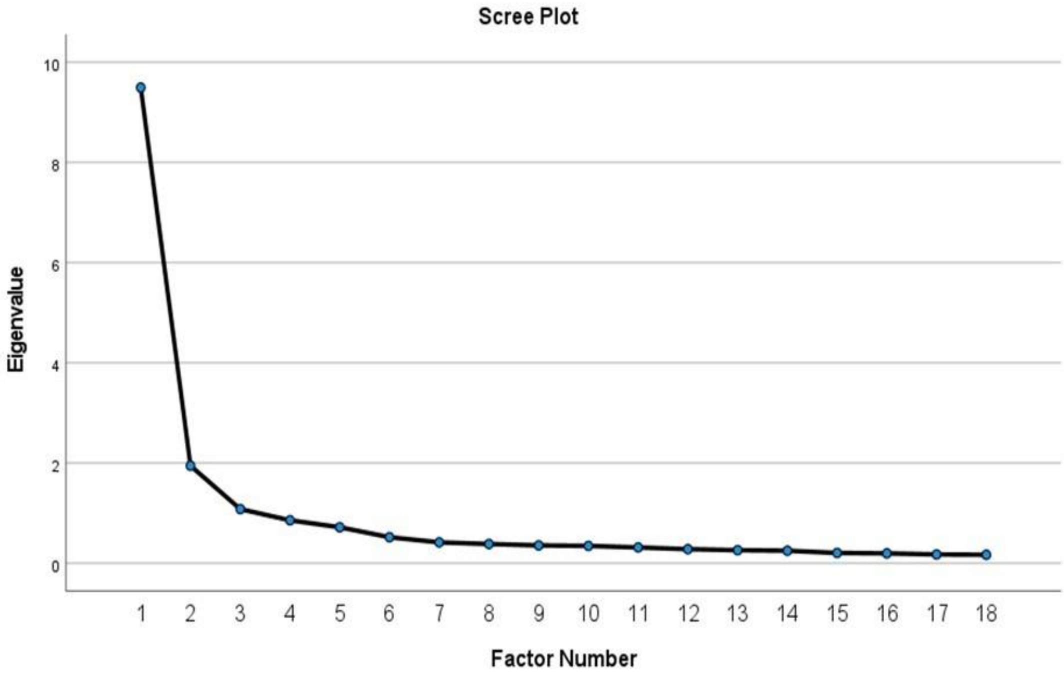

Figure 6.2: Scree Plot of the EDHQ constructs (Nigerian students)

Table 6.7: Exploratory Factor Analysis of the EDHQ (N = 300), Nigerian students

Items	Communality	Factor loading	
		1	2
EDH1	0.344	0.570	
EDH2	0.429	0.580	
EDH3	0.639	0.804	
EDH4	0.663	0.841	
EDH5	0.694	0.796	
EDH6	0.705	0.848	
EDH7	0.570	0.745	
EDH8	0.665	0.782	
EDH9	0.559		0.628
EDH10	0.489		0.634
EDH11	0.636		0.731
EDH12	0.489		0.660
EDH13	0.564		0.767
EDH14	0.667		0.823
EDH15	0.575		0.742
EDH16	0.583		0.839
EDH17	0.691		0.813
EDH18	0.699		0.813
Eigenvalue		9.50	1.95
Variance explained (%)		52.75	10.82
Cumulative variance (%)		52.75	63.57

Note: Factor correlation = 0.671.

6.2.5(c) EFA results of the DLQ

The KMO test yielded a value of 0.842, and the Bartlett's test of sphericity was significant ($p < 0.001$), indicating that factor analysis was appropriate for the dataset. Three factors emerged, with Eigenvalues greater than 1, collectively explaining 61.9% of the variance (Figure 6.3). The factor loadings of all 18 items were greater than 0.4 (Table 4.21). Furthermore, there were no instances of cross-loadings among items, communality of 0.344 to 0.705, and the range of factor correlations was 0.039–0.329, indicating adequate validity of the model (Table 6.8). Consequently, three factors were retained in accordance with the initially hypothesized structure of the DLQ. Promax rotation and principal axis factoring techniques were employed to derive these three factors.

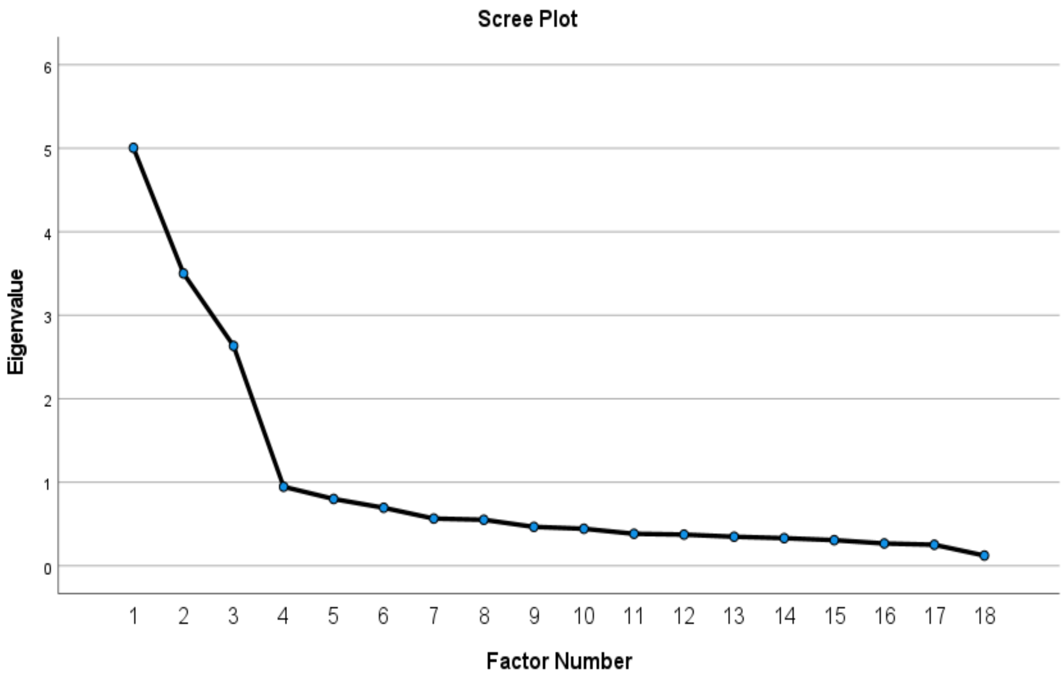

Figure 6.3: Scree Plot of the DLQ constructs (Nigerian students)

Table 6.8: Exploratory Factor Analysis of the DLQ (N = 300), Nigerian students

Items	Communality	Factor loading		
		1	2	3
DL1	0.492	0.619		
DL2	0.508	0.631		
DL3	0.591	0.766		
DL4	0.594	0.789		
DL5	0.590	0.783		
DL6	0.512	0.738		
DL7	0.440		0.648	
DL8	0.617		0.780	
DL9	0.708		0.844	
DL10	0.381		0.574	
DL11	0.524		0.728	
DL12	0.570		0.772	
DL13	0.699			0.823
DL14	0.764			0.865
DL15	0.357			0.559
DL16	0.530			0.727
DL17	0.440			0.611
DL18	0.523			0.681
Eigenvalue		5.01	3.50	2.63
Variance explained (%)		27.81	19.45	14.63
Cumulative variance (%)		27.81	47.26	61.89

Note: Factor correlation = Factor correlation = 0.329 (Physiological and psychosocial), 0.039 (psychosocial and environmental), 0.051 (physiological and environmental).

6.2.5(d) EFA results of the IPQ

The Bartlett's sphericity test revealed a significant result (p-value < 0.001), and the estimated KMO value of the EFA model of the original IPQ with 14 items was 0.905. The model is thus considered to have adequate convergent validity. In the preliminary EFA model, we identified two factors with eigenvalues greater than 1 and satisfactory factor loadings for all items (Figure 6.4). As a result, in the subsequent step, we set the number of factors at two in accordance with the initial hypothesised structure of the IP-Q. To generate the two factors, we used Promax rotation and principal axis factoring. The two factors had a cumulative percentage of 69.8%, factor loadings > 0.40, no cross-loadings, communality of 0.402 to 0.857, and a factor correlation of -0.361 (Table 6.9). Thus, the EFA did not require the removal of any items.

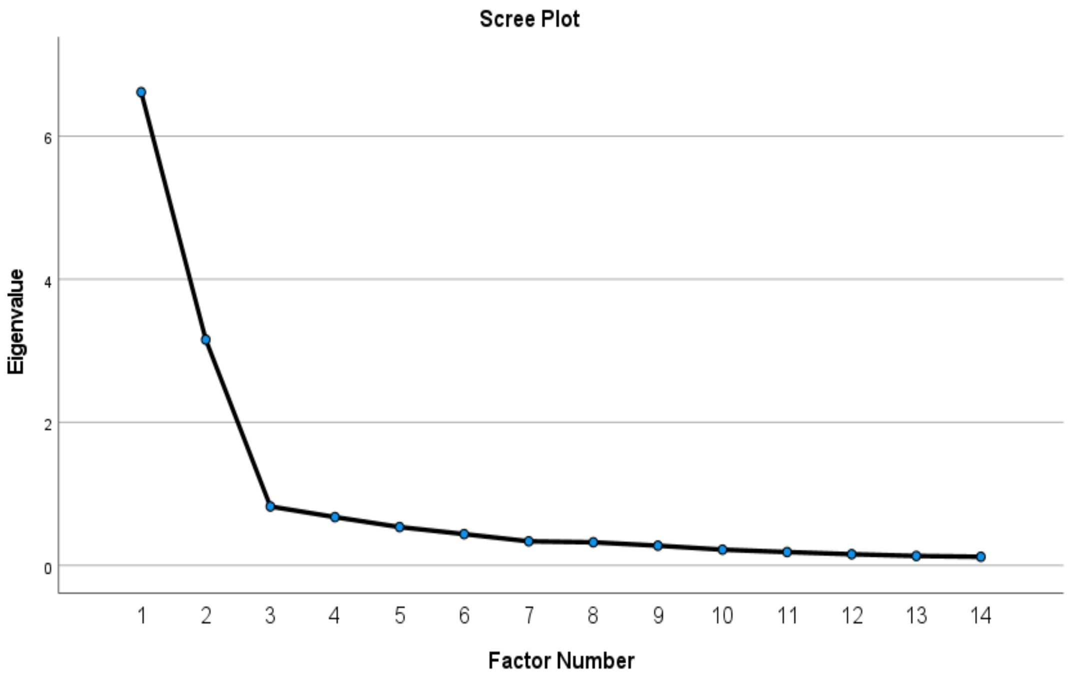

Figure 6.4: Scree Plot of the IPQ constructs (Nigerian students)

Table 6.9: Exploratory Factor Analysis of the IPQ (N = 300), Nigerian students

Items	Communality	Factor loading	
		1	2
IP1	0.594	0.739	
IP2	0.572	0.726	
IP3	0.680	0.848	
IP4	0.802	0.902	
IP5	0.777	0.901	
IP6	0.720	0.835	
IP7	0.496		0.701
IP8	0.402		0.629
IP9	0.839		0.909
IP10	0.491		0.686
IP11	0.790		0.897
IP12	0.497		0.723
IP13	0.625		0.771
IP14	0.857		0.933
Eigenvalue		6.62	3.16
Variance explained (%)		47.26	22.55
Cumulative variance (%)		47.26	69.81

Note: Factor correlation = -0.361.

6.3 CFA Nigerian based sample

This section presents the CFA results of the newly developed holistic health questionnaires conducted among Nigerian undergraduate students during the study's phase II. We divide this part into four sub-sections: preliminary data assessment, descriptive characteristics of the study participants, model assumption checking, and the CFA model of the holistic health questionnaires.

6.3.1 Preliminary data assessment

We examined the percentage of missing data for each item in each questionnaire. There were no items with missing values, and as a result, the response rate was 100% for all of the questionnaires

6.3.2 Descriptive characteristics of the study participants

Table 6.10 presents the general characteristics of study participants for the CFA sample. There were a total of 430 students (male 54.0%, female 46.0%), with a mean age of 22.4 (SD = 2.43). The mean frequency and duration of exercise per week were 3.4 (SD = 2.12) and 46.2 (SD = 52.01), respectively. More than half of the students were Hausa (70.9%) and studied medicine (53.4%). Furthermore, most of the students were in Year 3 (70.0%).

Table 6.10: General Characteristics of the Participants in CFA (N = 430), Nigerian students

Variables	Mean (SD)	n (%)
Age	22.4 (2.43)	
Frequency of exercise/week	3.4 (2.12)	
Duration of exercise (min)	46.2 (52.01)	
Gender		
Male		232 (54.0)
Female		198 (46.0)
Ethnicity		
Hausa		305 (70.9)
Yoruba		45 (10.5)
Igbo		6 (1.4)
Others		74 (17.2)
Field of study		
Medicine		229 (53.4)
Human anatomy		118 (27.5)
Human physiology		82 (19.1)
Study year		
Year 1		16 (3.7)
Year 2		14 (3.3)
Year 3		301 (70.0)
Year 4		99 (23.0)

SD = standard deviation, min = minutes.

6.3.3 Model assumption checking

6.3.3(a) Univariate normality

We assessed the univariate normality for each item in SDHQ, EDHQ, DLQ, and IPQ using skewness and kurtosis values obtained from the Mplus output.

According to the results, some items exhibited univariate non-normality (p-value < 0.05), as presented in Appendix J.

6.3.3(b) Multivariate normality

We assessed the multivariate normality for each item in SDHQ, EDHQ, DLQ, and IPQ using Mardia Kurtosis and Skewness p-values. The results reveal that both the two-sided multivariate skew test of fit and the two-sided multivariate kurtosis test of fit were significant (p-value < 0.05) (Appendix K). Consequently, all four scales failed to meet the assumption of normality, leading to the application of MLR in subsequent CFAs.

6.3.3(c) Positive definiteness

We verified the positive definiteness assumption for the variance-covariance data matrix by examining the determinant value. The initial models of the SDHQ, EDHQ, DLQ, and IPQ were positively definite, as no warning message indicated positive definiteness in the Mplus output.

6.3.4 Assessing the CFA measurement models

After the preliminary data assessment and model assumption checking, we subsequently tested the CFA measurement models of the SDHQ, EDHQ, DLQ, and IPQ.

6.3.4(a) SDHQ measurement model

The SDHQ measurement model was tested using CFA involving 20 items and two factors: structural determinants of SDH (10 items) and intermediary determinants of SDH (10 items). The results of the initial specified measurement model (Model-1) show poor fit indices (Table 6.11). However, all the items had a standardized factor loading greater than 0.40 (Figure 6.5). After adding 13 pairs of error covariances between items within the same factor, the model fit indices improved (Figure 6.6). The fit indices of the respecified model (Model-2) were acceptable (Table 6.11), with all the items retained. The result of the final model (Model-2) showed standardized factor loading ranging from 0.535 to 0.814, which was considered moderate to very good (Figure 6.6).

Table 6.11: Summary for SDH Model fit indices (N = 430), Nigerian students

Path model	RMSEA (90% CI)	CFI	TLI	SRMR	RMSEA P-value
Model-1	0.093 (0.086, 0.099)	0.779	0.752	0.067	< 0.001
Model-2	0.052 (0.045, 0.060)	0.935	0.921	0.048	0.296

Model-2 with 13 correlated items residual: S20 with S19; S12 with S11; S4 with S2; S3 with S1; S8 with S6; S10 with S8; S8 with S7; S17 with S13; S16 with S14; S9 with S3; S10 with S5; S20 with S18; S20 with S13.

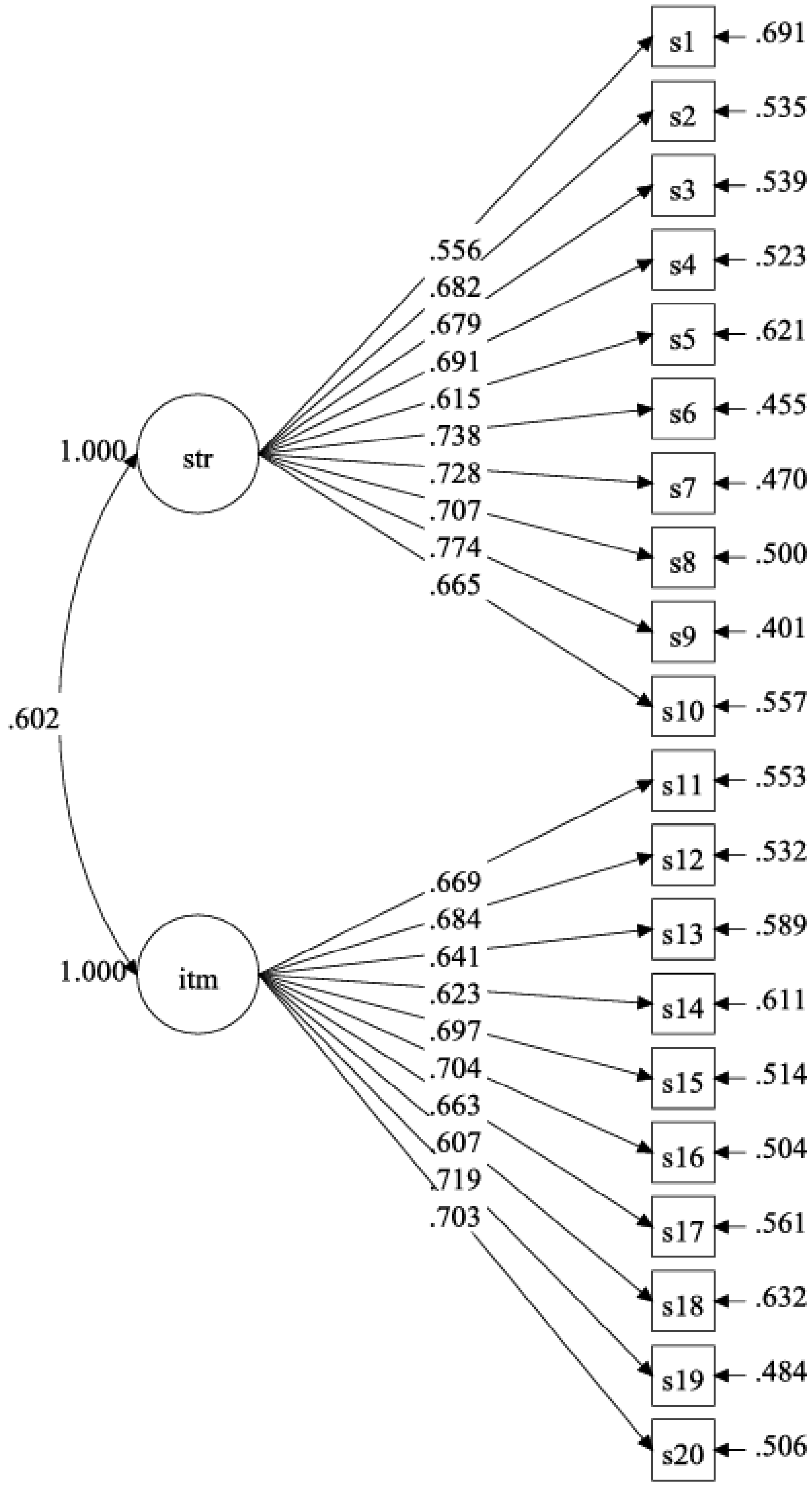

Figure 6.5: SDHQ measurement (Model-1), Nigerian students

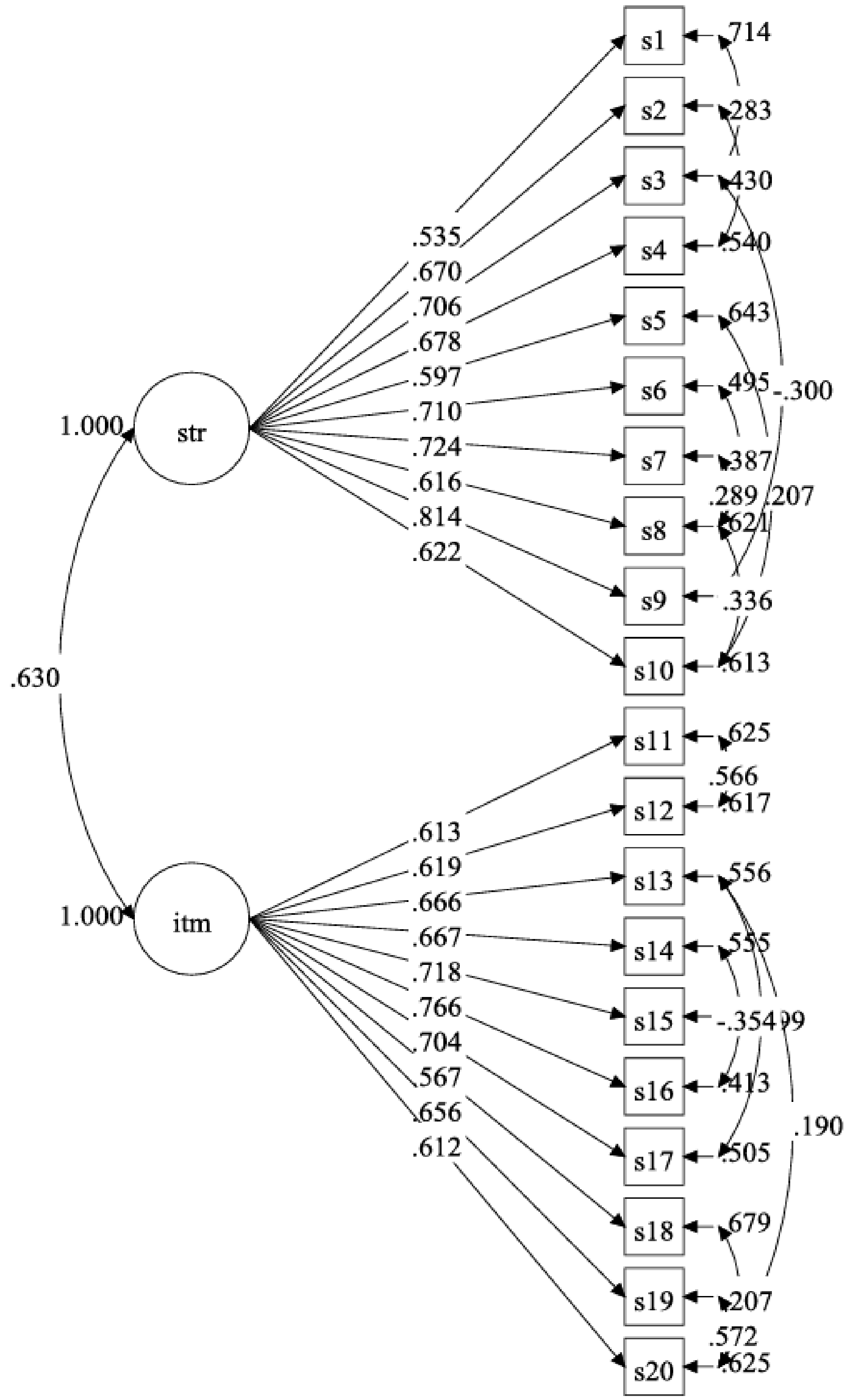

Figure 6.6: SDHQ measurement (Model-2), Nigerian students

The AVE was 0.451 and 0.437 for structural determinants of SDH and intermediary determinants of SDH, respectively. The correlation coefficient between the two factors is 0.216. Furthermore, the squared of the correlation coefficient between the two factors was 0.047, which is lower than all the AVE values. This indicates sufficient discriminant validity (Fornell & Larcker, 1981).

6.3.4(b) EDHQ measurement model

The EDHQ measurement model was tested using CFA with 18 items and two factors: the natural environment (8 items) and the built environment (10 items). The results of model 1 show that the fit indices were not satisfactory (Table 6.12). However, all the items had a standardized factor loading greater than 0.40 (Figure 6.7). After including four pairs of error covariances between items belonging to the same factor, the model fit indices were enhanced (Figure 6.8). The respecified model's (Model-2) fit indices were satisfactory (Table 6.12), and none of the items were removed from the model. The final model's (Model-2) results revealed acceptable factor loadings that ranged from 0.655 to 0.834 and were regarded as moderate to very good (Figure 6.8).

Table 6.12: Summary for EDH-Q Model fit indices (N = 430), Nigerian students

Path model	RMSEA (90% CI)	CFI	TLI	SRMR	RMSEA P-value
Model-1	0.081 (0.073, 0.088)	0.885	0.868	0.049	< 0.001
Model-2	0.053 (0.045, 0.061)	0.951	0.943	0.043	0.253

Model-2 with four correlated items residual: E18 with E17; E10 with E9; E2 with E1; E4 with E4.

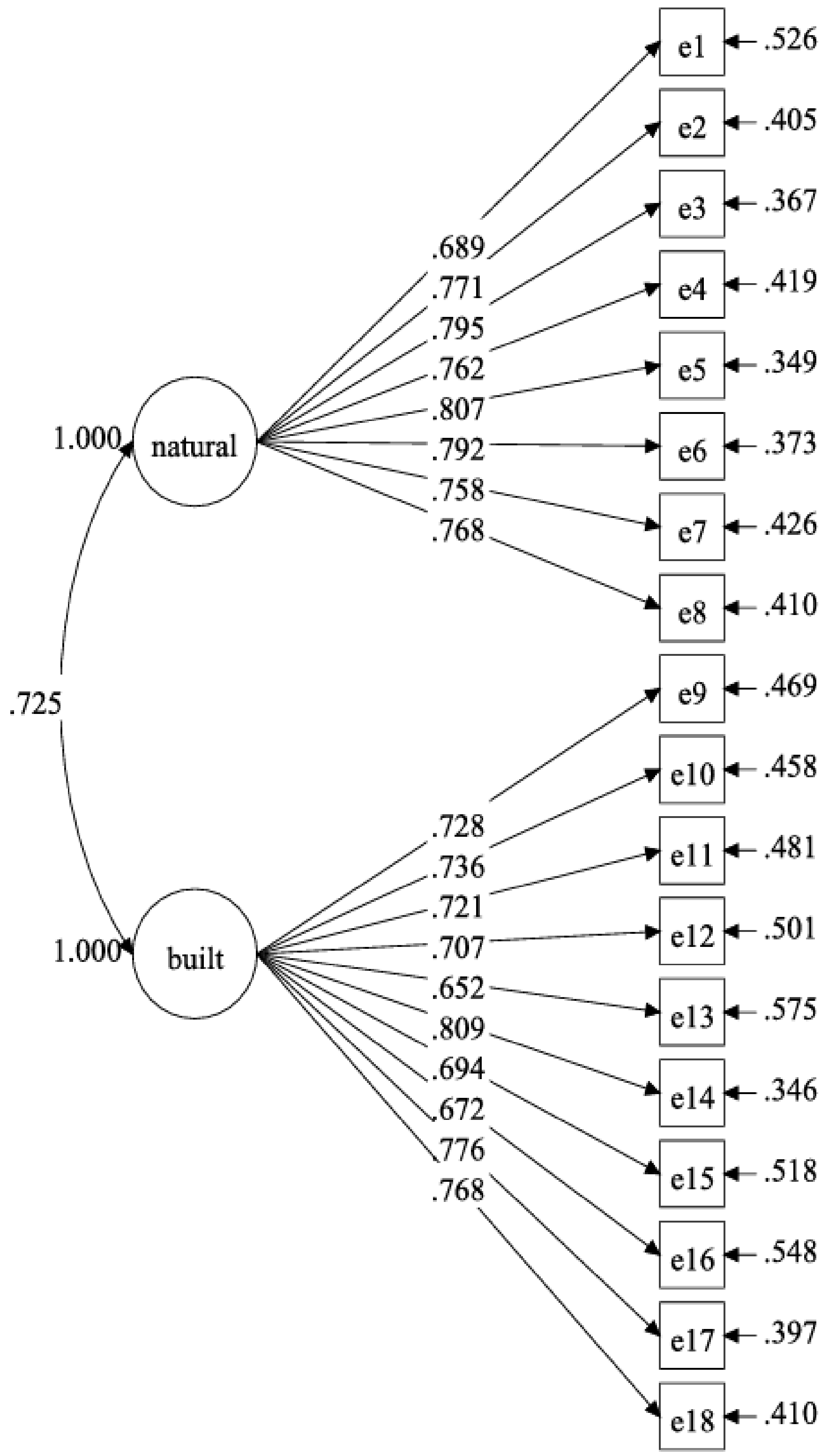

Figure 6.7: EDHQ measurement (Model-1), Nigerian students

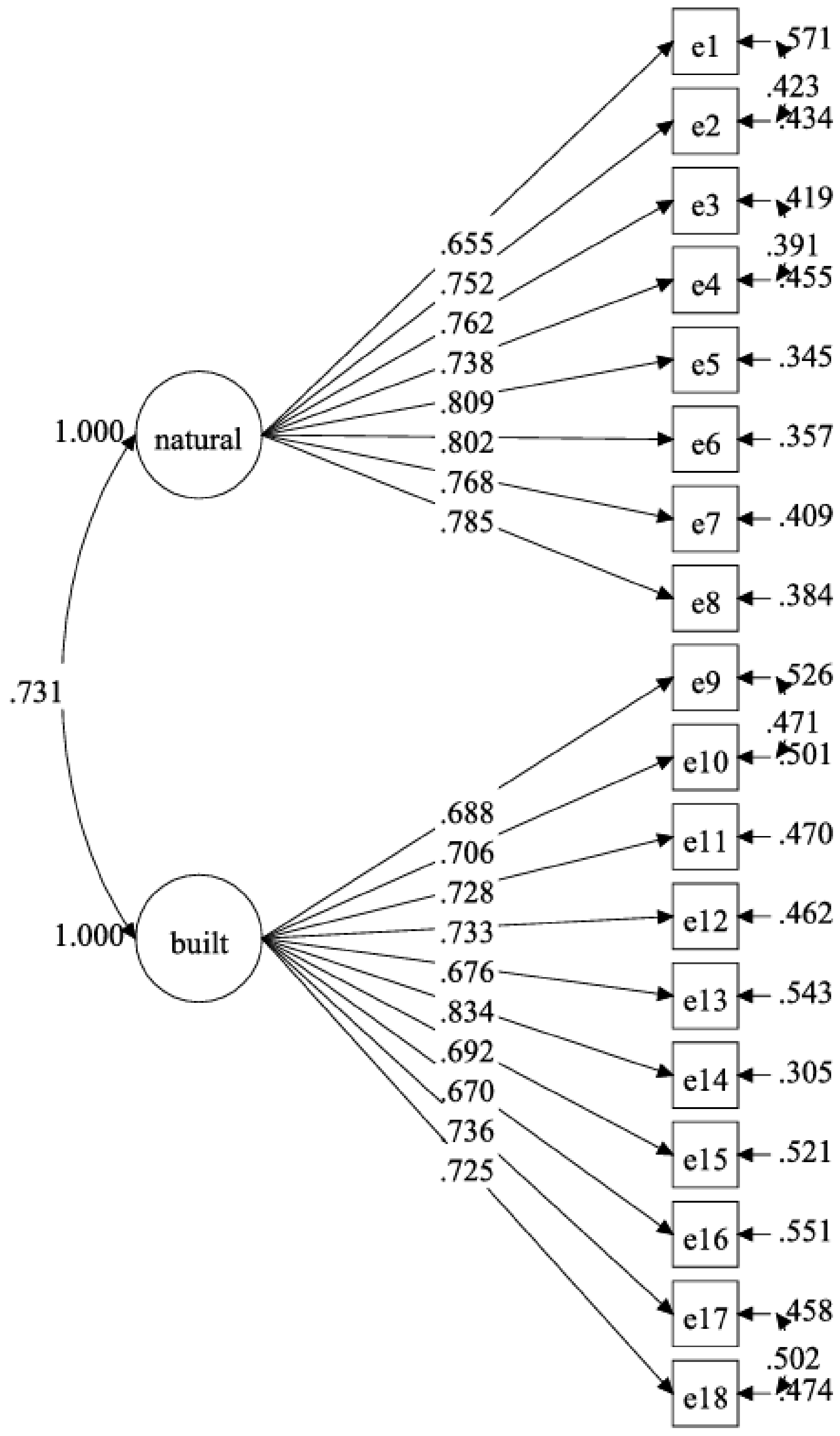

Figure 6.8: EDHQ measurement (Model-2), Nigerian students

The AVEs for the natural environment and the built environment, respectively, were 0.578 and 0.519. The two factors have a correlation coefficient of 0.311. Additionally, the squared correlation coefficient between the factors was 0.097, which is lower than all the AVE values. This shows adequate discriminant validity (Fornell & Larcker, 1981).

6.3.4(c) DLQ measurement model

We tested the DLQ measurement model using CFA, using 18 items that reflected three factors: physiological demand (6 items), psychosocial demand (6 items), and environmental demand (6 items). Model 1's results demonstrate that the fit indices were unsatisfactory (Table 6.13). All of the items, however, had standardized factor loadings higher than 0.40 (Figure 6.9). The model fit indices improved upon the inclusion of three pairs of error covariances between items that belonged to the same factor (Figure 6.10). As such, none of the items were removed from the model, and the respecified model's (Model-2) fit indices were satisfactory (Table 6.13). The final model's (Model-2) results showed factor loadings that were considered to be moderate to very good, with a range of 0.533 to 0.788 (Figure 6.10).

Table 6.13: Summary for DLQ Model fit indices (N = 430), Nigerian students

Path model	RMSEA (90% CI)	CFI	TLI	SRMR	RMSEA P-value
Model-1	0.058 (0.050, 0.066)	0.914	0.900	0.053	0.048
Model-2	0.041 (0.032, 0.050)	0.957	0.949	0.052	0.942

Model-2 with three correlated items residual: DL14 with DL13, DL6 with DL5, DL12 with DL11.

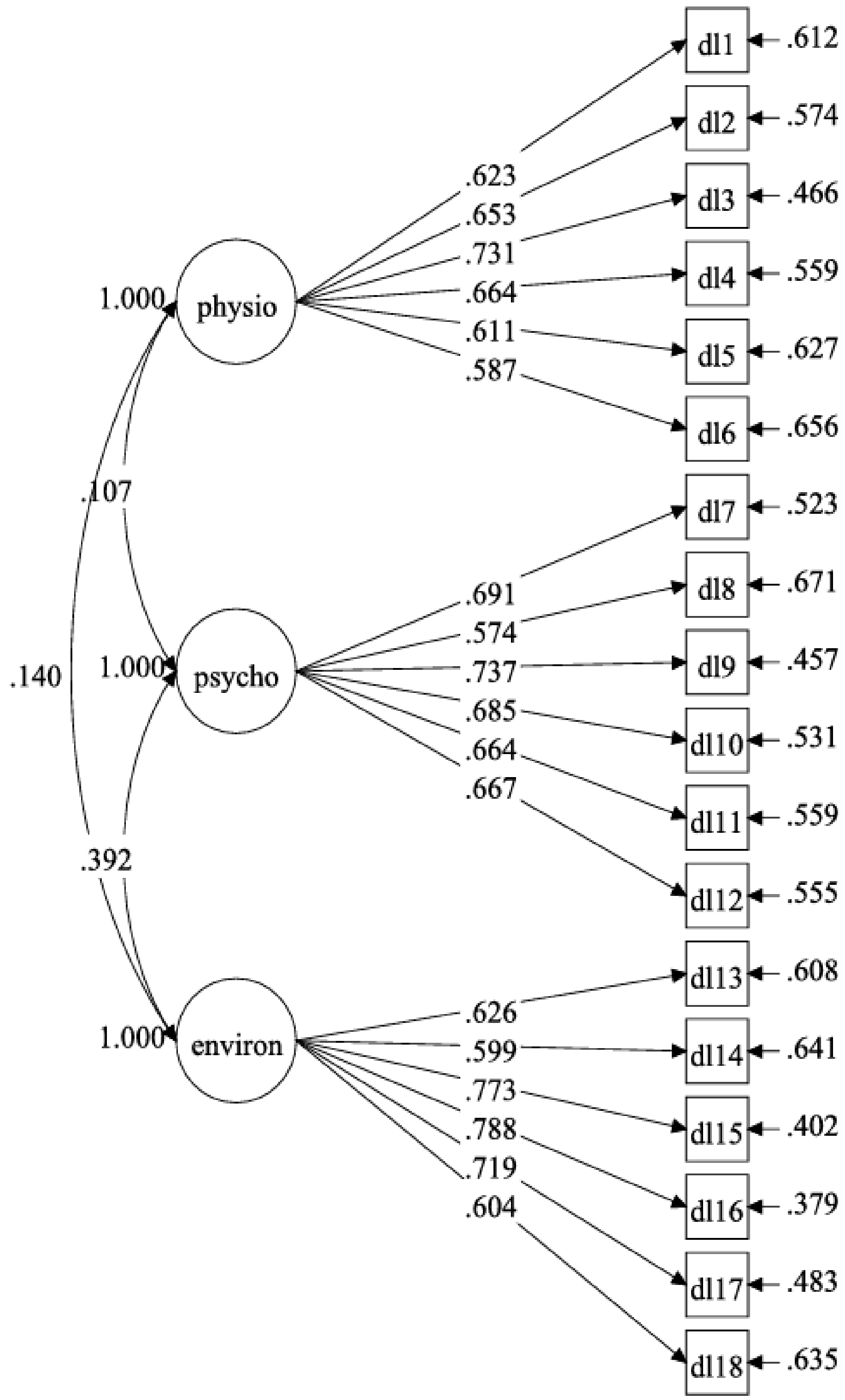

Figure 6.9: DLQ measurement (Model-1), Nigerian students

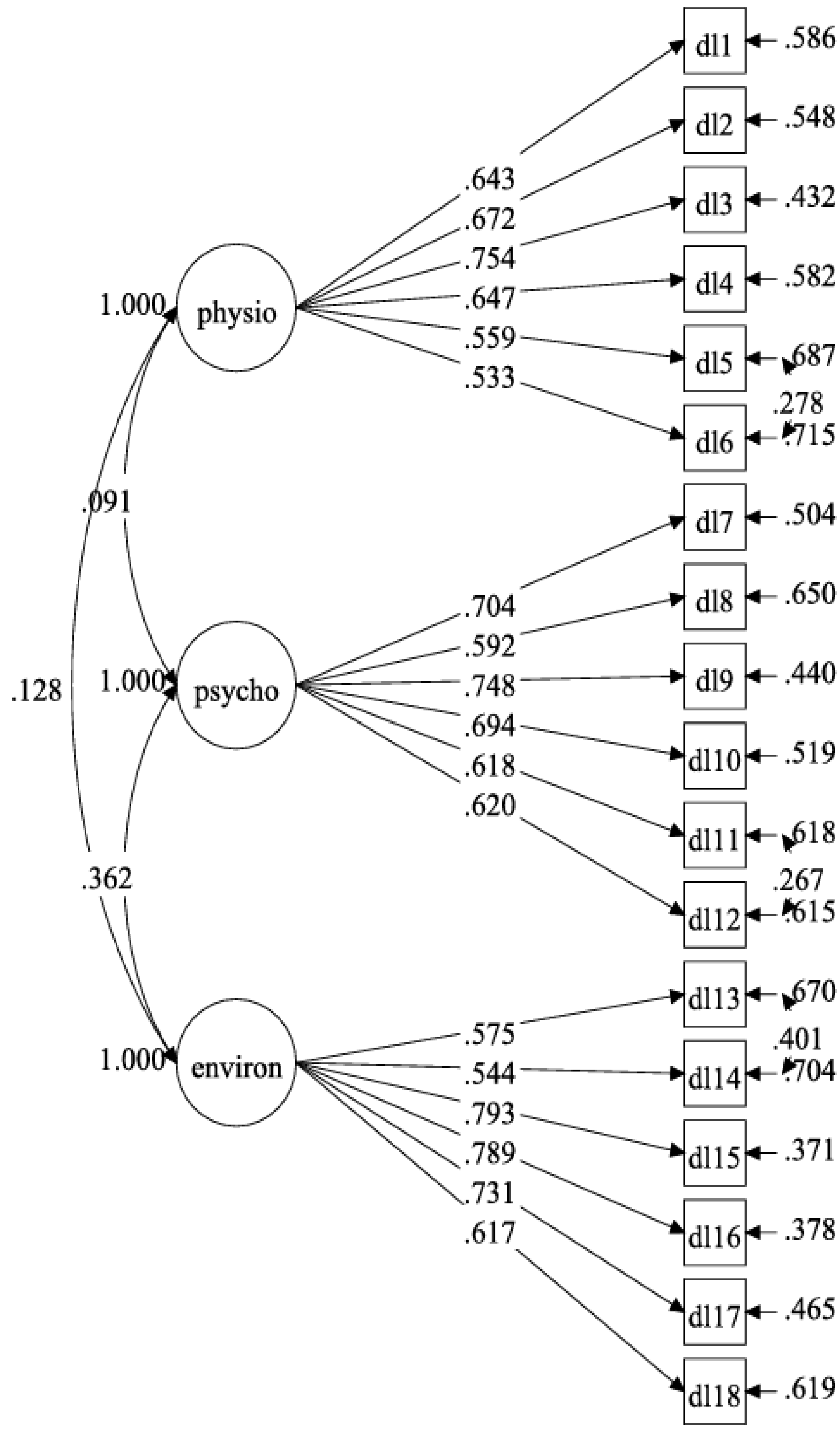

Figure 6.10: DLQ measurement (Model-2), Nigerian students

For physiological, psychosocial, and environmental demands, the AVEs were 0.408, 0.442, and 0.465, respectively. The factor correlations were 0.073 (physiological and psychosocial), 0.077 (physiological and environmental), and 0.255 (psychosocial and environmental). Additionally, all the squared correlation coefficients between the factors were lower than all the AVE values. Thus, the DL-Q has adequate discriminant validity (Fornell & Larcker, 1981).

6.3.4(d) IPQ measurement model

The IPQ measurement model was tested using CFA, which included 14 items reflecting two factors—biologically given potential (6 items) and personally acquired potential (8 items). Model 1's results demonstrate that the fit indices were unsatisfactory (Table 6.14). All of the items, however, had standardized factor loadings higher than 0.40 (Figure 6.11). The model fit indices improved when six pairs of error covariances between items that belonged to the same factor were included (Figure 6.12). The model retained all items, and Model-2's fit indices were satisfactory (Table 6.14). The final model's (Model-2) results showed factor loadings that were considered to be moderate to very good, with a range of 0.684 to 0.954 (Figure 6.12).

Table 6.14: Summary for IPQ Model fit indices (N = 430), Nigerian students

Path model	RMSEA (90% CI)	CFI	TLI	SRMR	RMSEA P-value
Model-1	0.116 (0.106, 0.125)	0.886	0.863	0.078	< 0.001
Model-2	0.065 (0.054, 0.076)	0.967	0.957	0.078	0.011

Model-2 with six correlated items residual: IP10 with IP7; IP2 with IP1; IP11 with IP7; IP13 with IP11; IP11 with IP10; IP12 with IP12.

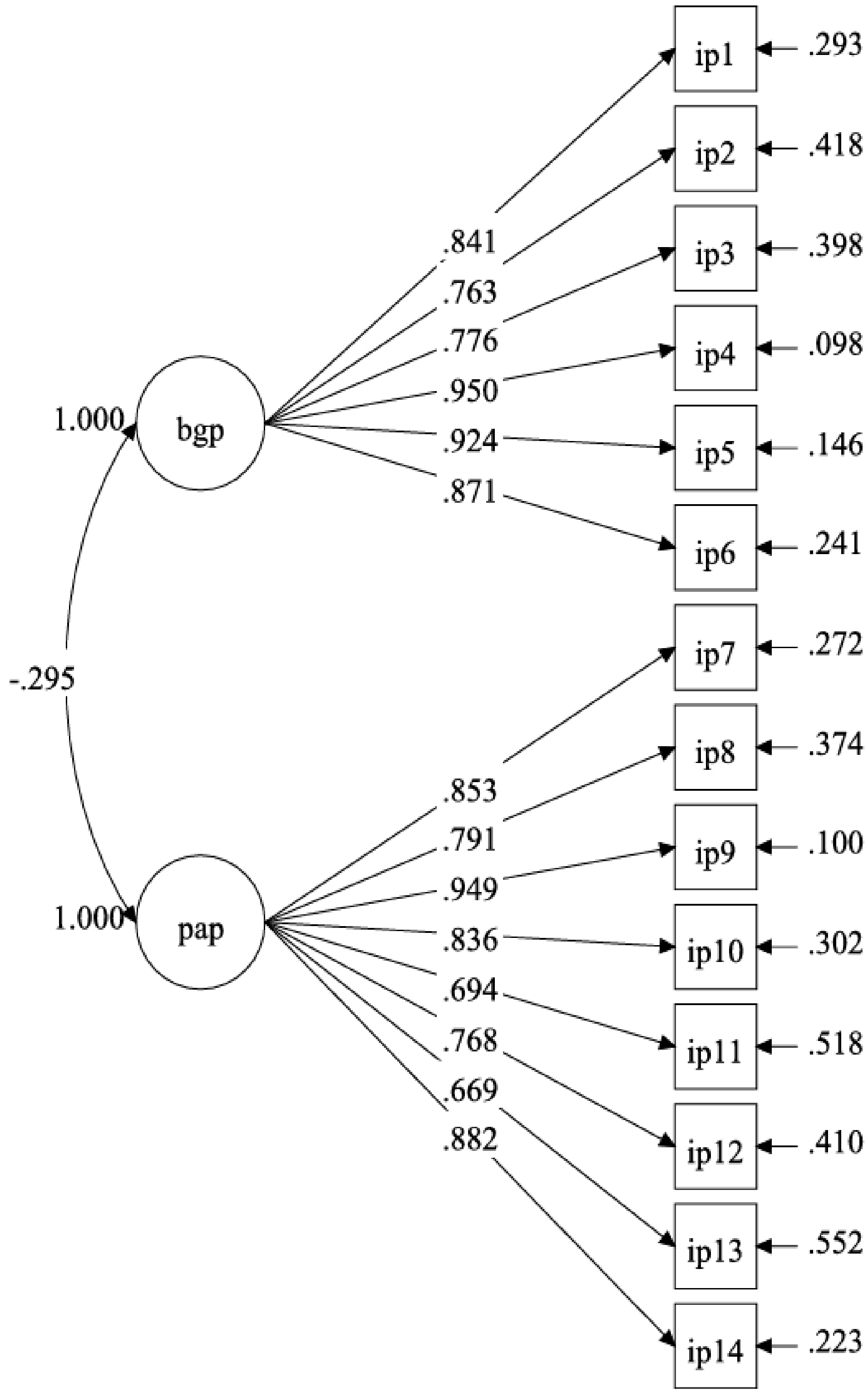

Figure 6.11: IPQ measurement (Model-1), Nigerian students

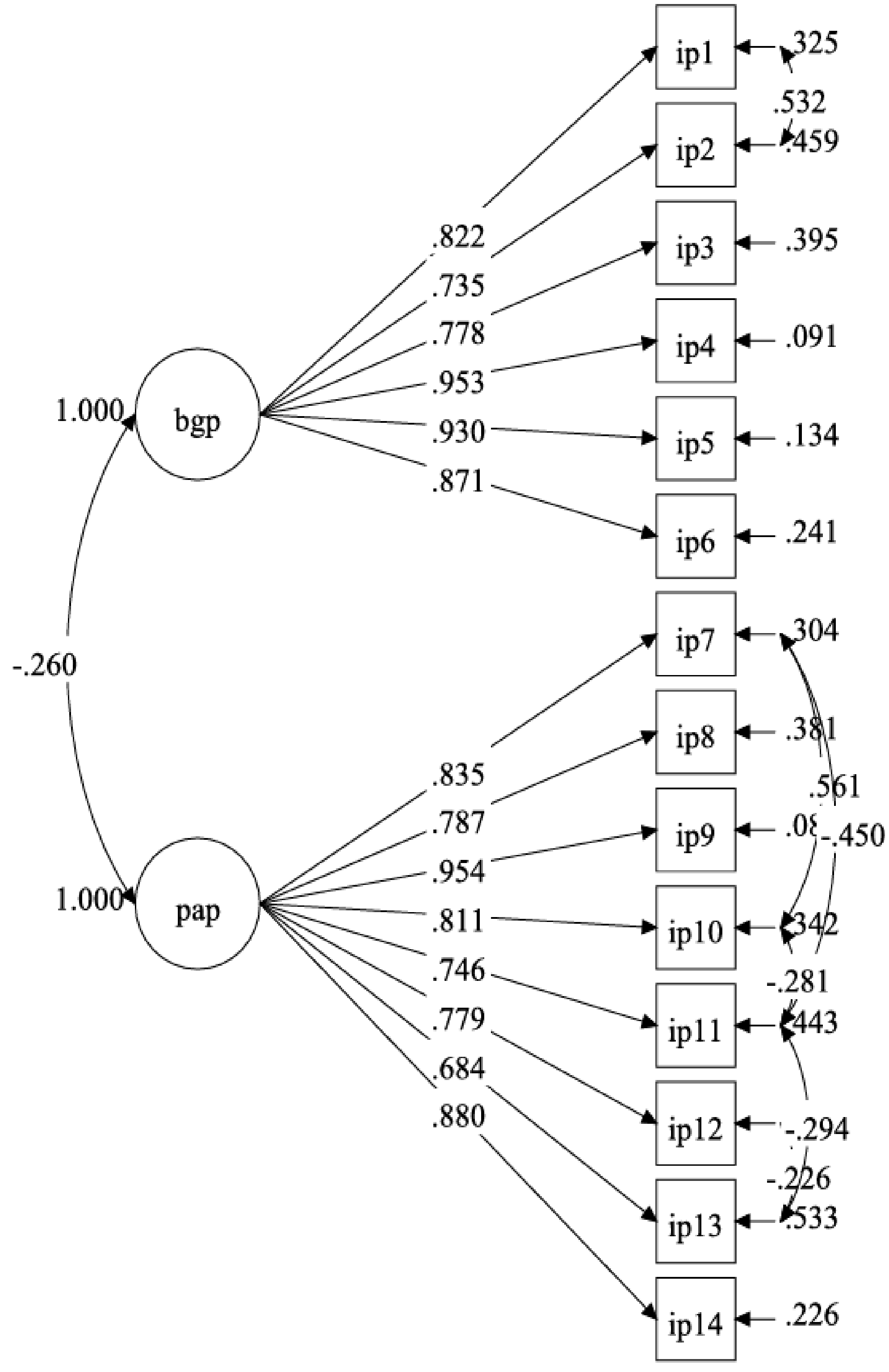

Figure 6.12: IPQ measurement (Model-2), Nigerian students

The AVEs were 0.728 for biologically given potential and 0.679 for personally acquired potential. The correlation coefficient between the factors was -0.160. Additionally, the squared correlation coefficient between the factors (0.026) was lower than the AVE values. As such, the IPQ has adequate discriminant validity (Fornell & Larcker, 1981).

6.4 Reliability results - Nigeria based sample

This section presents the reliability results based on Cronbach's alpha, CR, and ICC of the newly developed holistic health questionnaires conducted among Nigerian undergraduate students during the study's phase II. This section is divided into four sub-sections: SDHQ reliability results, EDHQ reliability results, DLQ reliability results, and IPQ reliability results.

6.4.1 SDHQ reliability results

6.4.1(a) Cronbach's alpha

Table 6.15 presents the SDHQ internal consistency reliability results based on Cronbach's alpha. For the whole scale, the Cronbach's alpha value was 0.902. The Cronbach's alpha values of the two factors were 0.917 (for structural determinants of SDH) and 0.939 (for intermediary determinants of SDH). Furthermore, the results did not recommend deleting any item.

Table 6.15: Internal consistency and reliability of the SDHQ (N = 300), Nigerian students

Item	Corrected item total correlation	Squared multiple correlation	Cronbach's alpha if item deleted	Cronbach's alpha
Structural determinants of SDH				0.917
SDH1	0.583	0.741	0.896	
SDH2	0.445	0.544	0.899	
SDH3	0.565	0.728	0.896	
SDH4	0.496	0.569	0.898	
SDH5	0.438	0.553	0.900	
SDH6	0.553	0.683	0.897	
SDH7	0.572	0.621	0.896	
SDH8	0.514	0.629	0.897	
SDH9	0.573	0.639	0.896	
SDH10	0.236	0.553	0.905	
Intermediary determinants of SDH				0.939
SDH11	0.542	0.667	0.897	
SDH12	0.563	0.711	0.896	
SDH13	0.578	0.753	0.896	
SDH14	0.559	0.646	0.896	
SDH15	0.612	0.768	0.895	
SDH16	0.662	0.823	0.893	
SDH17	0.632	0.713	0.894	
SDH18	0.532	0.664	0.897	
SDH19	0.540	0.723	0.897	
SDH20	0.467	0.567	0.899	

6.4.1(b) Composite reliability (CR)

The CR was 0.797 (95% CI: 0.754, 0.840) for structural determinants of SDH and 0.794 (95% CI: 0.750, 0.839) for intermediary determinants of SDH.

6.4.1(c) Test-retest reliability based on intraclass correlation coefficient (ICC)

A total of 70 participants completed the SDHQ twice within the interval of 7 days. For the structural determinants of SDH, the mean score decreased from 38.8 (SD = 4.77) at day 1 to 37.4 (SD = 5.53) at day 7, with an ICC value of 0.938 (95% CI: 0.901, 0.961, p-value < 0.001). For the intermediary determinants of SDH, the mean score decreased from 37.5 (SD = 5.37) at day 1 to 37.2 (SD = 4.37) at day 7, with an ICC value of 0.941 (95% CI: 0.907, 0.963, p-value < 0.001).

6.4.2 EDHQ reliability results

6.4.2(a) Cronbach's alpha

Table 6.16 presents the EDHQ internal consistency reliability results based on Cronbach's alpha. For the whole scale, the Cronbach's alpha value was 0.947. The Cronbach's alpha values of the two factors were 0.918 (for natural environment) and 0.935 (for built environment). Furthermore, the results did not recommend deleting any item.

Table 6.16: Internal consistency and reliability of the EDHQ (N = 300), Nigerian students

Item	Corrected item total correlation	Squared multiple correlation	Cronbach's alpha if item deleted	Cronbach's alpha
Natural environment				0.918
EDH1	0.574	0.489	0.918	
EDH2	0.638	0.540	0.914	
EDH3	0.762	0.637	0.904	
EDH4	0.768	0.713	0.903	
EDH5	0.787	0.722	0.902	
EDH6	0.791	0.717	0.901	
EDH7	0.720	0.613	0.908	
EDH8	0.772	0.651	0.903	
Built environment				0.935
EDH9	0.716	0.664	0.929	
EDH10	0.679	0.621	0.931	
EDH11	0.769	0.620	0.926	
EDH12	0.672	0.575	0.931	
EDH13	0.724	0.641	0.928	
EDH14	0.784	0.636	0.925	
EDH15	0.727	0.568	0.928	
EDH16	0.721	0.567	0.929	
EDH17	0.800	0.677	0.925	
EDH18	0.806	0.675	0.924	

6.4.2(b) Composite reliability (CR)

The CR was 0.845 (95% CI: 0.820, 0.870) for natural environment and 0.854 (95% CI: 0.829, 0.879) for built environment.

6.4.2(c) Test-retest reliability based on intraclass correlation coefficient (ICC)

A total of 70 participants completed the EDHQ twice within the interval of 7 days. The mean score for the natural environment dropped from 24.9 (SD = 5.50) on day 1 to 24.4 (SD = 5.56) on day 7, with an ICC value of 0.976 (95% CI: 0.961, 0.985, p-value < 0.001). The mean score for the built environment was 31.3 (SD = 6.09) on day 1 and 31.3 (SD = 5.89) on day 7, with an ICC value of 0.970 (95% CI: 0.951, 0.981, p-value < 0.001).

6.4.3 DLQ reliability results

6.4.3(a) Cronbach's alpha

Table 6.17 presents the DLQ internal consistency reliability results based on Cronbach's alpha. For the whole scale, the Cronbach's alpha value was 0.831. The Cronbach's alpha values of the three factors were 0.869 (for physiological demand), 0.870 (for psychosocial demand), and 0.858 (for environmental demand). Furthermore, the results did not recommend deleting any item.

Table 6.17: Internal consistency and reliability of the DLQ (N = 300), Nigerian students

Item	Corrected item total correlation	Squared multiple correlation	Cronbach's alpha if item deleted	Cronbach's alpha
Physiological demand				0.869
DL1	0.621	0.517	0.855	
DL2	0.632	0.534	0.853	
DL3	0.712	0.514	0.838	
DL4	0.699	0.512	0.840	
DL5	0.700	0.532	0.840	
DL6	0.655	0.494	0.850	
Psychosocial demand				0.870
DL7	0.605	0.389	0.861	
DL8	0.720	0.548	0.840	
DL9	0.767	0.604	0.832	
DL10	0.574	0.342	0.866	
DL11	0.689	0.499	0.845	
DL12	0.688	0.512	0.846	
Environmental demand				0.858
DL13	0.702	0.761	0.824	
DL14	0.746	0.777	0.816	
DL15	0.546	0.377	0.853	
DL16	0.662	0.489	0.832	
DL17	0.587	0.492	0.845	
DL18	0.650	0.498	0.834	

6.4.3(b) Composite reliability (CR)

The CR was 0.760 (95% CI: 0.716, 0.804) for physiological demand, 0.848 (95% CI: 0.816, 0.880) for psychosocial demand, and 0.797 (95% CI: 0.764, 0.830) for environmental demand.

6.4.3(c) Test-retest reliability based on intraclass correlation coefficient (ICC)

A total of 70 participants completed the DLQ twice within the interval of 7 days. For physiological demand, the mean decreased from 14.17 (SD = 4.23) on day 1 to 13.23 (SD = 4.71) on day 7, with an ICC value of 0.950 (95% CI: 0.921, 0.960). For psychosocial demand, the mean increased from 22.89 (SD = 5.25) on day 1 to 20.99 (5.21) on day 7, with an ICC value of 0.921 (95% CI: 0.875, 0.950). For environmental demand, the mean increased from 20.27 (3.31) on day 1 to 20.69 (3.57) on day 7, with an ICC value of 0.972 (95% CI; 0.956, 0.983).

6.4.4 IPQ reliability results

6.4.4(a) Cronbach's alpha

Table 6.18 presents the IPQ internal consistency reliability results based on Cronbach's alpha. For the whole scale, the Cronbach's alpha value was 0.752. The Cronbach's alpha values of the two factors were 0.928 (for biologically given potential) and 0.925 (for personally acquired potential). Furthermore, the results did not recommend deleting any item.

Table 6.18: Internal consistency and reliability of the IPQ (N = 300), Nigerian students

Item	Corrected item total correlation	Squared multiple correlation	Cronbach's alpha if item deleted	Cronbach's alpha
Biologically given potential				0.928
IP1	0.745	0.658	0.921	
IP2	0.731	0.641	0.923	
IP3	0.788	0.644	0.916	
IP4	0.848	0.788	0.908	
IP5	0.832	0.784	0.910	
IP6	0.805	0.705	0.914	
Personally acquired potential				0.925
IP7	0.675	0.561	0.921	
IP8	0.607	0.464	0.927	
IP9	0.875	0.815	0.906	
IP10	0.669	0.540	0.921	
IP11	0.847	0.799	0.907	
IP12	0.672	0.495	0.921	
IP13	0.764	0.615	0.914	
IP14	0.885	0.797	0.904	

6.4.4(b) Composite reliability (CR)

The CR was 0.878 (95% CI: 0.851, 0.906) for biologically given potential and 0.909 (95% CI: 0.897, 0.922) for personally acquired potential.

6.4.4(c) Test-retest reliability based on intraclass correlation coefficient (ICC)

A total of 70 participants completed the IPQ twice within the interval of 7 days. For biologically given potential, the mean decreased from 10.43 (SD = 5.06) on day 1 to 10.14 (SD = 4.94) on day 7, with an ICC value of 0.976 (95% CI: 0.962, 0.985). For the personally acquired potential, the mean decreased from 21.36 (SD = 2.81) on day 1 to 20.59 (SD = 2.62) on day 7, with an ICC value of 0.953 (95% CI: 0.925, 0.970).

Malaysian based sample – (EFA, CFA, and reliability)

6.5 EFA Malaysia based sample

6.5.1 Preliminary data assessment

We examined the percentage of missing data for each item in each questionnaire. There were no items with missing values, and as a result, the response rate was 100% for all of the questionnaires. Furthermore, the univariate normality of all the items was assessed using the Kolmogorov-Smirnov test, the Shapiro-Wilk test, boxplots, and histogram plots. The results of the Kolmogorov-Smirnov test and the Shapiro-Wilk test show that the scores of all the items were not normally distributed ($P < 0.05$). The results of the boxplot show that some items have outliers (see Appendix L). Lastly, the results of the histogram plot show that some items of the questionnaires were not normally distributed (see Appendix M).

6.5.2 Descriptive characteristics of the study participants

Table 6.19 presents the general characteristics of Malaysian study participants for the EFA sample. There were a total of 300 students (male 44.3%, female 55.7%), with a mean age of 21.5 (SD = 1.58). The mean frequency and duration of exercise per week were 2.5 (SD = 1.71) and 43.4 (SD = 31.01), respectively. About half of the students were Malays (49.3%) and studying in health sciences (52.0%). Furthermore, most of the students were in Year 2 (46.0%).

Table 6.19: General Characteristics of the Participants in EFA (N = 300), Malaysian students

Variables	Mean (SD)	n (%)
Age	21.5 (1.58)	
Frequency of exercise/week	2.5 (1.71)	
Duration of exercise (min)	43.4 (31.01)	
Gender		
Male		133 (44.3)
Female		167 (55.7)
Ethnicity		
Malay		148 (49.3)
Chinese		91 (30.3)
Indian		42 (14.0)
Others		19 (6.4)
Field of study		
Medical sciences		102 (34.0)
Health sciences		156 (52.0)
Dental sciences		42 (14.0)
Study year		
Year 1		77 (25.6)
Year 2		138 (46.0)
Year 3		38 (12.7)
Year 4		38 (12.7)
Year 5		9 (3.0)

SD = standard deviation, min = minutes.

6.5.3 Item's score distribution of the EFA sample

In this sub-section, we present the descriptive statistics for all the items in the holistic health questionnaires (SDH, EDH, DL, and IP) based on Malaysian sample. The following tables (Table 6.20–Table 6.23) provide the results in terms of mean, standard deviation, median, interquartile range, frequencies, and percentages. The minimum expected value for each scale is one, and the maximum value varies from four to five.

Table 6.20 presents the descriptive distribution of SDHQ items. The expected minimum and maximum scores were 20 and 100, respectively, with structural and intermediary determinants of SDH expected to range from 10 to 50 each. The mean (SD) score for the total SDHQ was 73.1 (14.20), with actual scores ranging from 31.0

to 100.0. For structural determinants of SDH, the mean (SD) was 35.8 (8.42), and for intermediary determinants, it was 37.3 (7.66). Item SDH11 (How do you rate the state of your current housing or accommodations?) had the highest rating of 5 (totally satisfied) by 61.7% of respondents, while item SDH10 (How do you rate the government's effort towards improving your standard of living?) received the highest rating of 1 (totally unsatisfied) by 10.3% of respondents.

Table 6.20: Score distribution of the SDHQ (N = 300), Malaysian students

Items	Mean (SD)	Median (IQR)	Score 1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)
SDH1	4.25(1.14)	5.00(1)	20(6.7)	6(2.0)	28(9.3)	70(23.3)	176(58.7)
SDH2	3.30(1.08)	3.00(1)	17(5.7)	53(17.7)	92(30.7)	98(32.7)	40(13.3)
SDH3	4.31(0.85)	4.00(1)	5(1.7)	5(1.7)	31(10.3)	111(37.0)	148(49.3)
SDH4	3.36(1.11)	3.00(1)	16(5.3)	54(18.0)	84(28.0)	98(32.7)	48(16.0)
SDH5	3.09(1.09)	3.00(2)	23(7.7)	62(20.7)	113(37.7)	68(22.7)	34(11.3)
SDH6	3.55(0.91)	4.00(1)	5(1.7)	30(10.0)	100(33.3)	124(41.3)	41(13.7)
SDH7	3.96(0.93)	4.00(1)	5(1.7)	20(6.7)	44(14.7)	143(47.7)	88(29.2)
SDH8	3.50(1.13)	4.00(1)	24(8.0)	25(8.3)	85(28.3)	110(36.7)	56(18.7)
SDH9	3.67(1.04)	4.00(1)	13(4.3)	29(9.7)	64(21.3)	133(44.3)	61(20.3)
SDH10	2.84(1.02)	3.00(1)	31(10.3)	72(24.0)	129(43.0)	49(16.3)	19(6.3)
SDH11	3.66(0.92)	4.00(1)	8(2.7)	18(6.0)	92(30.7)	132(44.0)	50(61.7)
SDH12	3.77(1.00)	4.00(1)	6(2.0)	33(11.0)	58(19.3)	131(43.7)	72(24.0)
SDH13	4.18(1.05)	5.00(1)	13(4.3)	8(2.7)	41(13.7)	87(29.0)	151(50.3)
SDH14	3.95(0.98)	4.00(2)	8(2.7)	12(4.0)	67(22.3)	113(37.7)	100(33.3)
SDH15	3.55(1.08)	4.00(1)	13(4.3)	36(12.0)	83(27.7)	109(36.3)	59(19.7)
SDH16	3.45(0.92)	4.00(1)	4(1.3)	44(14.7)	98(32.7)	121(40.3)	33(11.0)
SDH17	3.34(0.97)	3.00(1)	2(0.7)	63(21.0)	105(35.0)	91(30.3)	39(13.0)
SDH18	3.73(0.77)	4.00(1)	3(1.0)	9(3.0)	96(32.0)	150(50.0)	42(14.0)
SDH19	3.82(0.87)	4.00(1)	8(2.7)	7(2.3)	74(24.7)	152(50.7)	59(19.7)
SDH20	3.83(0.80)	4.00(1)	4(1.3)	9(3.0)	74(24.7)	160(53.3)	53(17.7)

Note: SDH1 – SDH10 (1 = totally unsatisfied, 2 = unsatisfied, 3 = somewhat satisfied, 4 = satisfied, 5 = totally satisfied), SDH11 – SDH20 (1 = very poor, 2 = poor, 3 = somewhat good, 4 = good, 5 = very good), SD = standard deviation, IQR = interquartile range.

Table 6.21 presents the descriptive distribution of EDHQ items. The expected minimum and maximum scores were 18 and 90, respectively, with natural and built environments expected to range from 8 to 40 and 10 to 50, respectively. The mean (SD) score for the total EDHQ was 67.26 (10.47), with actual scores ranging from 30.0

to 90.0. For the natural environment, the mean (SD) was 28.91 (5.81), and for the built environment, it was 38.36 (6.11). Items EDH4 (I always have access to clean drinking water) and EDH12 (There are sufficient locations to make purchases, including markets or shops) had the highest rating of 5 (strongly agree) by 25.3% of respondents, while item EDH11 (Transportation systems, either public or private, are always convenient) received the highest rating of 1 (strongly disagree) by 6.3% of respondents.

Table 6.21: Score distribution of the EDHQ (N = 300), Malaysian students

Items	Mean (SD)	Median (IQR)	Score 1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)
EDH1	3.20(0.88)	3.00(1)	8(2.7)	55(18.3)	117(39.0)	108(36.0)	12(4.0)
EDH2	3.31(0.90)	3.00(1)	10(3.3)	42(14.0)	111(37.0)	119(39.7)	18(6.0)
EDH3	3.87(0.86)	4.00(0)	5(1.7)	17(5.7)	51(17.0)	166(55.3)	61(20.3)
EDH4	3.96(0.87)	4.00(1)	6(2.0)	14(4.7)	43(14.3)	161(53.7)	76(25.3)
EDH5	3.86(0.76)	4.00(1)	2(0.7)	11(3.7)	65(21.7)	170(56.7)	52(17.3)
EDH6	3.90(0.77)	4.00(0)	1(0.3)	13(4.3)	60(20.0)	166(55.3)	60(20.0)
EDH7	3.13(0.94)	3.00(1)	18(6.0)	46(15.3)	129(43.0)	92(30.7)	15(5.0)
EDH8	3.67(0.79)	4.00(1)	4(1.3)	16(5.3)	88(29.3)	160(53.3)	32(10.7)
EDH9	3.84(0.69)	4.00(1)	1(0.3)	10(3.3)	64(21.3)	187(62.3)	38(12.7)
EDH10	3.70(0.78)	4.00(1)	5(1.7)	15(5.0)	74(24.7)	176(58.7)	30(10.0)
EDH11	3.47(1.05)	4.00(1)	19(6.3)	35(11.7)	66(22.0)	146(48.7)	34(11.3)
EDH12	4.09(0.66)	4.00(1)	0(0)	5(1.7)	38(12.7)	181(60.3)	76(25.3)
EDH13	4.09(0.70)	4.00(0)	3(1.0)	4(1.3)	31(10.3)	188(62.7)	74(24.7)
EDH14	4.07(0.66)	4.00(0)	1(0.3)	3(1.0)	39(13.0)	187(62.3)	70(23.3)
EDH15	3.42(0.94)	4.00(1)	14(4.7)	27(9.0)	104(34.7)	128(42.7)	27(9.0)
EDH16	3.82(0.81)	4.00(0)	6(2.0)	13(4.3)	55(18.3)	182(60.7)	44(14.7)
EDH17	3.87(0.72)	4.00(0)	4(1.3)	12(4.0)	42(14.0)	202(67.3)	40(13.3)
EDH18	3.98(0.63)	4.00(0)	1(0.7)	5(1.7)	41(13.7)	205(68.3)	48(16.0)

Note: 1 = strongly disagree, 2 = disagree, 3 = somewhat disagree, 4 = agree, 5 = strongly agree, SD = standard deviation, IQR = interquartile range.

Table 6.22 presents the descriptive distribution of DLQ items. The expected minimum and maximum scores were 18 and 90, respectively, with both the physiological, psychosocial, and environmental demands expected to range from 6 to 30 each. The mean (SD) score for the total DLQ was 50.27 (10.80), with actual scores ranging from 21.0 to 78.0. For the physiological demands, the mean (SD) was 14.07

(6.24), for the psychosocial demands, it was 18.41 (5.33), and for the environmental demands, it was 17.79 (6.83). Item DL13 (On average, how often are you busy?) had the highest rating of 5 (almost every day) by 43.3% of respondents, while item DL15 (How frequently do you miss classes because you're too busy?) received the highest rating of 1 (not at all) by 69.0% of respondents.

Table 6.22: Score distribution of the DLQ (N = 300), Malaysian students

			Score				
Items	Mean (SD)	Median (IQR)	1 n (%)	2 n (%)	3 n (%)	4 n (%)	5 n (%)
DL1	1.93(1.34)	1.00(3)	195(65.0)	14(4.7)	9(3.0)	81(27.0)	1(0.3)
DL2	2.29(1.35)	2.00(3)	136(45.3)	43(14.3)	23(7.7)	95(31.7)	3(1.0)
DL3	2.08(1.36)	1.00(3)	163(54.3)	45(15.0)	5(1.7)	79(26.3)	8(2.7)
DL4	2.64(1.30)	2.00(3)	76(25.3)	86(28.7)	19(6.3)	107(35.7)	12(4.0)
DL5	2.36(1.36)	2.00(3)	122(40.7)	58(19.3)	19(6.3)	92(30.7)	9(3.0)
DL6	2.77(1.39)	2.50(2)	74(24.7)	76(25.3)	31(10.3)	84(28.0)	35(11.7)
DL7	2.97(1.25)	3.00(2)	36(12.0)	92(30.7)	55(18.3)	79(26.3)	38(12.7)
DL8	3.22(1.29)	3.00(2)	18(6.0)	94(31.3)	67(22.3)	47(15.7)	74(24.7)
DL9	3.07(1.21)	3.00(2)	22(7.3)	92(30.7)	80(26.7)	54(18.0)	52(17.3)
DL10	2.94(1.13)	3.00(2)	19(6.3)	111(37.0)	70(23.3)	69(23.0)	31(10.3)
DL11	2.90(1.24)	3.00(2)	35(11.7)	103(34.3)	56(18.7)	69(23.0)	37(12.3)
DL12	3.31(1.28)	3.00(2)	21(7.0)	77(25.7)	63(21.0)	65(21.7)	74(24.7)
DL13	3.63(1.29)	3.00(2)	6(2.0)	67(22.3)	88(29.3)	9(3.0)	130(43.3)
DL14	3.53(1.32)	3.00(3)	9(3.0)	80(26.7)	70(23.3)	25(8.3)	116(38.7)
DL15	1.80(1.28)	1.00(2)	207(69.0)	17(5.7)	8(2.7)	65(21.7)	3(1.0)
DL16	2.74(1.51)	2.00(3)	87(29.0)	72(24.0)	32(10.7)	50(16.7)	59(19.7)
DL17	2.96(1.40)	3.00(2)	53(17.7)	76(25.3)	63(21.0)	45(15.0)	63(21.0)
DL18	3.12(1.42)	3.00(3)	35(11.7)	88(29.3)	75(25.0)	9(3.0)	93(31.0)

Note: 1 = not at all, 2 = 1/month, 3 = 1-2 times/week, 4 = 3-4 times/week, 5 = almost every day, SD = standard deviation, IQR = interquartile range.

Table 6.23 presents the descriptive distribution of IPQ items. The expected minimum and maximum scores were 14 and 56, respectively, with biologically given potential and personally acquired potential expected to range from 6 to 24 and 8 to 32, respectively. The mean (SD) score for the total IPQ was 36.52 (5.58), with actual scores ranging from 19.0 to 50.0. For the biologically given potential, the mean (SD) was 16.53 (2.85), and for the personally acquired potential, it was 19.99 (5.12). Item IP11 (Do you believe that your state of happiness may be affected by pain or health issues?) had the highest rating of 4 (very often) by 24.7% of respondents, while item IP3 (During your early childhood, did you have any challenges because of your health condition?) received the highest rating of 1 (not at all) by 22.0% of respondents.

Table 6.23: Score distribution of the IPQ (N = 300), Malaysian students

Items	Mean (SD)	Median (IQR)	Score 1 n (%)	2 n (%)	3 n (%)	4 n (%)
IP1	2.79(0.58)	3.00(0)	26(8.7)	10(3.3)	264(88.0)	0(0)
IP2	2.75(0.64)	3.00(0)	31(10.3)	16(5.3)	251(83.7)	2(0.7)
IP3	2.51(0.84)	3.00(1)	66(22.0)	18(6.0)	214(71.3)	2(0.7)
IP4	2.82(0.57)	3.00(0)	24(8.0)	9(3.0)	265(88.3)	2(0.7)
IP5	2.79(0.60)	3.00(0)	27(9.0)	10(3.3)	261(87.0)	2(0.7)
IP6	2.87(0.50)	3.00(0)	18(6.0)	6(2.0)	273(91.0)	3(1.0)
IP7	2.37(0.78)	2.00(1)	22(7.3)	178(59.3)	66(22.0)	34(11.3)
IP8	2.50(0.91)	3.00(1)	56(18.7)	68(22.7)	147(49.0)	29(9.7)
IP9	2.56(0.82)	3.00(1)	30(10.0)	104(34.7)	133(44.3)	33(11.0)
IP10	2.34(0.70)	2.00(1)	12(4.0)	202(67.3)	58(19.3)	28(9.3)
IP11	2.64(0.96)	2.00(1)	29(9.7)	124(41.3)	73(24.3)	74(24.7)
IP12	2.70(0.87)	3.00(1)	31(10.3)	79(26.3)	140(46.7)	50(16.7)
IP13	2.49(0.90)	3.00(1)	54(18.0)	74(24.7)	143(47.7)	29(9.7)
IP14	2.39(0.79)	2.00(1)	35(11.7)	135(45.0)	108(36.0)	22(7.3)

Note: IP1 – IP6 (1 = none, 2 = mild, 3 = moderate, 4 = severe), IP7 – IP14 (1 = not at all, 2 =rarely, 3 = often, 4 = very often), SD = standard deviation, IQR = interquartile range.

6.5.4 Model assumption checking

Before conducting the EFA, we assessed the data for adherence to assumptions regarding positive definiteness and multicollinearity. We confirmed positive definiteness by applying principal component analysis to the sample covariance matrix, thereby verifying that the covariance matrix was positive-definite. Additionally, we used the variance inflation factor (VIF) and tolerance (squared multiple correlation) to examine multicollinearity. Results indicated that tolerance exceeded 0.1 and VIF was below 10 for each item, suggesting that there was no multicollinearity issue.

6.5.5 EFA model of the holistic health questionnaires

Following assumption checking, which revealed that the assumptions were not met for all the items, principal axis factoring and Promax rotation were used in the EFA process. Principal axis factoring can handle data with non-normal distributions (Costello & Osborne, 2019).

6.5.5(a) EFA results of the SDHQ

The initial EFA model of the SDHQ with 20 items yielded good sampling adequacy with an estimated Kaiser-Meyer-Olkin (KMO) value of 0.909, and the Bartlett's test of sphericity was significant ($p < 0.001$). Thus, the model is considered to have adequate validity. Two factors in the initial EFA model had eigenvalues greater than 1, and the factors loaded well with all the items (Figure 6.13). Hence, the number of factors was set at two in the subsequent stage, which conforms with the SDHQ hypothesized structure. Using principal axis factoring with Promax rotation, two factors were extracted. The findings indicate that the two factors had factor loadings greater than 0.40 with no cross-loadings, a factor correlation of 0.567, communality of 0.453 to 0.805, and a cumulative percentage of 67.7%. As such, none of the items were deleted from the EFA (Table 6.24).

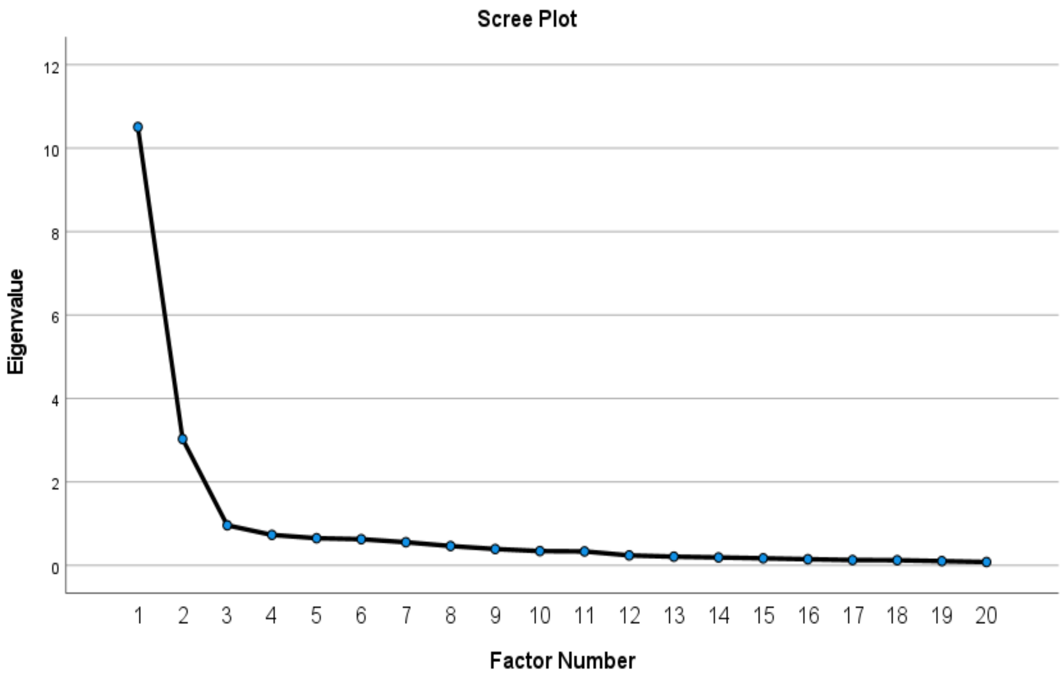

Figure 6.13: Scree Plot of the SDHQ constructs (Malaysian students)

Table 6.24: Exploratory Factor Analysis of the SDHQ (N = 300), Malaysian students

Items	Communality	Factor loading	
		1	2
SDH1	0.459	0.747	
SDH2	0.656	0.762	
SDH3	0.611	0.817	
SDH4	0.610	0.679	
SDH5	0.565	0.705	
SDH6	0.805	0.910	
SDH7	0.646	0.745	
SDH8	0.724	0.884	
SDH9	0.654	0.763	
SDH10	0.697	0.847	
SDH11	0.669		0.847
SDH12	0.679		0.845
SDH13	0.453		0.663
SDH14	0.570		0.677
SDH15	0.742		0.842
SDH16	0.770		0.884
SDH17	0.618		0.736
SDH18	0.535		0.688
SDH19	0.666		0.869
SDH20	0.720		0.864
Eigenvalue		10.51	3.03
Variance explained (%)		52.54	15.15
Cumulative variance (%)		52.54	67.69

Note: Factor correlation = 0.567.

6.5.5(b) EFA results of the EDHQ

The estimated KMO value of the EFA model of the initial EDHQ with 18 items was 0.934, and the Bartlett's test of sphericity was significant ($p < 0.001$). As a result, the model is considered to have sufficient validity. In the initial EFA model, two factors exhibited eigenvalues exceeding 1, and the items demonstrated satisfactory factor loadings on the two factors (Figure 6.14). Thus, in accordance with the hypothesized structure of the EDHQ, the number of factors was fixed at two in the subsequent stage. Two factors were obtained with Promax rotation and Principal Axis Factoring. The results indicate that the two factors displayed factor loadings exceeding 0.40, with no instances of cross-loadings. The factor correlation was 0.572, communality of 0.404

to 0.909, and the cumulative percentage was 69.2%. Consequently, all items were retained in the final EFA, as shown in Table 6.25.

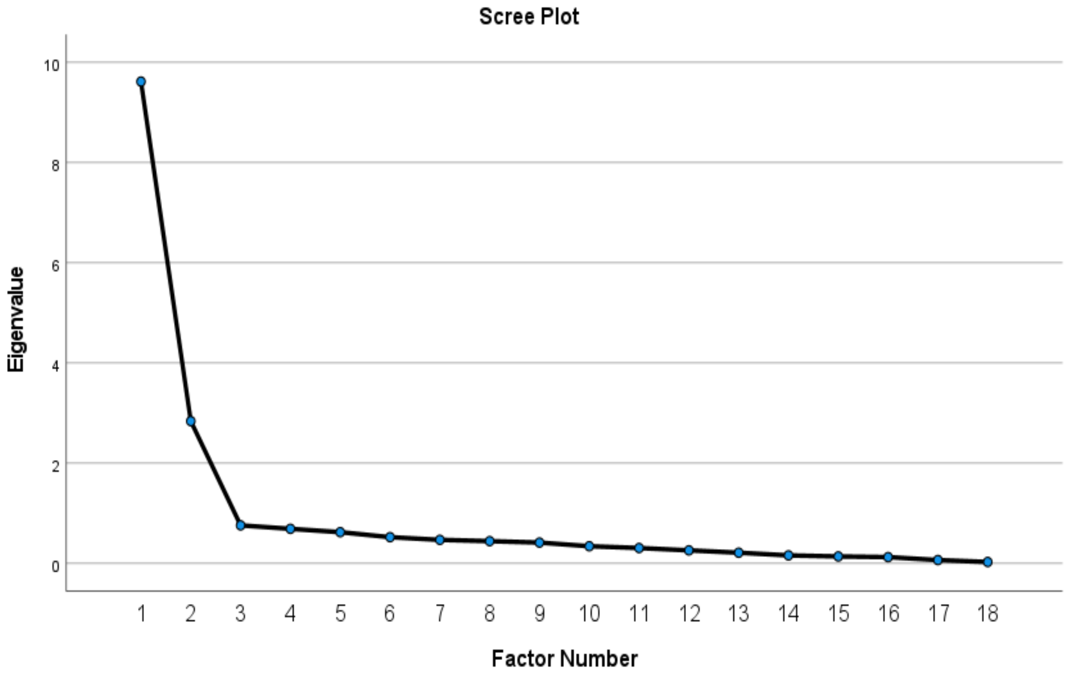

Figure 6.14 Scree Plot of the EDHQ constructs (Malaysian students)

Table 6.25: Exploratory Factor Analysis of the EDHQ (N = 300), Malaysian students

Items	Communality	Factor loading	
		1	2
EDH1	0.742	0.864	
EDH2	0.785	0.845	
EDH3	0.523	0.798	
EDH4	0.512	0.796	
EDH5	0.565	0.722	
EDH6	0.852	0.894	
EDH7	0.909	0.931	
EDH8	0.812	0.826	
EDH9	0.564		0.791
EDH10	0.550		0.732
EDH11	0.863		0.873
EDH12	0.820		0.911
EDH13	0.404		0.571
EDH14	0.819		0.911
EDH15	0.479		0.778
EDH16	0.477		0.734
EDH17	0.610		0.729
EDH18	0.528		0.660
Eigenvalue		9.62	2.84
Variance explained (%)		53.42	15.77
Cumulative variance (%)		53.42	69.18

Note: Factor correlation = 0.572.

6.5.5(c) EFA results of the DLQ

The KMO test yielded a value of 0.826, and the Bartlett's test of sphericity was significant ($p < 0.001$), indicating that factor analysis was appropriate for the dataset. Three factors emerged, with Eigenvalues greater than 1, collectively explaining 62.1% of the variance (Figure 6.15). The factor loadings of all 18 items were greater 0.4. Furthermore, there were no instances of cross-loadings among items, communality of 0.268 to 0.918, and the range of factor correlations was -0.024–0.031, indicating adequate validity of the model (Table 6.26). Consequently, three factors were retained in accordance with the initially hypothesized structure of the DLQ. Promax rotation and principal axis factoring techniques were employed to derive these three factors.

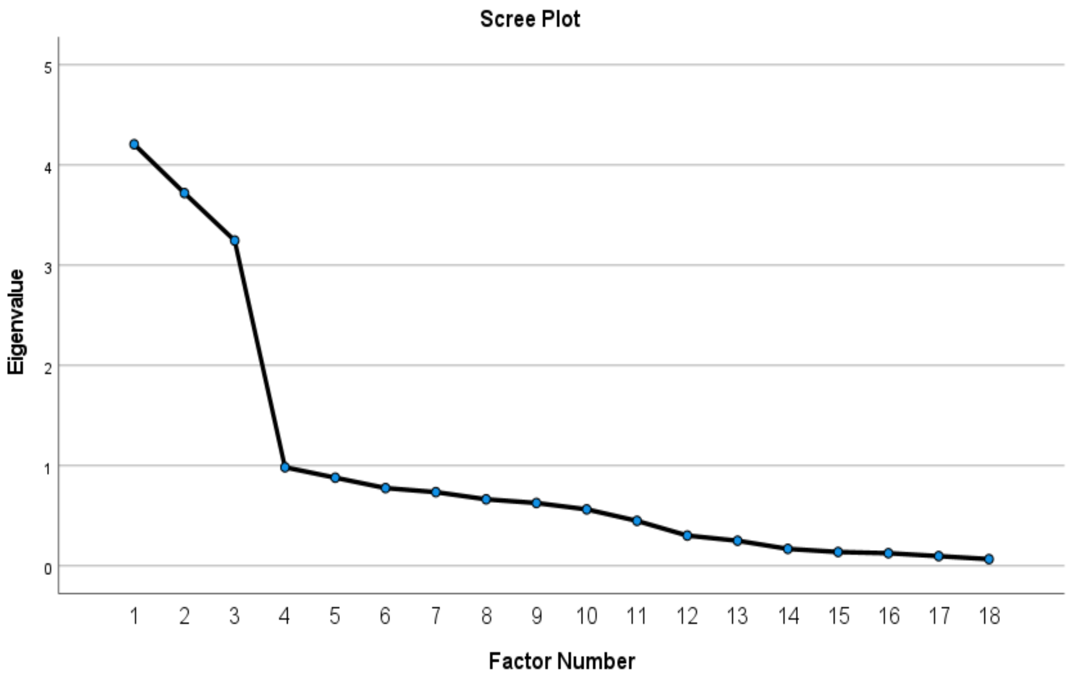

Figure 6.15: Scree Plot of the DLQ constructs (Malaysian students)

Table 6.26: Exploratory Factor Analysis of the DLQ (N = 300), Malaysian students

Items	Communality	Factor loading		
		1	2	3
DL1	0.786	0.886		
DL2	0.910	0.953		
DL3	0.899	0.949		
DL4	0.281	0.506		
DL5	0.281	0.528		
DL6	0.259	0.507		
DL7	0.869		0.931	
DL8	0.268		0.513	
DL9	0.308		0.553	
DL10	0.889		0.943	
DL11	0.286		0.534	
DL12	0.276		0.508	
DL13	0.399			0.630
DL14	0.257			0.506
DL15	0.621			0.785
DL16	0.876			0.936
DL17	0.918			0.957
DL18	0.849			0.921
Eigenvalue		4.21	3.72	3.25
Variance explained (%)		23.37	20.67	18.03
Cumulative variance (%)		23.37	44.04	62.07

Note: Factor correlation = Factor correlation = -0.024 (Physiological and psychosocial), 0.031 (psychosocial and environmental), 0.009 (physiological and environmental).

6.5.5(d) EFA results of the IPQ

The Bartlett's sphericity test revealed a significant result (p-value < 0.001), and the estimated KMO value of the EFA model of the original IPQ with 14 items was 0.864. The model is thus considered to have adequate convergent validity. In the preliminary EFA model, we identified two factors with eigenvalues greater than 1 and satisfactory factor loadings for all items (Figure 6.16). As a result, in the subsequent step, we set the number of factors at two in accordance with the initial hypothesised structure of the IP-Q. To generate the two factors, we used Promax rotation and principal axis factoring. The two factors had a cumulative percentage of 61.1%, factor loadings > 0.40, no cross-loadings, communality of 0.265 to 0.834, and a factor correlation of -0.065 (Table 6.27). Thus, the EFA did not require the removal of any items.

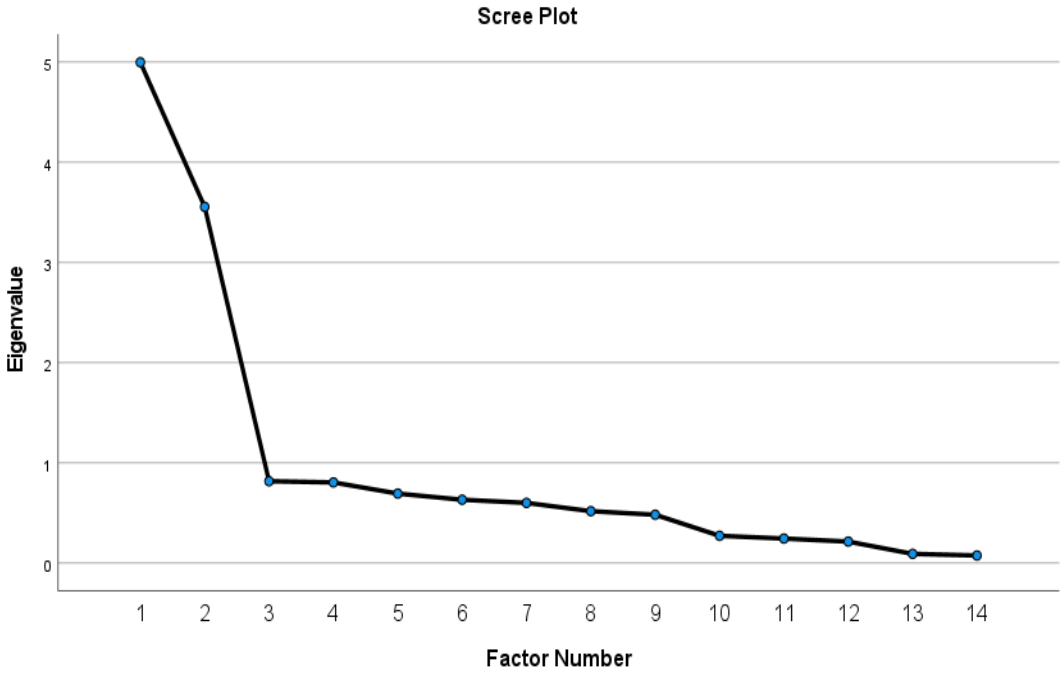

Figure 6.16: Scree Plot of the IPQ constructs (Malaysian students)

Table 6.27: Exploratory Factor Analysis of the IPQ (N = 300), Malaysian students

Items	Communality	Factor loading	
		1	2
IP1	0.834	0.914	
IP2	0.301	0.508	
IP3	0.319	0.552	
IP4	0.769	0.879	
IP5	0.600	0.775	
IP6	0.470	0.687	
IP7	0.877		0.936
IP8	0.270		0.509
IP9	0.265		0.515
IP10	0.795		0.893
IP11	0.829		0.912
IP12	0.354		0.583
IP13	0.321		0.567
IP14	0.851		0.923
Eigenvalue		5.00	3.56
Variance explained (%)		36.00	25.39
Cumulative variance (%)		36.00	61.09

Note: Factor correlation = -0.065

6.6 CFA Malaysia based sample

This section presents the CFA results of the newly developed holistic health questionnaires conducted among Malaysian undergraduate students during the study's phase II. We divide this part into four sub-sections: preliminary data assessment, descriptive characteristics of the study participants, model assumption checking, and the CFA model of the holistic health questionnaires.

6.6.1 Preliminary data assessment

We examined the percentage of missing data for each item in each questionnaire. There were no items with missing values, and as a result, the response rate was 100% for all of the questionnaires.

6.6.2 Descriptive characteristics of the study participants

Table 6.28 presents the general characteristics of study participants for the CFA sample. There were a total of 430 students (male 37.4%, female 62.6%), with a mean age of 21.4 (SD = 1.47). The mean frequency and duration of exercise per week were 2.6 (SD = 1.74) and 45.2 (SD = 30.80), respectively. About half of the students were Malay (54.7%) and studying health sciences (45.3%). Furthermore, the highest proportion of the students were in Year 2 (52.1%).

Table 6.28: General Characteristics of the Participants in CFA (N = 430), Malaysian students

Variables	Mean (SD)	n (%)
Age	21.4 (1.47)	
Frequency of exercise/week	2.6 (1.74)	
Duration of exercise (min)	45.3 (30.80)	
Gender		
Male		161 (37.4)
Female		269 (62.6)
Ethnicity		
Malay		235 (54.7)
Chinese		110 (25.6)
Indian		55 (12.8)
Others		30 (7.0)
Field of study		
Medical sciences		186 (43.3)
Health sciences		195 (45.3)
Dental sciences		49 (11.4)
Study year		
Year 1		95 (22.1)
Year 2		224 (52.1)
Year 3		59 (13.7)
Year 4		43 (10.0)
Year 5		9 (2.1)

SD = standard deviation, min = minutes.

6.6.3 Model assumption checking

6.6.3(a) Univariate normality

We assessed the univariate normality for each item in SDHQ, EDHQ, DLQ, and IPQ using skewness and kurtosis values obtained from the Mplus output. According to the results, some items exhibited univariate non-normality (p-value < 0.05), as presented in Appendix N.

6.6.3(b) Multivariate normality

We assessed the multivariate normality for each item in SDHQ, EDHQ, DLQ, and IPQ using Mardia Kurtosis and Skewness p-values. The results reveal that both the two-sided multivariate skew test of fit and the two-sided multivariate kurtosis test of fit were significant (p-value < 0.05) (Appendix O). Consequently, all four scales failed to meet the assumption of normality, leading to the application of MLR in subsequent CFAs.

6.6.3(c) Positive definiteness

We verified the positive definiteness assumption for the variance-covariance data matrix by examining the determinant value. The initial models of the SDHQ, EDHQ, DLQ, and IPQ were positively definite, as no warning message indicated positive definiteness in the Mplus output.

6.6.4 Assessing the CFA measurement models

After the preliminary data assessment and model assumption checking, we subsequently tested the CFA measurement models of the SDHQ, EDHQ, DLQ, and IPQ.

6.6.4(a) SDHQ measurement model

The SDHQ measurement model was tested using CFA involving 20 items and two factors: structural determinants of SDH (10 items) and intermediary determinants of SDH (10 items). The results of the initial specified measurement model (Model-1) show poor fit indices (Table 6.29). However, all the items had a standardized factor loading greater than 0.40 (Figure 6.17). After adding 16 pairs of error covariances between items within the same factor, the model fit indices improved (Figure 6.18). The fit indices of the respecified model (Model-2) were acceptable (Table 6.29), with all the items retained. The result of the final model (Model-2) showed standardized factor loading ranging from 0.500 to 0.791, which was considered good to very good (Figure 6.18).

Table 6.29: Summary for SDH Model fit indices (N = 430), Malaysian students

Path model	RMSEA (90% CI)	CFI	TLI	SRMR	RMSEA P-value
Model-1	0.099 (0.093, 0.106)	0.737	0.705	0.075	< 0.001
Model-2	0.055 (0.047, 0.062)	0.928	0.910	0.051	0.149

Model-2 with 16 correlated items residual: S20 with S19; S12 with S11; S8 with S6; S4 with S2; S3 with S1; S17 with S16; S16 with S15; S18 with S13; S17 with S15; S10 with S5; S20 with S18; S19 with S18; S10 with S8; S8 with S1; S5 with S1; S9 with S3.

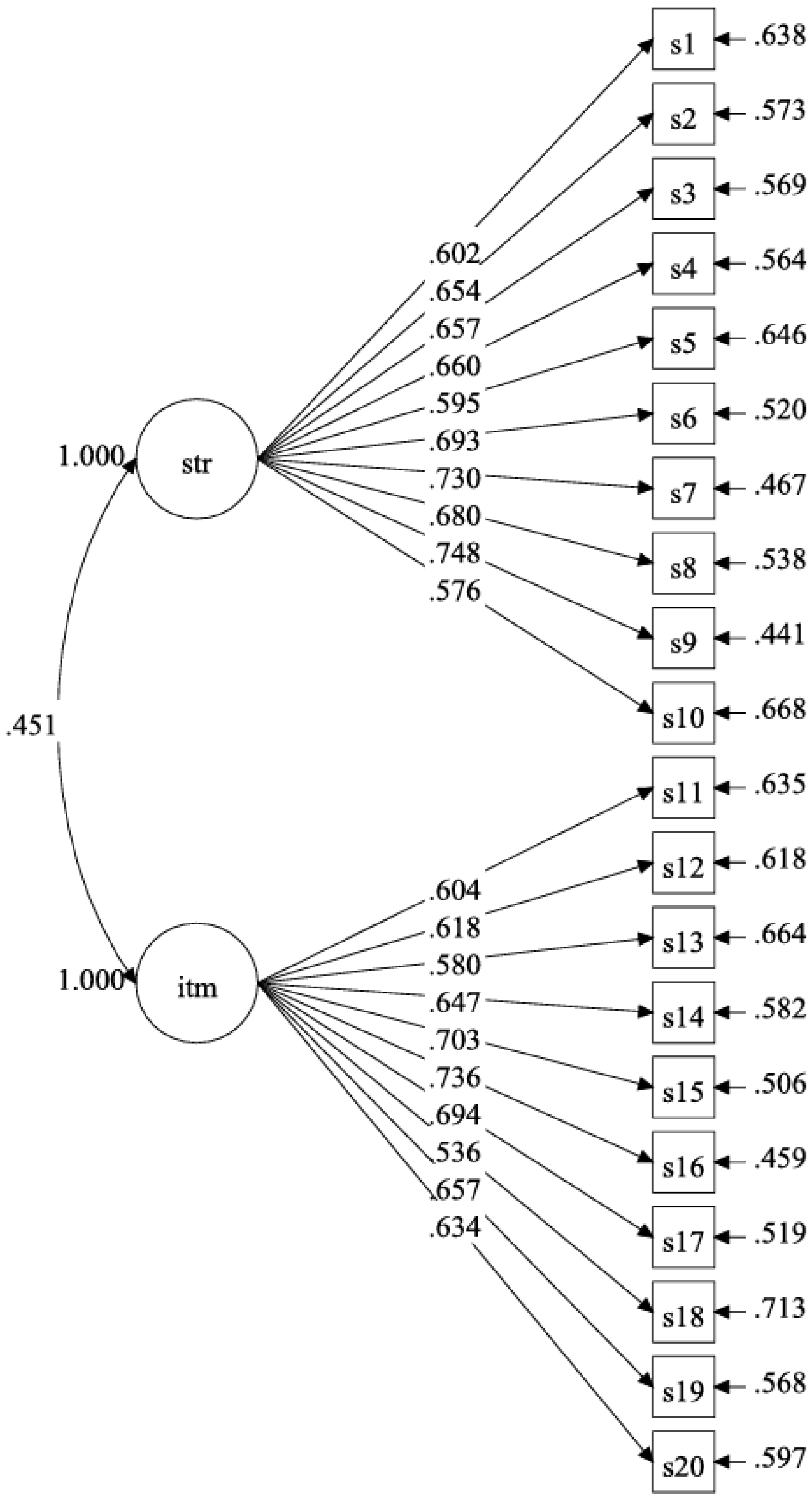

Figure 6.17: SDHQ measurement (Model-1), Malaysian students

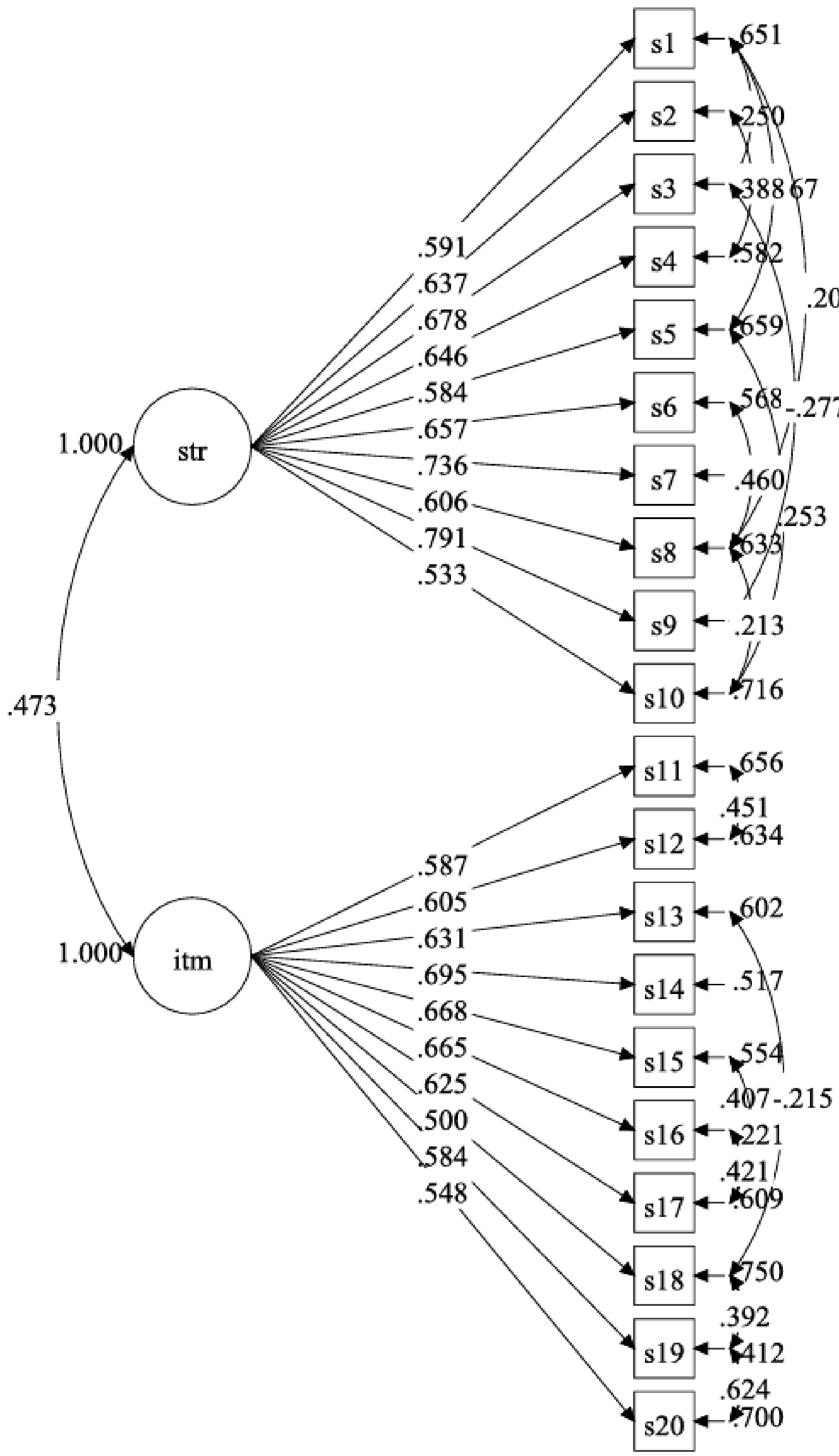

Figure 6.18: SDHQ measurement (Model-2), Malaysian students

The AVE was 0.422 and 0.376 for structural determinants of SDH and intermediary determinants of SDH, respectively. The correlation coefficient between the two factors is 0.164. Furthermore, the squared of the correlation coefficient between the two factors was 0.027, which is lower than all the AVE values. This indicates sufficient discriminant validity (Fornell & Larcker, 1981).

6.6.4(b) EDHQ measurement model

The EDHQ measurement model was tested using CFA with 18 items and two factors: the natural environment (8 items) and the built environment (10 items). The results of model 1 show that the fit indices were not satisfactory (Table 6.30). However, all the items had a standardized factor loading greater than 0.40 (Figure 6.19). After including six pairs of error covariances between items belonging to the same factor, the model fit indices were enhanced (Figure 6.20). The respecified model's (Model-2) fit indices were satisfactory (Table 6.30), and none of the items were removed from the model. The final model's (Model-2) results revealed acceptable factor loadings that ranged from 0.593 to 0.809 and were regarded as moderate to very good (Figure 6.20).

Table 6.30: Summary for EDHQ Model fit indices (N = 430), Malaysian students

Path model	RMSEA (90% CI)	CFI	TLI	SRMR	RMSEA P-value
Model-1	0.081 (0.074, 0.089)	0.889	0.873	0.049	< 0.001
Model-2	0.054 (0.046, 0.063)	0.952	0.943	0.039	0.182

Model-2 with six correlated items residual: E10 with E9; E2 with E1; E4 with E; E13 with E12; E14 with E13; E6 with E5.

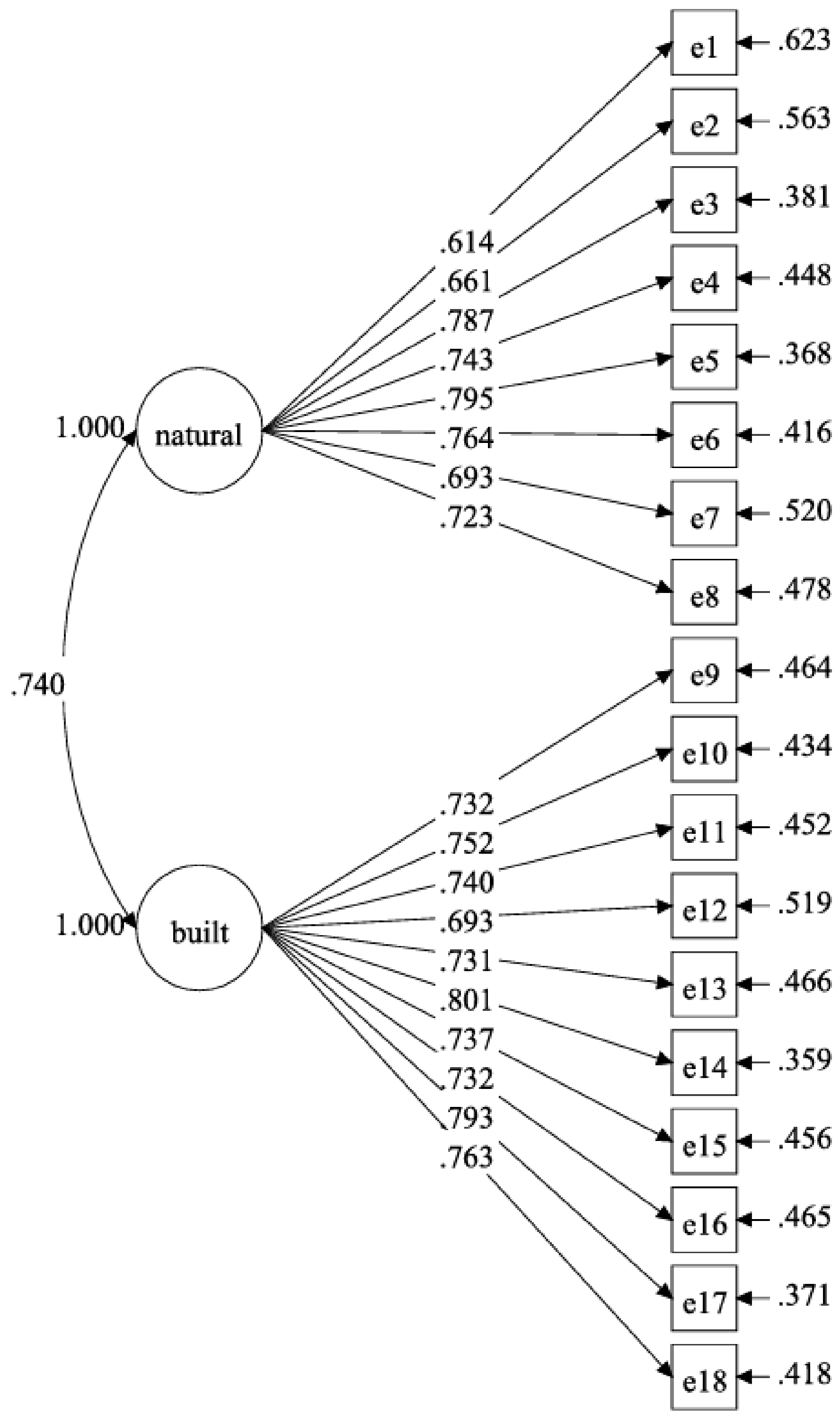

Figure 6.19: EDHQ measurement (Model-1), Malaysian students

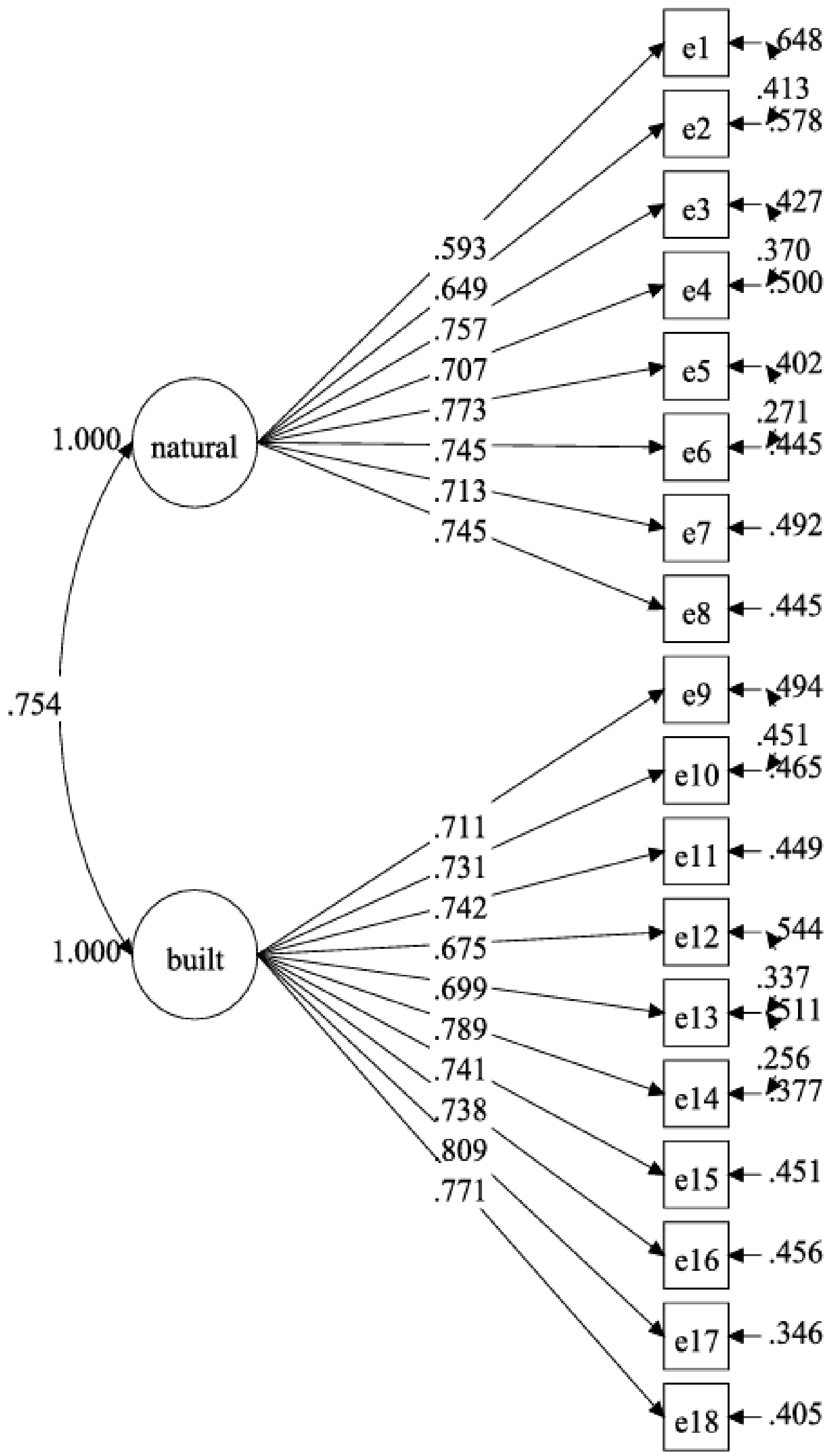

Figure 6.20: EDHQ measurement (Model-2), Malaysian students

The AVEs for the natural environment and the built environment, respectively, were 0.508 and 0.550. The two factors have a correlation coefficient of 0.301. Additionally, the squared correlation coefficient between the factors was 0.091, which is lower than all the AVE values. This shows adequate discriminant validity (Fornell & Larcker, 1981).

6.6.4(c) DLQ measurement model

We tested the DLQ measurement model using CFA, using 18 items that reflected three factors: physiological demand (6 items), psychosocial demand (6 items), and environmental demand (6 items). Model 1's results demonstrate that the fit indices were unsatisfactory (Table 6.31). All of the items, however, had standardized factor loadings higher than 0.40 (Figure 6.21). The model fit indices improved upon the inclusion of five pairs of error covariances between items that belonged to the environmental demands factor (Figure 6.22). As such, none of the items were removed from the model, and the respecified model's (Model-2) fit indices were satisfactory (Table 6.31). The final model's (Model-2) results showed factor loadings that were considered to be moderate to very good, with a range of 0.444 to 0.849 (Figure 6.22).

Table 6.31: Summary for DLQ Model fit indices (N = 430), Malaysian students

Path model	RMSEA (90% CI)	CFI	TLI	SRMR	RMSEA P-value
Model-1	0.076 (0.068, 0.083)	0.858	0.836	0.066	< 0.001
Model-2	0.047 (0.038, 0.055)	0.948	0.937	0.060	0.718

Model-2 with five correlated items residual: DL14 with DL13; DL6 with DL5; DL2 with DL1; DL18 with DL17; DL12 with DL11.

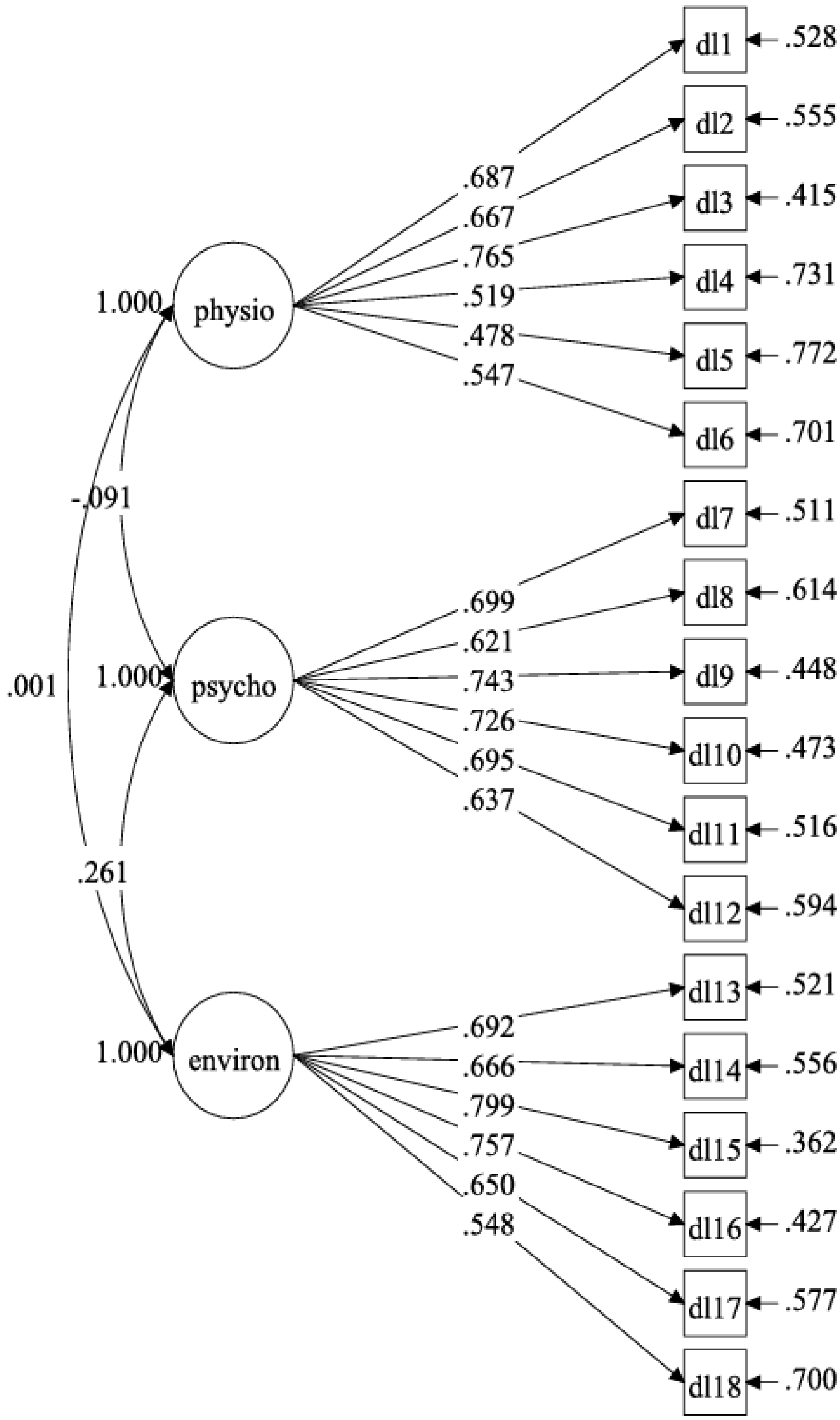

Figure 6.21: DLQ measurement (Model-1), Malaysian students

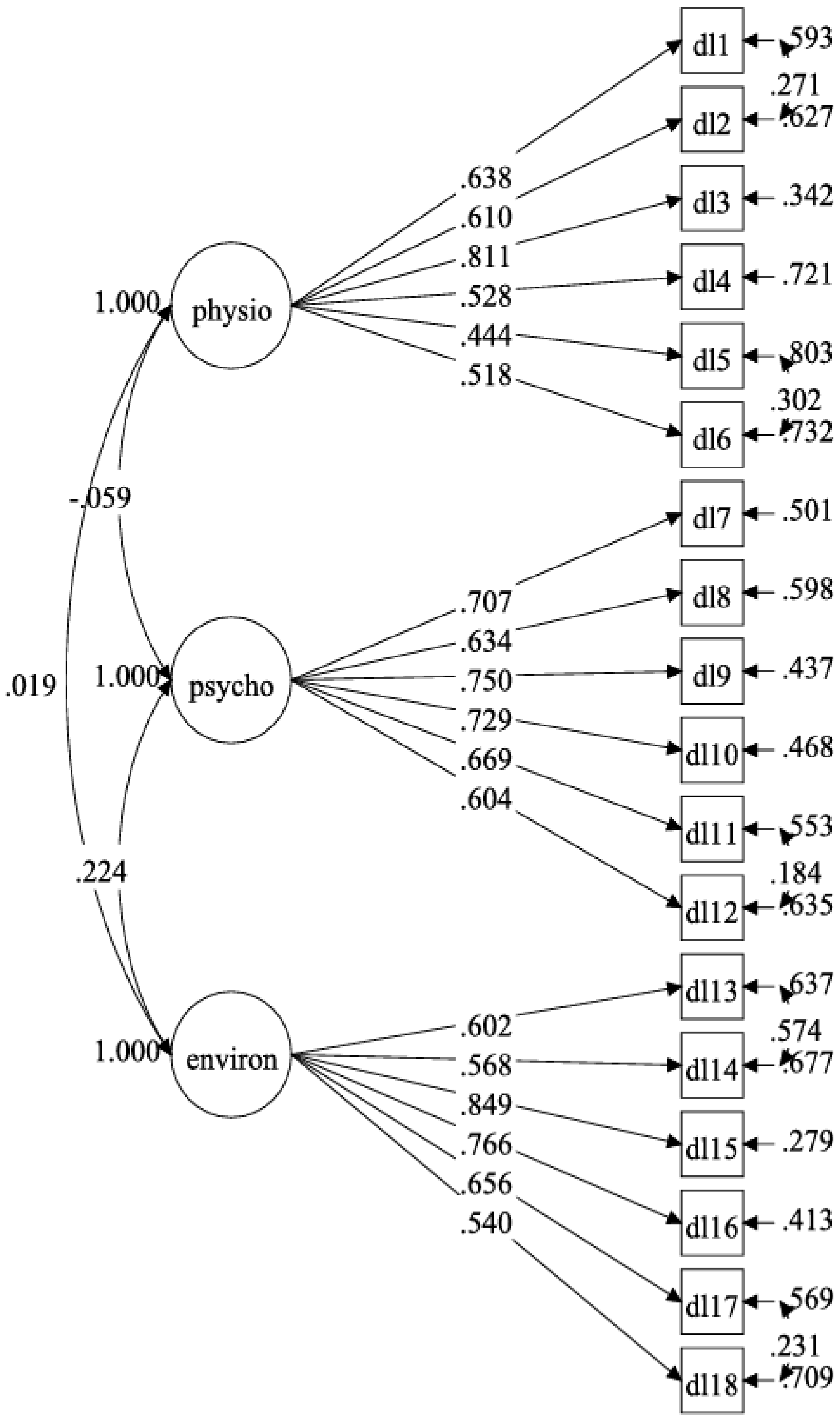

Figure 6.22: DLQ measurement (Model-2), Malaysian students

For physiological, psychosocial, and environmental demands, the AVEs were 0.364, 0.468, and 0.452, respectively. The factor correlations were -0.044 (physiological and psychosocial), 0.010 (physiological and environmental), and 0.157 (psychosocial and environmental). Additionally, all the squared correlation coefficients between the factors were lower than all the AVE values. Thus, the DL-Q has adequate discriminant validity (Fornell & Larcker, 1981).

6.6.4(d) IPQ measurement model

The IPQ measurement model was tested using CFA, which included 14 items reflecting two factors—biologically given potential (6 items) and personally acquired potential (8 items). Model 1's results demonstrate that the fit indices were unsatisfactory (Table 6.32). All of the items, however, had standardized factor loadings higher than 0.40 (Figure 6.23). The model fit indices improved when eight pairs of error covariances between items that belonged to the same factor were included (Figure 6.24). The model retained all items, and Model-2's fit indices were satisfactory (Table 6.32). The final model's (Model-2) results showed factor loadings that were considered to be moderate to very good, with a range of 0.668 to 0.958 (Figure 6.24).

Table 6.32: Summary for IPQ Model fit indices (N = 430), Malaysian students

Path model	RMSEA (90% CI)	CFI	TLI	SRMR	RMSEA P-value
Model-1	0.109 (0.099, 0.118)	0.899	0.879	0.082	< 0.001
Model-2	0.068 (0.057, 0.079)	0.965	0.953	0.080	0.004

Model-2 with eight correlated items residual: IP10 with IP7; IP2 with IP1; IP11 with IP9; IP13 with IP11; IP11 with IP7; IP5 with IP1; IP13 with IP12; IP11 with IP10.

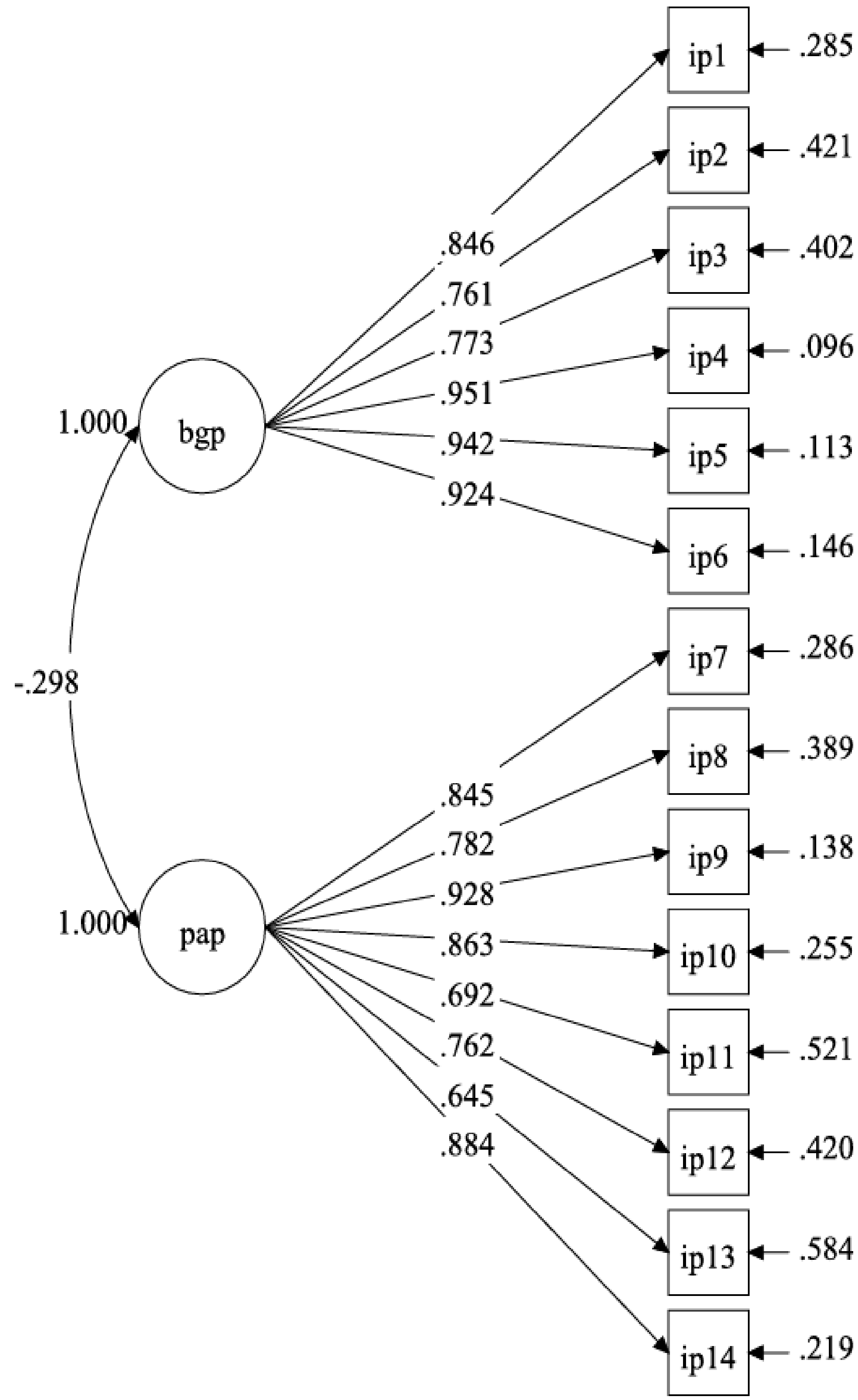

Figure 6.23: IPQ measurement (Model-1), Malaysian students

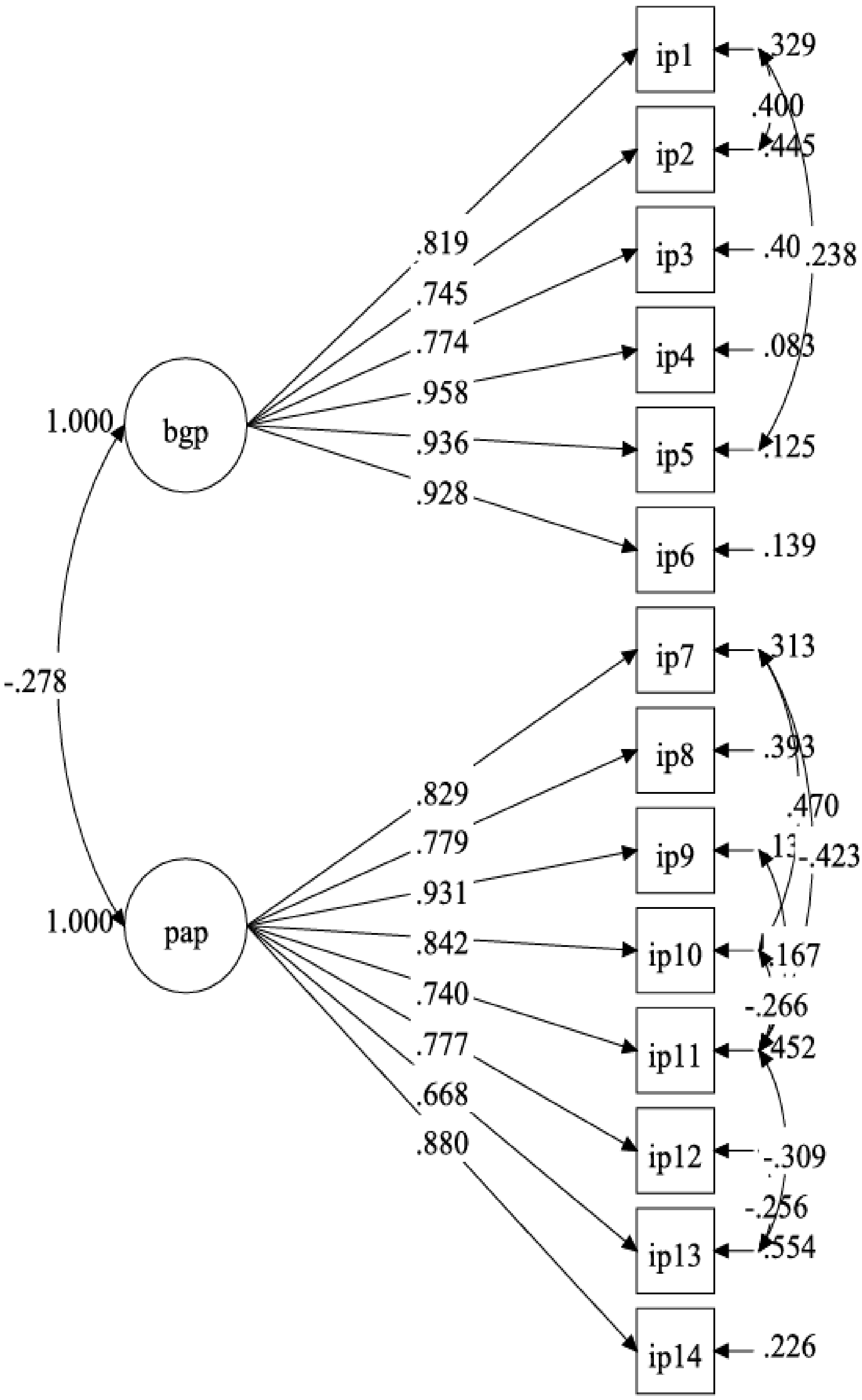

Figure 6.24: IPQ measurement (Model-2), Malaysian students

The AVEs were 0.747 for biologically given potential and 0.655 for personally acquired potential. The correlation coefficient between the factors was -0.159. Additionally, all the squared correlation coefficient between the factors (0.003) was lower than the AVE values. As such, the IPQ has adequate discriminant validity (Fornell & Larcker, 1981).

6.7 Reliability results - Malaysia based sample

This section presents the reliability results based on Cronbach's alpha, CR, and ICC of the newly developed holistic health questionnaires conducted among Malaysian undergraduate students during the study's phase II. This section is divided into four sub-sections: SDHQ reliability results, EDHQ reliability results, DLQ reliability results, and IPQ reliability results.

6.7.1 SDHQ reliability results

6.7.1(a) Cronbach's alpha

Table 6.33 presents the SDHQ internal consistency reliability results based on Cronbach's alpha. For the whole scale, the Cronbach's alpha value was 0.951. The Cronbach's alpha values of the two factors were 0.943 (for structural determinants of SDH) and 0.944 (for intermediary determinants of SDH). Furthermore, the results did not recommend deleting any item.

Table 6.33: Internal consistency and reliability of the SDHQ (N = 300), Malaysian students

Item	Corrected item total correlation	Squared multiple correlation	Cronbach's alpha if item deleted	Cronbach's alpha
Structural determinants of SDH				0.943
SDH1	0.634	0.599	0.944	
SDH2	0.792	0.766	0.936	
SDH3	0.755	0.703	0.938	
SDH4	0.747	0.729	0.938	
SDH5	0.724	0.617	0.939	
SDH6	0.870	0.798	0.933	
SDH7	0.778	0.703	0.937	
SDH8	0.813	0.751	0.935	
SDH9	0.790	0.749	0.936	
SDH10	0.806	0.708	0.935	
Intermediary determinants of SDH				0.944
SDH11	0.795	0.751	0.937	
SDH12	0.805	0.763	0.936	
SDH13	0.653	0.526	0.944	
SDH14	0.728	0.576	0.940	
SDH15	0.834	0.767	0.935	
SDH16	0.850	0.804	0.934	
SDH17	0.762	0.669	0.938	
SDH18	0.712	0.658	0.941	
SDH19	0.776	0.788	0.938	
SDH20	0.813	0.811	0.937	

6.7.1(b) Composite reliability (CR)

The CR was 0.894 (95% CI: 0.871, 0.917) for structural determinants of SDH and 0.909 (95% CI: 0.882, 0.926) for intermediary determinants of SDH.

6.7.1(c) Test-retest reliability based on intraclass correlation coefficient (ICC)

A total of 70 participants completed the SDHQ twice within the interval of 7 days. For the structural determinants of SDH, the mean score decreased from 37.8 (SD = 4.88) at day 1 to 37.4 (SD = 4.42) at day 7, with an ICC value of 0.780 (95% CI: 0.646, 0.863, p-value < 0.001). For the intermediary determinants of SDH, the mean score decreased from 37.4 (SD = 4.42) at day 1 to 37.3 (SD = 4.37) at day 7, with an ICC value of 0.799 (95% CI: 0.677, 0.875, p-value < 0.001).

6.7.2 EDHQ reliability results

6.7.2(a) Cronbach's alpha

Table 6.34 presents the EDHQ internal consistency reliability results based on Cronbach's alpha. For the whole scale, the Cronbach's alpha value was 0.945. The Cronbach's alpha values of the two factors were 0.947 (for natural environment) and 0.932 (for built environment). Furthermore, the results did not recommend deleting any item.

Table 6.34: Internal consistency and reliability of the EDHQ (N = 300), Malaysian students

Item	Corrected item total correlation	Squared multiple correlation	Cronbach's alpha if item deleted	Cronbach's alpha
Natural environment				0.947
EDH1	0.839	0.822	0.938	
EDH2	0.857	0.800	0.937	
EDH3	0.694	0.594	0.948	
EDH4	0.684	0.595	0.949	
EDH5	0.727	0.564	0.946	
EDH6	0.894	0.831	0.935	
EDH7	0.921	0.908	0.932	
EDH8	0.868	0.794	0.937	
Built environment				0.932
EDH9	0.726	0.587	0.926	
EDH10	0.718	0.539	0.926	
EDH11	0.891	0.807	0.917	
EDH12	0.862	0.945	0.920	
EDH13	0.609	0.413	0.931	
EDH14	0.864	0.947	0.920	
EDH15	0.657	0.479	0.931	
EDH16	0.672	0.480	0.928	
EDH17	0.751	0.602	0.924	
EDH18	0.693	0.554	0.927	

6.7.2(b) Composite reliability (CR)

The CR was 0.893 (95% CI: 0.870, 0.912) for natural environment and 0.906 (95% CI: 0.890, 0.923) for built environment.

6.7.2(c) Test-retest reliability based on intraclass correlation coefficient (ICC)

A total of 70 participants completed the EDHQ twice within the interval of 7 days. The mean score for the natural environment increased from 26.5 (SD = 4.90) on day 1 to 26.6 (SD = 5.37) on day 7, with an ICC value of 0.765 (95% CI: 0.621, 0.854, p-value < 0.001). The mean score for the built environment was 34.9 (SD = 6.54) on day 1 and 34.8 (SD = 6.88) on day 7, with an ICC value of 0.836 (95% CI: 0.736, 0.898, p-value < 0.001).

6.7.3 DLQ reliability results

6.7.3(a) Cronbach's alpha

Table 6.35 presents the DLQ internal consistency reliability results based on Cronbach's alpha. For the whole scale, the Cronbach's alpha value was 0.774. The Cronbach's alpha values of the three factors were 0.863 (for physiological demand), 0.815 (for psychosocial demand), and 0.909 (for environmental demand). Furthermore, the results did not recommend deleting any item.

Table 6.35: Internal consistency and reliability of the DLQ (N = 300), Malaysian students

Item	Corrected item total correlation	Squared multiple correlation	Cronbach's alpha if item deleted	Cronbach's alpha
Physiological demand				0.863
DL1	0.793	0.809	0.815	
DL2	0.864	0.835	0.801	
DL3	0.846	0.875	0.804	
DL4	0.490	0.249	0.868	
DL5	0.504	0.287	0.867	
DL6	0.484	0.241	0.871	
Psychosocial demand				0.815
DL7	0.832	0.743	0.725	
DL8	0.446	0.317	0.814	
DL9	0.483	0.337	0.805	
DL10	0.834	0.745	0.732	
DL11	0.470	0.341	0.808	
DL12	0.460	0.282	0.811	
Environmental demand				0.909
DL13	0.623	0.429	0.909	
DL14	0.494	0.293	0.926	
DL15	0.733	0.669	0.894	
DL16	0.878	0.822	0.871	
DL17	0.897	0.867	0.869	
DL18	0.868	0.831	0.874	

6.7.3(b) Composite reliability (CR)

The CR was 0.818 (95% CI: 0.790, 0.845) for physiological demand, 0.815 (95% CI: 0.786, 0.845) for psychosocial demand, and 0.826 (95% CI: 0.797, 0.856) for environmental demand.

6.7.3(c) Test-retest reliability based on intraclass correlation coefficient (ICC)

A total of 70 participants completed the DLQ twice within the interval of 7 days. For physiological demand, the mean was 13.27 (SD = 4.45) on day 1 and 12.73 (SD = 4.63) on day 7, with an ICC value of 0.808 (95% CI: 0.692, 0.881). For psychosocial demand, the mean was 21.71 (SD = 5.65) on day 1 and 21.43 (SD = 5.33) on day 7, with an ICC value of 0.776 (95% CI: 0.639, 0.861). For environmental demand, the mean was 18.66 (SD = 3.19) on day 1 and 19.00 (SD = 3.34) on day 7, with an ICC value of 0.985 (95% CI; 0.976, 0.991).

6.7.4 IPQ reliability results

6.7.4(a) Cronbach's alpha

Table 6.36 presents the IPQ internal consistency reliability results based on Cronbach's alpha. For the whole scale, the Cronbach's alpha value was 0.797. The Cronbach's alpha values of the two factors were 0.848 (for biologically given potential) and 0.895 (for personally acquired potential). Furthermore, the results did not recommend deleting any item.

Table 6.36: Internal consistency and reliability of the IPQ (N = 300), Malaysian students

Item	Corrected item total correlation	Squared multiple correlation	Cronbach's alpha if item deleted	Cronbach's alpha
Biologically given potential				0.848
IP1	0.826	0.707	0.787	
IP2	0.478	0.261	0.851	
IP3	0.520	0.310	0.861	
IP4	0.783	0.675	0.797	
IP5	0.703	0.590	0.810	
IP6	0.607	0.497	0.830	
Personally acquired potential				0.895
IP7	0.865	0.884	0.865	
IP8	0.485	0.314	0.900	
IP9	0.482	0.266	0.899	
IP10	0.831	0.832	0.870	
IP11	0.840	0.843	0.864	
IP12	0.572	0.356	0.891	
IP13	0.554	0.337	0.894	
IP14	0.872	0.845	0.864	

6.7.4(b) Composite reliability (CR)

The CR was 0.950 (95% CI: 0.939, 0.959) for biologically given potential and 0.909 (95% CI: 0.893, 0.925) for personally acquired potential.

6.7.4(c) Test-retest reliability based on intraclass correlation coefficient (ICC)

A total of 70 participants completed the IPQ twice within the interval of 7 days. For biologically given potential, the mean decreased from 8.50 (SD = 3.73) on day 1 to 8.00 (SD = 3.43) on day 7, with an ICC value of 0.854 (95% CI: 0.766, 0.909). For the personally acquired potential, the mean decreased from 20.87 (SD = 2.96) on day 1 to 20.77 (SD = 2.70) on day 7, with an ICC value of 0.987 (95% CI: 0.979, 0.992).

6.8 Summary

The present chapter presented the findings of the study's phase II, which covers the validation of the newly developed questionnaires (i.e., SDHQ, EDHQ, DLQ, and

IPQ) based on independent samples among undergraduate students in FUD, Nigeria, and USM health campus. The chapter presents the results obtained based on Nigerian samples and subsequently presents the results obtained based on Malaysian samples. The summary of the chapter findings is presented in Table 6.37 below.

Table 6.37: Summary of the chapter findings

Scale	EFA	CFA	Reliability
Nigerian based sample			
SDHQ	2 factors extracted. 20 items. KMO = 0.899 Variance extracted = 61.8% Factor loadings = 0.557-0.869	2 factors. 20 items. Factor loadings = 0.535-0.814 Fit indices – Fulfilled. Factor correlation = 0.216 AVE = 0.451 & 0.437	Cronbach's alpha = 0.902 CR = 0.797 & 0.794 ICC = 0.938 & 0.941
EDHQ	2 factors extracted. 18 items. KOM = 0.937 Variance extracted = 63.5% Factor loadings = 0.570-0.848	2 factors. 18 items. Factor loadings = 0.655-0.834 Fit indices – Fulfilled. Factor correlation = 0.311 AVE = 0.578 & 0.519	Cronbach's alpha = 0.947 CR = 0.845 & 0.854 ICC = 0.976 & 0.970
DLQ	3 factors extracted. 18 items. KMO = 0.842 Variance extracted = 61.9% Factor loadings = 0.574-0.865	3 factors. 18 items. Factor loadings = 0.533-0.788 Fit indices – Fulfilled. Factor correlation = 0.073-0.255 AVE = 0.408-0.465	Cronbach's alpha = 0.831 CR = 0.760-0.848 ICC = 0.921-0.972
IPQ	2 factors extracted. 14 items. KMO = 0.905 Variance extracted = 69.8% Factor loadings = 0.629-0.933	2 factors. 14 items. Factor loadings = 0.684-0.954 Fit indices – Fulfilled. Factor correlation = -0.160 AVE = 0.728 & 0.679	Cronbach's alpha = 0.752 CR = 0.878 & 0.909 ICC = 0.976 & 0.953

Table 6.37 Continued

Scale	EFA	CFA	Reliability
Malaysia based samples			
SDHQ	2 factors extracted. 20 items. KMO = 0.909 Variance extracted = 67.7%. Factor loadings = 0.677-0.910	2 factors. 20 items. Factor loadings = 0.500-0.791 Fit indices – Fulfilled. Factor correlation = 0.164 AVE = 0.422 & 0.376	Cronbach's alpha = 0.951 CR = 0.894 & 0.909 ICC = 0.780 & 0.799
EDHQ	2 factors extracted. 18 items. KMO = 0.934 Variance extracted = 69.2% Factor loadings = 0.571-0.931	2 factors. 18 items. Factor loadings = 0.593-0.809 Fit indices – Fulfilled. Factor correlation = 0.301 AVE = 0.508 & 0.550	Cronbach's alpha = 0.945 CR = 0.893 & 0.906 ICC = 0.765 & 0.836
DLQ	3 factors extracted. 18 items. KMO = 0.826 Variance extracted = 62.1% Factor loadings = 0.506-0.957	3 factors. 18 items. Factor loadings = 0.444-0.849 Fit indices – Fulfilled. Factor correlation = -0.044-0.157 AVE = 0.364-0.452	Cronbach's alpha = 0.774 CR = 0.815-0.826 ICC = 0.776-0.985
IPQ	2 factors extracted. 14 items. KMO = 0.864 Variance extracted = 61.1% Factor loadings = 0.508-0.923	2 factors. 14 items. Factor loadings = 0.668-0.958 Fit indices – Fulfilled. Factor correlation = -0.159 AVE = 0.747 & 0.655	Cronbach's alpha = 0.797 CR = 0.950 & 0.909 ICC = 0.854 & 0.987

CHAPTER 7

RESULTS OF PHASE III: STRUCTURAL RELATIONSHIP STUDY

7.1 Introduction

This chapter covers the results of phase III, which covers structural relationships between social determinants of health (SDH), environmental determinants of health (EDH), demands of life (DL), individual potentials (IP), healthy diet (HD), physical activity (PA), and quality of life among undergraduate students in FUD, Nigeria, and USM health campus. The chapter covers the study's objectives 8 to 11. Thus, we organize the results into six sections: (1) descriptive statistics and parceling of study variables; (2) hypothesized structural model; (3) SEM of the study variables (i.e., SDH, EDH, DL, IP, HD, PA, and quality of life) among undergraduate students in FUD, Nigeria; (4) SEM of the study variables among undergraduate students in the USM health campus; (5) measurement and structural invariance of the SDHQ, EDHQ, DLQ, and IPQ across Nigerian and Malaysian undergraduate students; and (6) multigroup SEM comparison.

7.2 Descriptive statistics and parceling of study variables

The scores of the holistic health questionnaires were parcelled by computing the total scale score. Specifically, for SDH, scores were derived by summing up responses across items SDH1 to SDH20, resulting in a single score ranging from 20 to 100. Higher scores signify a higher perceived level of SDH, while lower scores signify a lower perceived level of SDH. For EDH, scores were derived by summing up responses across items EDH1 to EDH18, resulting in a single score ranging from 18 to 90. Higher scores signify a higher perceived level of EDH, while lower scores signify a lower perceived level of EDH. For DL, scores were derived by summing up responses across items DL1 to DL18, resulting in a single score ranging from 18 to 90. Higher scores signify a lower perceived level of DL, while lower scores signify a higher perceived level of DL. For IP, scores were derived by summing up responses across items IP1 to IP14, resulting in a single score ranging from 14 to 56. Higher scores signify a higher perceived level of IP, while lower scores signify a lower perceived level of IP. We derived scores for HD by summing up responses across items HD1 to IP10, which resulted in a single score ranging from 10 to 50. Higher scores signify a healthy diet, while lower scores signify a poor diet. Furthermore, we computed the PA and QOL total scores using the formulas presented in the method chapter provided by Craig et al. (2003) and Hoang et al. (2021), respectively, with higher scores indicating both higher PA and QOL. Table 7.1 presents the variable names, types used in SEM, the number of items for each scale before and after validation, means (SD), and internal consistency.

Table 7.1: Variable names, types used in SEM, the number of items for each scale before and after validation, means (SD), and internal consistency among FUD, Nigerian and USM health campus, Malaysian students

Variable	Type in SEM	Number of constructs	Number of items before validation	Number of items after validation	Mean (SD)	Cronbach's alpha
SDH	Exogenous	2	20	20	76.22(9.01)	0.831
EDH	Exogenous	2	18	18	56.88(12.36)	0.908
DL	Endogenous	3	18	18	57.98(8.49)	0.747
IP	Endogenous	2	14	14	32.28(5.74)	0.733
HD	Endogenous	1	10	NA	25.42(7.95)	0.877
PA	Endogenous	1	NA	NA	6.32(4.55)	NA
QOL	Endogenous	1	14	NA	65.34(25.07)	0.955

SDH = social determinants of health, EDH = environmental determinants of health, DL = demands of life, IP = individual potential, HD = healthy diet, PA = physical activity, QOL = quality of life, SD = standard deviation, NA = not applicable.

7.3 Hypothesized structural model

The initial structural equation model was developed using the Meikirch model conceptual framework outlined in Chapter 2. This model included four key study variables: SDH, EDH, DL, and IP. The researchers hypothesized that these variables would interact to affect QOL. Additionally, HD and PA were incorporated into the model due to their strong association with QOL. Due to the violation of multivariate normality, the MLR estimator was utilized in the analysis. Table 7.2 outlines the hypotheses examined in the SEM analysis. Figure 7.1 illustrates the initially proposed SEM model.

Table 7.2: The initial SEM model and specific hypotheses for FUD, Nigerian and USM health campus, Malaysian undergraduate students

Hypotheses	
H1	SDH significantly associated with DL
H2	EDH significantly associated with DL
H3	SDH significantly associated with IP
H4	EDH significantly associated with IP
H5	SDH significantly associated with QOL
H6	EDH significantly associated with QOL
H7	DL significantly associated with QOL
H8	IP significantly associated with QOL
H9	HD significantly associated with QOL
H10	PA significantly associated with QOL

SDH = social determinants of health, EDH = environmental determinants of health, DL = demands of life, IP = individual potential, HD = healthy diet, PA = physical activity, QOL = quality of life.

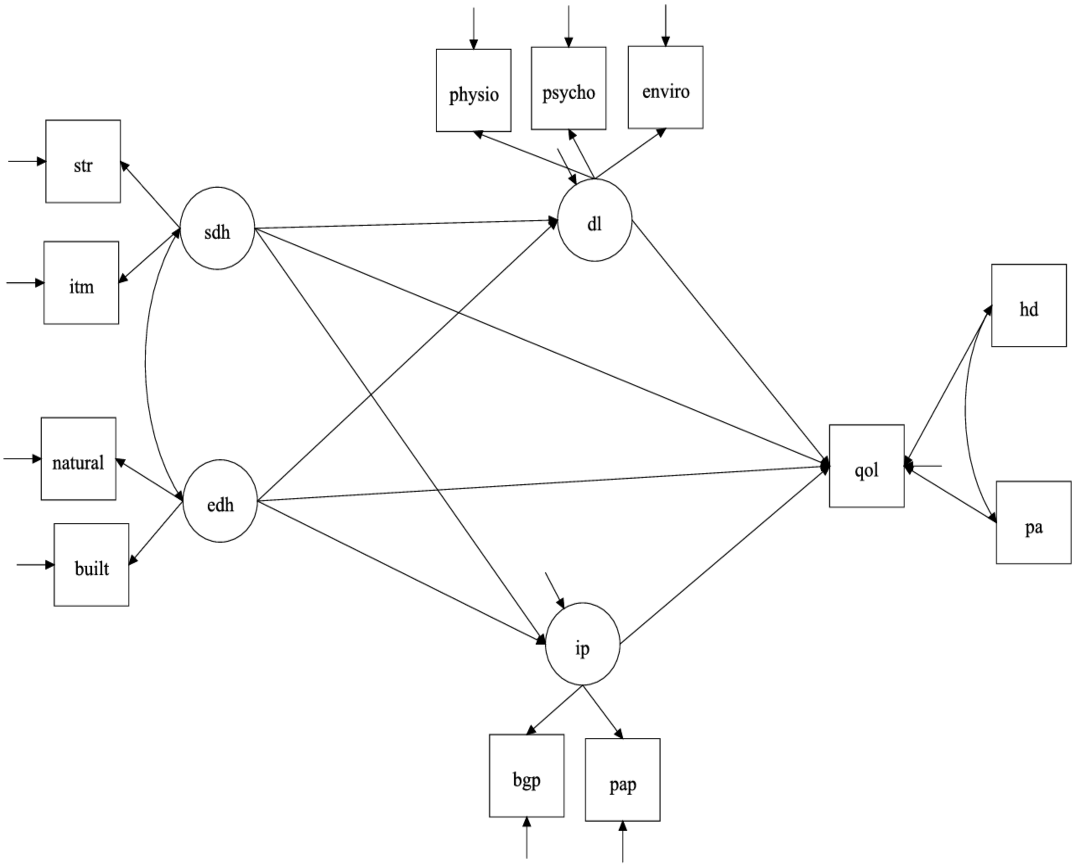

Figure 7.1: Initial hypothesized SEM of the relationship between SDH, EDH, DL, IP, HD, PA, and QOL

Note: SDH = social determinants of health, STR = structural determinants, ITM = intermediary determinants, EDH = environmental determinants of health, DL = demands of life, Physio = physiological demands, Psycho = psychosocial demands, Enviro = environmental demands, IP = individual potential, BGP = biologically given potential, PAP = personally acquired potential, HD = healthy diet, PA = physical activity, QOL = quality of life.

7.4 Structural relationship between SDH, EDH, DL, IP, healthy diet, physical activity, and quality of life among undergraduate students in FUD, Nigeria

In this section, the study investigated the structural relationship of the four holistic health components (SDH, EDH, DL, and IP) assessed using the four validated holistic health questionnaires (SDHQ, EDHQ, DLQ, and IPQ) with the addition of healthy diet (HD), physical activity (PA), and quality of life (QOL) with an independent sample of 570 undergraduate students from college of medicine and allied medical sciences FUD, Nigeria.

7.4.1 Initial SEM (model-1)

We tested the initial SEM to identify potential significant relationships among the hypothesized study variables. The results from the initial model demonstrated that the fit indices were not satisfactory (Table 7.3).

Table 7.3: Model fit indices of the initial SEM, FUD, Nigerian students

Model	CFI	TLI	SRMR	RMSEA (90%CI)	RMSEA p-value
Model-1	0.782	0.685	0.297	0.155 (0.144, 0.165)	< 0.001

CFI = Comparative Fit Index, TLI = Tucker-Lewis Index, SRMR = Standardised Root Mean square Residual, RMSEA = Root Mean Square Error of Approximation, CI = Confidence Interval.

Figure 7.2 presents the specific hypotheses for each pathway in the initially hypothesized structural model of holistic health variables (SDH, EDH, DL, IP), along with HD, PA, and QOL. The initial model included a total of 10 hypothesized path relationships. Out of the 10 hypotheses, seven pathways emerged as significant: DL significantly associated with SDH (β = -0.275, p-value < 0.001); DL significantly associated with EDH (β = -0.415, p-value < 0.001); IP significantly associated with SDH (β = 0.272, p-value < 0.001); IP significantly associated with EDH (β = 0.304, p-value < 0.001); QOL significantly associated with SDH (β = 0.465, p-value < 0.001); QOL significantly associated with EDH (β = 0.522, p-value < 0.001); and QOL significantly associated with DL (β = 0.135, p-value = 0.035). Table 7.4 below presents the standardized regression pathways and 95% CI for the initial model (model-1).

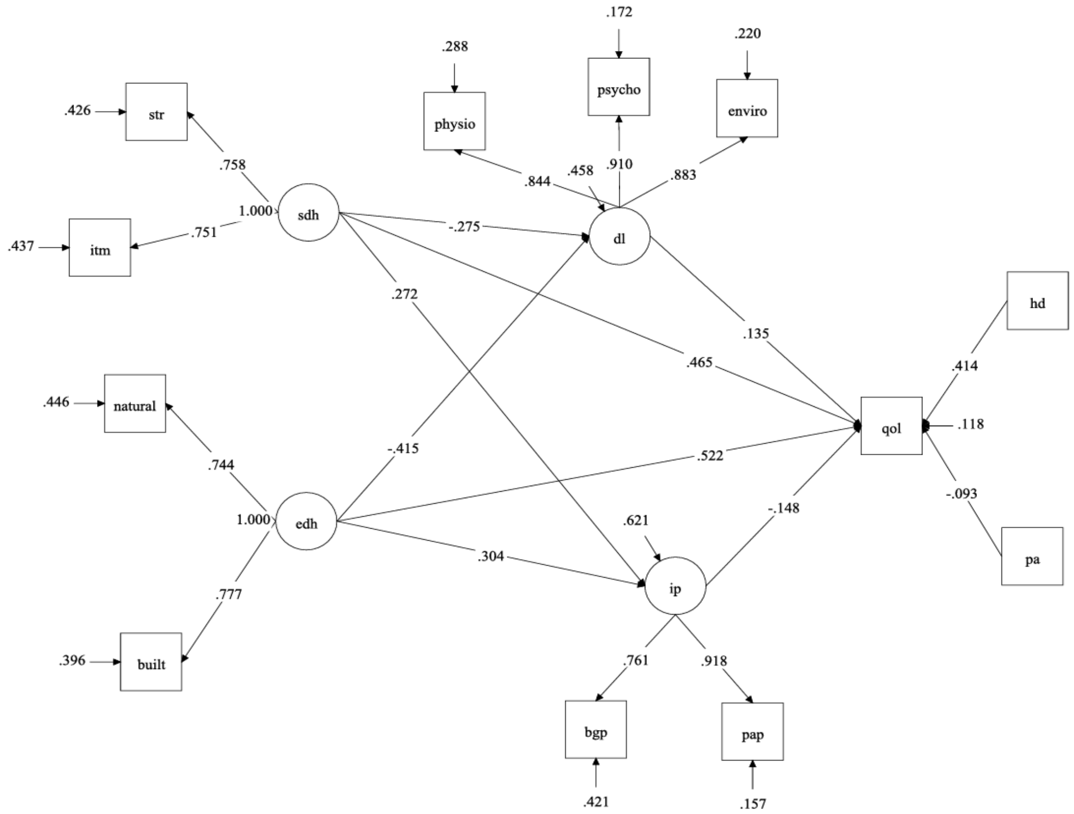

Figure 7.2: Initial SEM (model-1) of the relationship between SDH, EDH, DL, IP, HD, PA, and QOL (FUD Nigerian students)

Note: SDH = social determinants of health, STR = structural determinants, ITM = intermediary determinants, EDH = environmental determinants of health, DL = demands of life, Physio = physiological demands, Psycho = psychosocial demands, Enviro = environmental demands, IP = individual potential, BGP = biologically given potential, PAP = personally acquired potential, HD = healthy diet, PA = physical activity, QOL = quality of life.

Table 7.4: Hypothesized path relationships in model-1, FUD, Nigerian students

Hypothesis	Pathways	β (95% CI)	Critical ratios	p-value
H1	DL ← SDH	-0.275 (-0.374, -0.176)	-5.457	< 0.001
H2	DL ← EDH	-0.415 (-0.499, -0.330)	-9.623	< 0.001
H3	IP ← SDH	0.272 (0.178, 0.366)	5.653	< 0.001
H4	IP ← EDH	0.304 (0.203, 0.405)	5.889	< 0.001
H5	QOL ← SDH	0.465 (0.345, 0.585)	7.601	< 0.001
H6	QOL ← EDH	0.522 (0.387, 0.657)	7.572	< 0.001
H7	QOL ← DL	0.135 (0.009, 0.260)	2.104	0.035
H8	QOL ← IP	-0.148 (-0.217, 0.079)	-4.210	0.098
H9	QOL ← HD	0.414 (-0.217, 0.611)	4.116	0.170
H10	QOL ← PA	-0.097 (-0.206, 0.020)	-1.614	0.106

SDH = social determinants of health, EDH = environmental determinants of health, DL = demands of life, IP = individual potential, HD = healthy diet, PA = physical activity, QOL = quality of life.

7.4.2 Re-specified SEM (Model-2) after removal of some pathways

Model-2 was further tested after removing two pathways from the initial model: QOL associated with IP, and QOL associated with HD. These pathways were removed based on a higher significance value to improve the initial SEM model. Despite its non-significance in the initial model, we kept the pathway (QOL associated with PA) in the model because removing it made the model fit indices worse. The results from Model-2 indicated improved fit indices (Table 7.5), although they still did not fall within the acceptable range of values. The output also recommended adding additional pathways based on MI to improve the model fit indices.

Table 7.5: Model fit indices of the second SEM, FUD, Nigerian students

Model	CFI	TLI	SRMR	RMSEA (90%CI)	RMSEA p-value
Model-2	0.790	0.670	0.223	0.169 (0.157, 0.181)	< 0.001

CFI = Comparative Fit Index, TLI = Tucker-Lewis Index, SRMR = Standardised Root Mean square Residual, RMSEA = Root Mean Square Error of Approximation, CI = Confidence Interval.

7.4.3 Re-specified SEM (Model-3) after additional residual covariances

Since model-2 does not show acceptable fit indices, as shown in Table 7.5 above, we further tested model-3 by adding one residual covariances between SHD and PA, as suggested by MI in Mplus output, after ensuring adequate theoretical support. The results of model 3 demonstrated satisfactory fit indices (Table 7.6), and no further modifications were suggested by the MI in the Mplus outputs. Hence, model-3 is considered to be the final structural model. Figure 7.3 shows the final diagram of the SDH, EDH, DL, IP, PA, and QOL final structural models.

Table 7.6: Model fit indices of the final SEM, FUD, Nigerian students

Model	CFI	TLI	SRMR	RMSEA (90%CI)	RMSEA p-value
Model-3	0.989	0.982	0.021	0.039 (0.024, 0.054)	0.879

CFI = Comparative Fit Index, TLI = Tucker-Lewis Index, SRMR = Standardised Root Mean square Residual, RMSEA = Root Mean Square Error of Approximation, CI = Confidence Interval.

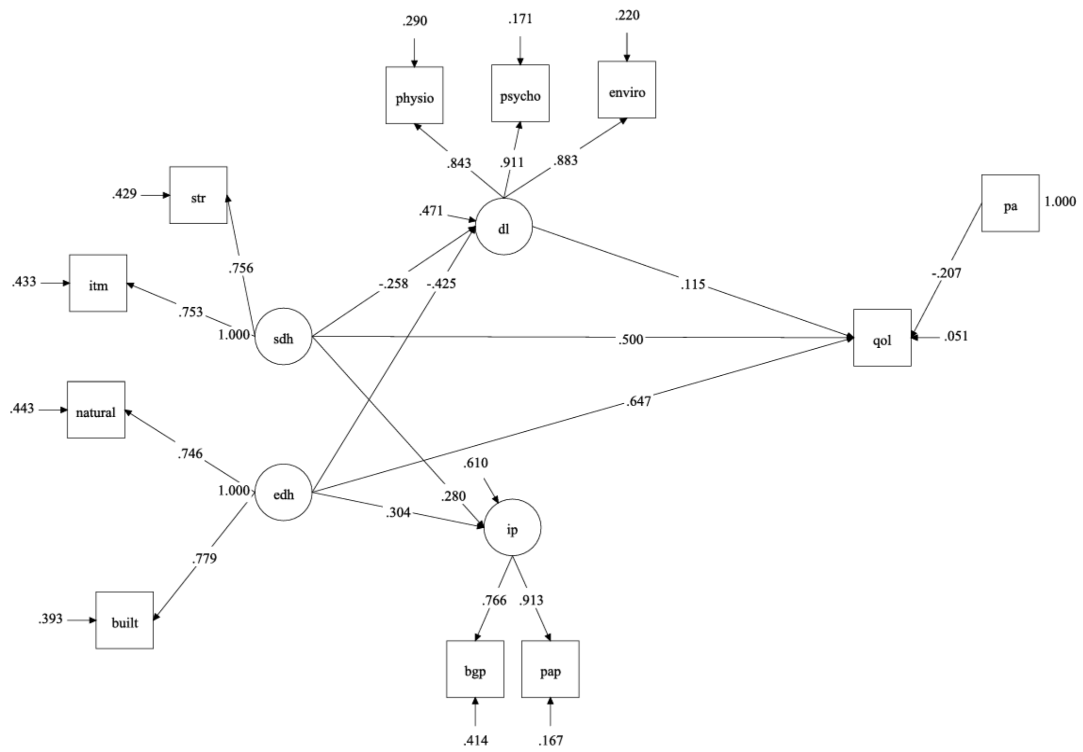

Figure 7.3: Final structural model of the relationship between SDH, EDH, DL, IP, PA, and QOL among FUD, Nigeria students

Note: SDH = social determinants of health, STR = structural determinants, ITM = intermediary determinants, EDH = environmental determinants of health, DL = demands of life, Physio = physiological demands, Psycho = psychosocial demands, Enviro = environmental demands, IP = individual potential, BGP = biologically given potential, PAP = personally acquired potential, PA = physical activity, QOL = quality of life.

7.4.4 FUD, Nigerian students structural model summary

Table 7.7 summarizes the final decisions on the hypotheses tested in the SEM analysis based on Nigerian sample. Out of the 10 pathways, eight were supported by the data. To assess the amount of variance in each dependent variable explained by the model, the coefficient of determination (R^2) for the dependent variables was analyzed. The results indicated that the hypothesized model statistically explained the variance for each dependent variable: DL ($R^2 = 0.529$, p-value < 0.001), IP ($R^2 = 0.390$, p-value < 0.001), and QOL ($R^2 = 0.949$, p-value < 0.001).

Table 7.7: Final decisions of the final structural model, FUD, Nigerian students

Hypotheses		Decisions
H1	SDH significantly associated with DL	Supported
H2	EDH significantly associated with DL	Supported
H3	SDH significantly associated with IP	Supported
H4	EDH significantly associated with IP	Supported
H5	SDH significantly associated with QOL	Supported
H6	EDH significantly associated with QOL	Supported
H7	DL significantly associated with QOL	Supported
H8	IP significantly associated with QOL	Not supported
H9	HD significantly associated with QOL	Not supported
H10	PA significantly associated with QOL	Supported

SDH = social determinants of health, EDH = environmental determinants of health, DL = demands of life, IP = individual potential, HD = healthy diet, PA = physical activity, QOL = quality of life, A = additional.

Table 7.8 below presents the standardized regression pathways and 95% CI for the final structural model (model-3). The results indicated that DL was significantly and negatively associated with SDH (β = -0.258, p-value < 0.001) and EDH (β = -0.425, p-value < 0.001). IP was significantly and positively associated with both SDH (β = 0.280, p-value < 0.001) and EDH (β = 0.304, p-value < 0.001). QOL was significantly and positively associated with SDH (β = 0.500, p-value < 0.001), EDH (β = 0.647, p-value < 0.001), and DL (β = 0.115, p-value = 0.001), while it was significantly and negatively associated with PA (β = -0.207, p-value = 0.047).

Table 7.8: Hypothesized path relationships in the final structural model, FUD, Nigerian students

Hypothesis	Pathways	β (95% CI)	Critical ratios	p-value
H1	DL ← SDH	-0.258 (-0.344, -0.172)	-5.885	< 0.001
H2	DL ← EDH	-0.425 (-0.512, -0.337)	-9.529	< 0.001
H3	IP ← SDH	0.280 (0.191, 0.369)	6.183	< 0.001
H4	IP ← EDH	0.304 (0.209, 0.400)	6.238	< 0.001
H5	QOL ← SDH	0.500 (0.353, 0.647)	6.573	< 0.001
H6	QOL ← EDH	0.647 (0.479, 0.815)	7.535	< 0.001
H7	QOL ← DL	0.115 (0.010, 0.220)	2.144	0.032
H10	QOL ← PA	-0.207 (-0.411, -0.036)	-1.986	0.047

SDH = social determinants of health, EDH = environmental determinants of health, DL = demands of life, IP = individual potential, HD = healthy diet, PA = physical activity, QOL = quality of life.

7.4.5 Structural model testing of indirect relationships among FUD, Nigerian students

Table 7.9 presents both the standardized total and specific indirect effects. The total indirect effect of SDH on QOL was positive and statistically significant (β = 0.470, p-value < 0.001), consisting of one specific indirect effect via DL, which was not statistically significant (β = -0.030, p-value = 0.060). The total indirect effect of EDH on QOL was positive and statistically significant (β = 0.598, p-value < 0.001), consisting of one specific indirect effect via DL, which was statistically significant (β = -0.049, p-value = 0.042).

Table 7.9: Standardised Total Indirect and Specific Indirect Effects, FUD, Nigerian students

Predictor variable	Through	Specific indirect effect (p-value)	Total effect (p-value)
SDH to QOL			0.470 (< 0.001)
SDH to QOL			
	DL	-0.030 (0.060)	
EDH to QOL			0.598 (< 0.001)
EDH to QOL			
	DL	-0.049 (0.042)	

SDH = social determinants of health, EDH = environmental determinants of health, DL = demands of life, QOL = quality of life.

7.5 Structural relationship between SDH, EDH, DL, IP, healthy diet, physical activity, and quality of life among undergraduate students in USM health campus, Malaysia

7.5.1 Initial SEM (model-1)

We tested the initial SEM to identify potential significant relationships among the hypothesized study variables. The results from the initial model demonstrated that the fit indices were not satisfactory (Table 7.10).

Table 7.10: Model fit indices of the initial SEM, USM health campus, Malaysian students

Model	CFI	TLI	SRMR	RMSEA (90%CI)	RMSEA p-value
Model-1	0.740	0.625	0.308	0.162 (0.151, 0.172)	< 0.001

CFI = Comparative Fit Index, TLI = Tucker-Lewis Index, SRMR = Standardised Root Mean square Residual, RMSEA = Root Mean Square Error of Approximation, CI = Confidence Interval.

Figure 7.4 presents the specific hypotheses for each pathway in the initially hypothesized structural model of holistic health variables (SDH, EDH, DL, IP), along with HD, PA, and QOL. The initial model included a total of 10 hypothesized path relationships. Out of the 10 hypotheses, seven pathways emerged as significant: DL significantly associated with SDH ($\beta = -0.299$, p-value < 0.001); DL significantly associated with EDH ($\beta = -0.426$, p-value < 0.001); IP significantly associated with SDH ($\beta = 0.245$, p-value < 0.001); IP significantly associated with EDH ($\beta = 0.365$, p-value < 0.001); QOL significantly associated with SDH ($\beta = 0.498$, p-value < 0.001); QOL significantly associated with EDH ($\beta = 0.616$, p-value < 0.001); and QOL significantly associated with IP ($\beta = -0.183$, p-value < 0.001). Table 7.11 below presents the standardized regression pathways and 95% CI for the initial model (model-1).

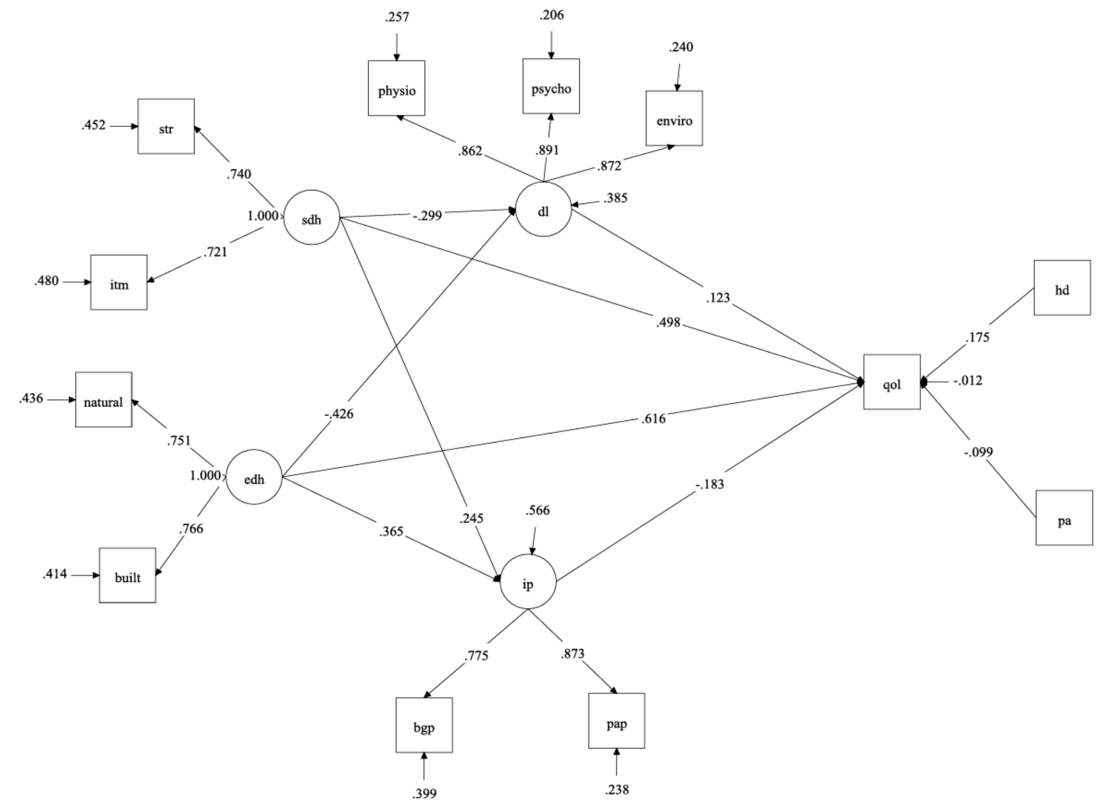

Figure 7.4: Initial SEM (model-1) of the relationship between SDH, EDH, DL, IP, HD, PA, and QOL (USM health campus students)

Note: SDH = social determinants of health, STR = structural determinants, ITM = intermediary determinants, EDH = environmental determinants of health, DL = demands of life, Physio = physiological demands, Psycho = psychosocial demands, Enviro = environmental demands, IP = individual potential, BGP = biologically given potential, PAP = personally acquired potential, HD = healthy diet, PA = physical activity, QOL = quality of life.

Table 7.11: Hypothesized path relationships in model-1, USM health campus students

Hypothesis	Pathways	β (95% CI)	Critical ratios	p-value
H1	DL ← SDH	-0.299 (-0.382, -0.216)	-7.065	< 0.001
H2	DL ← EDH	0.426 (-0.501, -0.352)	-11.190	< 0.001
H3	IP ← SDH	0.245 (0.167, 0.322)	6.178	< 0.001
H4	IP ← EDH	0.365 (0.280, 0.450)	8.406	< 0.001
H5	QOL ← SDH	0.498 (0.377, 0.618)	8.080	< 0.001
H6	QOL ← EDH	0.616 (0.477, 0.755)	8.660	< 0.001
H7	QOL ← DL	0.123 (-0.043, 0.289)	1.458	0.145
H8	QOL ← IP	-0.183 (-0.256, -0.110)	-4.926	< 0.001
H9	QOL ← HD	0.175 (-0.023, 0.374)	1.736	0.083
H10	QOL ← PA	-0.099 (-0.221, 0.023)	-1.586	0.113

SDH = social determinants of health, EDH = environmental determinants of health, DL = demands of life, IP = individual potential, HD = healthy diet, PA = physical activity, QOL = quality of life.

7.5.2 Re-specified SEM (Model-2) after removal of non-significant pathways

Model-2 was further tested after removing two non-significant pathways from the initial model: QOL associated with DL, and QOL associated with PA. The results from Model-2 indicated improved fit indices (Table 7.12), however, the results demonstrated that the fit indices were still not satisfactory.

Table 7.12: Model fit indices of the second SEM, USM health campus students

Model	CFI	TLI	SRMR	RMSEA (90%CI)	RMSEA p-value
Model-2	0.741	0.605	0.238	0.175 (0.163, 0.187)	< 0.001

CFI = Comparative Fit Index, TLI = Tucker-Lewis Index, SRMR = Standardised Root Mean square Residual, RMSEA = Root Mean Square Error of Approximation, CI = Confidence Interval.

7.5.3 Re-specified SEM (Model-3) after additional significant pathways

We further tested model-3 by adding two residual covariances between SDH with HD and environmental demands with physiological demands, as suggested by MI in Mplus output, after ensuring adequate theoretical support. The results of model 3 demonstrated satisfactory fit indices (Table 7.13), and no further modifications were suggested by the MI in the Mplus outputs. Hence, model-3 is considered to be the final structural model. Figure 7.5 shows the final diagram of the SDH, EDH, DL, IP, HD, PA, and QOL final structural models.

Table 7.13: Model fit indices of the final SEM, USM health campus students

Model	CFI	TLI	SRMR	RMSEA (90%CI)	RMSEA p-value
Model-3	0.972	0.954	0.026	0.060 (0.046, 0.073)	0.110

CFI = Comparative Fit Index, TLI = Tucker-Lewis Index, SRMR = Standardised Root Mean square Residual, RMSEA = Root Mean Square Error of Approximation, CI = Confidence Interval.

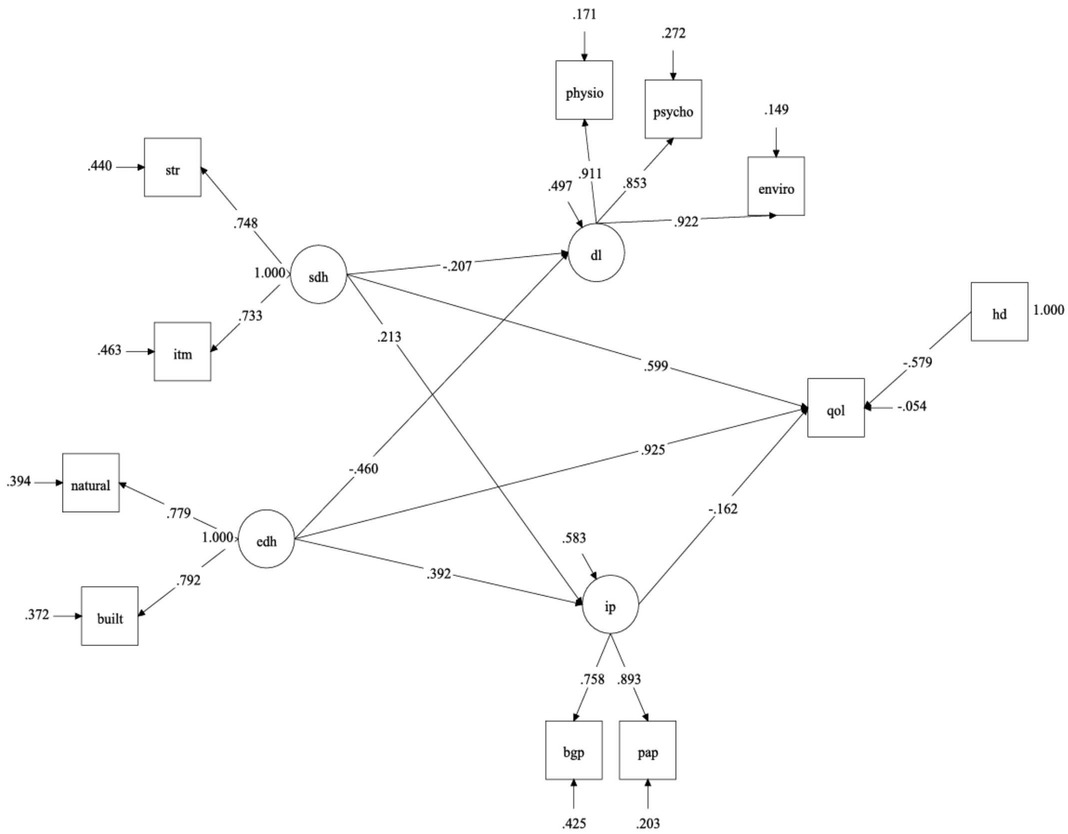

Figure 7.5: Final structural model of the relationship between SDH, EDH, DL, IP, HD, and QOL (USM health campus students)

Note: SDH = social determinants of health, STR = structural determinants, ITM = intermediary determinants, EDH = environmental determinants of health, DL = demands of life, Physio = physiological demands, Psycho = psychosocial demands, Enviro = environmental demands, IP = individual potential, BGP = biologically given potential, PAP = personally acquired potential, HD = healthy diet, QOL = quality of life.

7.5.4 USM health campus structural model summary

Table 7.14 summarizes the final decisions on the hypotheses tested in the SEM analysis. Out of the 10 pathways, eight were supported by the data. To assess the amount of variance in each dependent variable explained by the model, the coefficient of determination (R^2) for the dependent variables was analyzed. The results indicated that the hypothesized model statistically explained the variance for each dependent variable: DL (R^2 = 0.503, p-value < 0.001), IP (R^2 = 0.417, p-value < 0.001), and QOL (R^2 = 0.866, p-value < 0.001).

Table 7.14: Final decisions of the final structural model, USM health campus students

Hypotheses		Decisions
H1	SDH significantly associated with DL	Supported
H2	EDH significantly associated with DL	Supported
H3	SDH significantly associated with IP	Supported
H4	EDH significantly associated with IP	Supported
H5	SDH significantly associated with QOL	Supported
H6	EDH significantly associated with QOL	Supported
H7	DL significantly associated with QOL	Not supported
H8	IP significantly associated with QOL	Supported
H9	HD significantly associated with QOL	Supported
H10	PA significantly associated with QOL	Not supported

SDH = social determinants of health, EDH = environmental determinants of health, DL = demands of life, IP = individual potential, HD = healthy diet, PA = physical activity, QOL = quality of life, A = additional.

Table 7.15 below presents the standardized regression pathways and 95% CI for the final structural model (model-3). The results indicated that DL was significantly and negatively associated with SDH (β = -0.207, p-value < 0.001) and EDH (β = -0.460, p-value < 0.001); IP was significantly and positively associated with SDH (β = 0.213, p-value < 0.001) and EDH (β = 0.392, p-value < 0.001); QOL was significantly and positively associated with SDH (β = 0.599, p-value < 0.001) and EDH (β = 0.925, p-value < 0.001); and QOL was significantly and negatively associated with IP (β = -0.162, p-value < 0.001) and HD (β = -0.579, p-value = 0.021).

Table 7.15: Hypothesized path relationships in the final structural model, USM health campus students

Hypothesis	Pathways	β (95% CI)	Critical ratios	p-value
H1	DL ← SDH	-0.207 (-0.309, -0.105)	-3.990	< 0.001
H2	DL ← EDH	-0.460 (-0.568, -0.351)	-8.291	< 0.001
H3	IP ← SDH	0.213 (0.129, 0.298)	4.947	< 0.001
H4	IP ← EDH	0.392 (0.293, 0.490)	7.771	< 0.001
H5	QOL ← SDH	0.599 (0.354, 0.844)	4.789	< 0.001
H6	QOL ← EDH	0.925 (-0.591, 1.259)	5.436	< 0.001
H8	QOL ← IP	-0.162 (-0.221, -0.104)	-5.431	< 0.001
H9	QOL ← HD	-0.579 (-1.070, -0.088)	-2.310	0.021

SDH = social determinants of health, EDH = environmental determinants of health, DL = demands of life, IP = individual potential, HD = healthy diet, PA = physical activity, QOL = quality of life.

7.5.5 Structural model testing of indirect relationships

Table 7.16 presents both the standardized total and specific indirect effects. The total indirect effect of SDH on QOL was positive and statistically significant (β = 0.564, p-value < 0.001), consisting of one specific indirect effect via IP, which was statistically significant (β = -0.035, p-value = 0.001). The total indirect effect of EDH on QOL was positive and statistically significant (β = 0.861, p-value < 0.001), consisting of one specific indirect effect via IP, which was statistically significant (β = -0.064, p-value < 0.001).

Table 7.16: Standardised Total Indirect and Specific Indirect Effects, USM health campus students

Predictor variable	Through	Specific indirect effect (p-value)	Total effect (p-value)
SDH to QOL			0.564 (< 0.001)
SDH to QOL			
	IP	-0.035 (0.001)	
EDH to QOL			0.861 (< 0.001)
	IP	-0.064 (< 0.001)	

SDH = social determinants of health, EDH = environmental determinants of health, IP = individual potential, QOL = quality of life.

7.6 Measurement and structural invariance

This section covers the measurement and structural invariance models of the SDHQ, EDHQ, DLQ, and IPQ across the samples of Nigerian and Malaysian undergraduate students. The section covers the study's objective 10.

7.6.1 Measurement and structural invariance of the SDHQ

The configural invariance of the SDHQ model showed a good fit across countries (Table 7.17). Next, the weak measurement invariance model was tested and produced acceptable fit indices (Table 7.17). In addition, when compared to the non-restrictive configural model, the weak measurement invariance model revealed adequate metric invariance across countries (ΔCFI = 0.001, ΔTLI = 0.005, ΔRMSEA = -0.001), indicating that Nigerian and Malaysian students interpreted the items similarly. Third, the strong invariance model, a more restrictive model, was tested. The results (ΔCFI = 0, ΔTLI = 0.004, ΔRMSEA = -0.001) showed adequate metric invariance, suggesting that the factor loadings and intercepts were invariant across countries. Finally, the strict invariance model, the most restrictive, was tested. The results (ΔCFI = 0, ΔTLI = 0.004, ΔRMSEA = -0.002) indicated adequate metric invariance, implying that the items' mean scores were invariant across countries.

The structural invariance of the SDHQ was assessed using the factor variance and factor covariance invariance, and the factor means invariance (Table 7.17). The factor variance and factor covariance invariance fit indices were satisfactory (CFI = 0.932, TLI = 0.925, SRMR = 0.058, RMSEA = 0.050): also, its differences with the less restrictive invariance model (strong invariance) are within the acceptable values (ΔCFI = 0, ΔTLI = 0, ΔRMSEA = -0.001). These results signified that the relationships among the two factors of the SDHQ remained the same across the countries. The factor means invariance fit indices were also within the recommended values (CFI = 0.932,

TLI = 0.926, SRMR = 0.058, RMSEA = 0.050), and its differences with the less-restrictive model (factor variance and covariance) are within the recommended values (ΔCFI = 0, ΔTLI = 0.001, ΔRMSEA = 0). This result illustrates that the factor means are invariant across the countries

Table 7.17: Measurement and structural invariance of the SDHQ (N = 860)

Models	CFI	TLI	RMSEA	SRMR	Model comparison	ΔCFI	ΔTLI	ΔRMSEA
Configural (Model-1)	0.931	0.916	0.053	0.050	-	-	-	-
Measurement invariance								
Weak (Model-2)	0.932	0.921	0.052	0.050	2 versus 1	0.001	0.005	-0.001
Strong (Model-3)	0.932	0.925	0.051	0.051	3 versus 2	0	0.004	-0.001
Strict (Model-4)	0.932	0.929	0.049	0.055	4 versus 3	0	0.004	-0.002
Structural invariance								
Factor variance and factor covariance invariance (model-5)	0.932	0.925	0.050	0.058	5 versus 3	0	0	-0.001
Factor variance, covariance, and factor means invariance (model-6)	0.932	0.926	0.050	0.058	6 versus 5	0	0.001	0

7.6.2 Measurement and structural invariance of the EDHQ

The configural invariance of the EDHQ model showed a good fit across countries (Table 7.18). Next, the weak measurement invariance model was tested and produced acceptable fit indices (Table 7.18). In addition, when compared to the non-restrictive configural model, the weak measurement invariance model revealed adequate metric invariance across countries (ΔCFI = 0, ΔTLI = 0.003, ΔRMSEA = 0.006), indicating that Nigerian and Malaysian students interpreted the items similarly. Third, the strong invariance model, a more restrictive model, was tested. The results (ΔCFI = -0.010, ΔTLI = -0.007, ΔRMSEA = -0.004) showed adequate metric invariance, suggesting that the factor loadings and intercepts were invariant across countries. Finally, the strict invariance model, the most restrictive, was tested. The results (ΔCFI = 0, ΔTLI = 0.003, ΔRMSEA = 0.006) indicated adequate metric invariance, implying that the items' mean scores were invariant across countries.

The structural invariance of the EDHQ was assessed using the factor variance and factor covariance invariance, and the factor means invariance (Table 7.18). The factor variance and factor covariance invariance fit indices were satisfactory (CFI = 0.942, TLI = 0.939, SRMR = 0.052, RMSEA = 0.056): also, its differences with the less restrictive invariance model (strong invariance) are within the acceptable values (ΔCFI = 0, ΔTLI = 0, ΔRMSEA = 0.006). These results signified that the relationships among the two factors of the EDHQ remained the same across the countries. The factor means invariance fit indices were also within the recommended values (CFI = 0.935, TLI = 0.932, SRMR = 0.054, RMSEA = 0.059), and its differences with the less-restrictive model (factor variance and covariance) are within the recommended values (ΔCFI = -0.007, ΔTLI = -0.007, ΔRMSEA = 0.003). This result illustrates that the factor means are invariant across the countries.

Table 7.18: Measurement and structural invariance of the EDHQ (n = 860)

Models	CFI	TLI	RMSEA	SRMR	Model comparison	ΔCFI	ΔTLI	ΔRMSEA
Configural (Model-1)	0.952	0.943	0.054	0.041	-	-	-	-
Measurement invariance								
Weak (Model-2)	0.952	0.946	0.060	0.043	2 versus 1	0	0.003	0.006
Strong (Model-3)	0.942	0.939	0.056	0.046	3 versus 2	-0.010	-0.007	-0.004
Strict (Model-4)	0.942	0.942	0.054	0.052	4 versus 3	0	0.003	-0.002
Structural invariance								
Factor variance and factor covariance invariance (model-5)	0.942	0.939	0.056	0.052	5 versus 3	0	0	0.006
Factor variance, covariance, and factor means invariance (model-6)	0.935	0.932	0.059	0.054	6 versus 5	-0.007	-0.007	0.003

7.6.3 Measurement and structural invariance of the DLQ

The configural invariance of the DLQ model showed a good fit across countries (Table 7.19). Next, the weak measurement invariance model was tested and produced acceptable fit indices (Table 7.19). In addition, when compared to the non-restrictive configural model, the weak measurement invariance model revealed adequate metric invariance across countries (ΔCFI = -0.001, ΔTLI = 0.002, ΔRMSEA = -0.001), indicating that Nigerian and Malaysian students interpreted the items similarly. Third, the strong invariance model, a more restrictive model, was tested. The results (ΔCFI = 0.001, ΔTLI = 0.004, ΔRMSEA = -0.001) showed adequate metric invariance, suggesting that the factor loadings and intercepts were invariant across countries. Finally, the strict invariance model, the most restrictive, was tested. The results (ΔCFI = 0.001, ΔTLI = 0.004, ΔRMSEA = -0.002) indicated adequate metric invariance, implying that the items' mean scores were invariant across countries.

The structural invariance of the DLQ was assessed using the factor variance and factor covariance invariance, and the factor means invariance (Table 7.19). The factor variance and factor covariance invariance fit indices were satisfactory (CFI = 0.951, TLI = 0.949, SRMR = 0.064, RMSEA = 0.042); also, its differences with the less restrictive invariance model (strong invariance) are within the acceptable values (ΔCFI = -0.001, ΔTLI = 0, ΔRMSEA = 0). These results signified that the relationships among the two factors of the DLQ remained the same across the countries. The factor means invariance fit indices were also satisfactory (CFI = 0.951, TLI = 0.949, SRMR = 0.065, RMSEA = 0.042), and its differences with the less-restrictive model (factor variance and covariance) are with the recommended values (ΔCFI = 0, ΔTLI = 0, ΔRMSEA = 0). This result illustrates that the factor means are invariant across the countries.

Table 7.19: Measurement and structural invariance of the DLQ (N = 860)

Models	CFI	TLI	RMSEA	SRMR	Model comparison	ΔCFI	ΔTLI	ΔRMSEA
Configural (Model-1)	0.952	0.943	0.044	0.056	-	-	-	-
Measurement invariance								
Weak (Model-2)	0.951	0.945	0.043	0.058	2 versus 1	-0.001	0.002	-0.001
Strong (Model-3)	0.952	0.949	0.042	0.058	3 versus 2	0.001	0.004	-0.001
Strict (Model-4)	0.953	0.953	0.040	0.059	4 versus 3	0.001	0.004	-0.002
Structural invariance								
Factor variance and factor covariance invariance (model-5)	0.951	0.949	0.042	0.064	5 versus 3	-0.001	0	0
Factor variance, covariance, and factor means invariance (model-6)	0.951	0.949	0.042	0.065	6 versus 5	0	0	0

7.6.4 Measurement and structural invariance of the IPQ

The configural invariance of the IPQ model showed a good fit across countries (Table 7.20). Next, the weak measurement invariance model was tested and produced acceptable fit indices (Table 7.20). In addition, when compared to the non-restrictive configural model, the weak measurement invariance model revealed adequate metric invariance across countries (ΔCFI = 0, ΔTLI = 0.004, ΔRMSEA = -0.002), indicating that Nigerian and Malaysian students interpreted the items similarly. Third, the strong invariance model, a more restrictive model, was tested. The results (ΔCFI = 0, ΔTLI = 0.003, ΔRMSEA = -0.002) showed adequate metric invariance, suggesting that the factor loadings and intercepts were invariant across countries. Finally, the strict invariance model, the most restrictive, was tested. The results (ΔCFI = 0.003, ΔTLI = 0.008, ΔRMSEA = -0.006) indicated adequate metric invariance, implying that the items' mean scores were invariant across countries.

The structural invariance of the IPQ was assessed using the factor variance and factor covariance invariance, and the factor means invariance (Table 7.20). The factor variance and factor covariance invariance fit indices were satisfactory (CFI = 0.957, TLI = 0.952, SRMR = 0.085, RMSEA = 0.064); also, its differences with the less restrictive invariance model (strong invariance) are within the acceptable values (ΔCFI = 0, ΔTLI = 0.001, ΔRMSEA = -0.001). These results signified that the relationships among the two factors of the IPQ remained the same across the countries. The factor means invariance fit indices were also satisfactory (CFI = 0.956, TLI = 0.952, SRMR = 0.087, RMSEA = 0.067), and its differences with the less-restrictive model (factor variance and covariance) are with the recommended values (ΔCFI = -0.001, ΔTLI = 0, ΔRMSEA = 0.003). This result illustrates that the factor means are invariant across the countries.

Table 7.20: Measurement and structural invariance of the IPQ (N = 860)

Models	CFI	TLI	RMSEA	SRMR	Model comparison	ΔCFI	ΔTLI	ΔRMSEA
Configural (Model-1)	0.957	0.944	0.069	0.083	-	-	-	-
Measurement invariance								
Weak (Model-2)	0.957	0.948	0.067	0.084	2 versus 1	0	0.004	-0.002
Strong (Model-3)	0.957	0.951	0.065	0.085	3 versus 2	0	0.003	-0.002
Strict (Model-4)	0.960	0.959	0.059	0.086	4 versus 3	0.003	0.008	-0.006
Structural invariance								
Factor variance and factor covariance invariance (model-5)	0.957	0.952	0.064	0.085	5 versus 3	0	0.001	-0.001
Factor variance, covariance, and factor means invariance (model-6)	0.956	0.952	0.067	0.087	6 versus 5	-0.001	0	0.003

7.7 Multigroup SEM models

The two samples shared the following six hypotheses: 1) SDH was significantly associated with DL, 2) EDH was significantly associated with DL, 3) SDH was significantly associated with IP, 4) EDH was significantly associated with IP, 5) SDH was significantly associated with QOL, and 6) EDH was significantly associated with QOL. Subsequently, we tested the multigroup SEM models for the two samples based on these six significant paths. The results from the initial multigroup SEM model demonstrated acceptable fit indices. (Table 7.21).

Table 7.21: Model fit indices of the multigroup SEM model of Nigerian and Malaysian samples

Model	CFI	TLI	SRMR	RMSEA (90%CI)	RMSEA p-value
Model-3	0.982	0.969	0.020	0.052 (0.042, 0.062)	0.360

CFI = Comparative Fit Index, TLI = Tucker-Lewis Index, SRMR = Standardised Root Mean square Residual, RMSEA = Root Mean Square Error of Approximation, CI = Confidence Interval.

Table 7.22 and Figures 7.6 and 7.7 below presents the path relationships of the two SEM models. The strength and direction of the regression coefficients were found to be similar across the samples of Nigerian and university undergraduate students. Across the Nigerian and Malaysian students' samples, the results indicated that DL was significantly and negatively associated with SDH (β = -0.281 and -0.308) and EDH (β = -0.415 and -0.425); IP was significantly and positively associated with SDH (β = 0.284 and 0.257) and EDH (β = 0.299 and 0.363); QOL was significantly and positively associated with SDH (β = 0.422 and 0.426) and EDH (β = 0.481 and 0.500). However, the results indicated that all the standardized coefficients in the Malaysian students sample are greater than those of the Nigerian students sample.

Table 7.22: Multigroup SEM comparisons across Nigerian and Malaysian undergraduate students

Hypotheses	Nigerian students β (p-value)	Malaysian students β (p-value)
H1: SDH significantly associated with DL	-0.281 (< 0.001)	-0.308 (< 0.001)
H2: EDH significantly associated with DL	-0.415 (< 0.001)	-0.425 (< 0.001)
H3: SDH significantly associated with IP	0.284 (< 0.001)	0.257 (< 0.001)
H4: EDH significantly associated with IP	0.299 (< 0.001)	0.363 (< 0.001)
H5: SDH significantly associated with	0.422 (< 0.001)	0.426 (< 0.001)
H6: EDH significantly associated with QOL	0.481 (< 0.001)	0.500 (< 0.001)

SDH = social determinants of health, EDH = environmental determinants of health, IP = individual potential, QOL = quality of life.

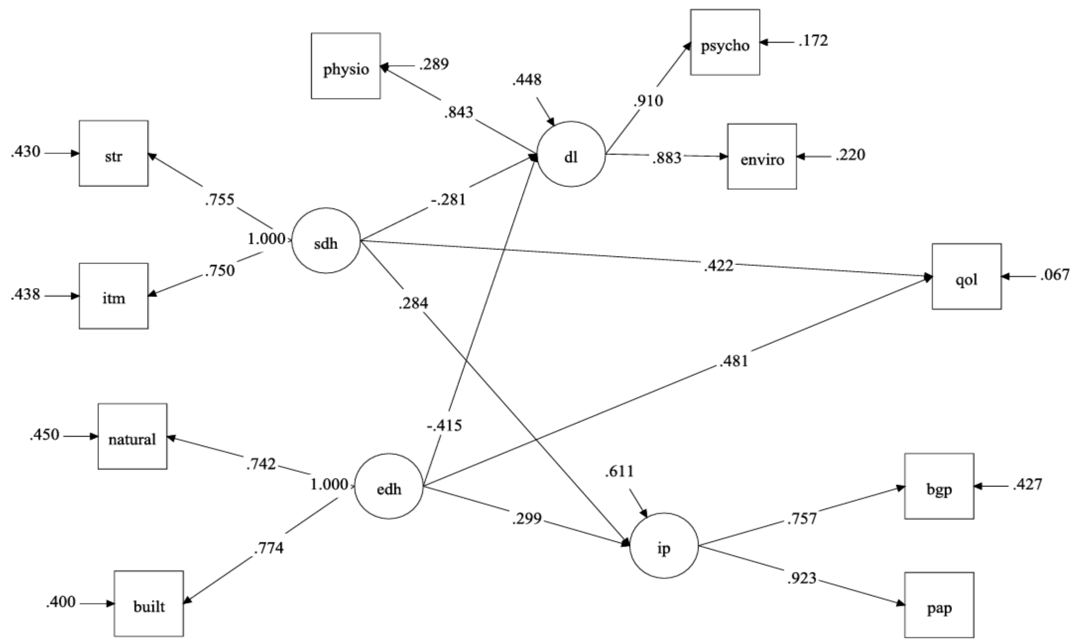

Figure 7.6: Multigroup SEM model of the relationship between SDH, EDH, DL, IP, and QOL (FUD, Nigeria students)

Note: SDH = social determinants of health, STR = structural determinants, ITM = intermediary determinants, EDH = environmental determinants of health, DL = demands of life, Physio = physiological demands, Psycho = psychosocial demands, Enviro = environmental demands, IP = individual potential, BGP = biologically given potential, PAP = personally acquired potential, QOL = quality of life.

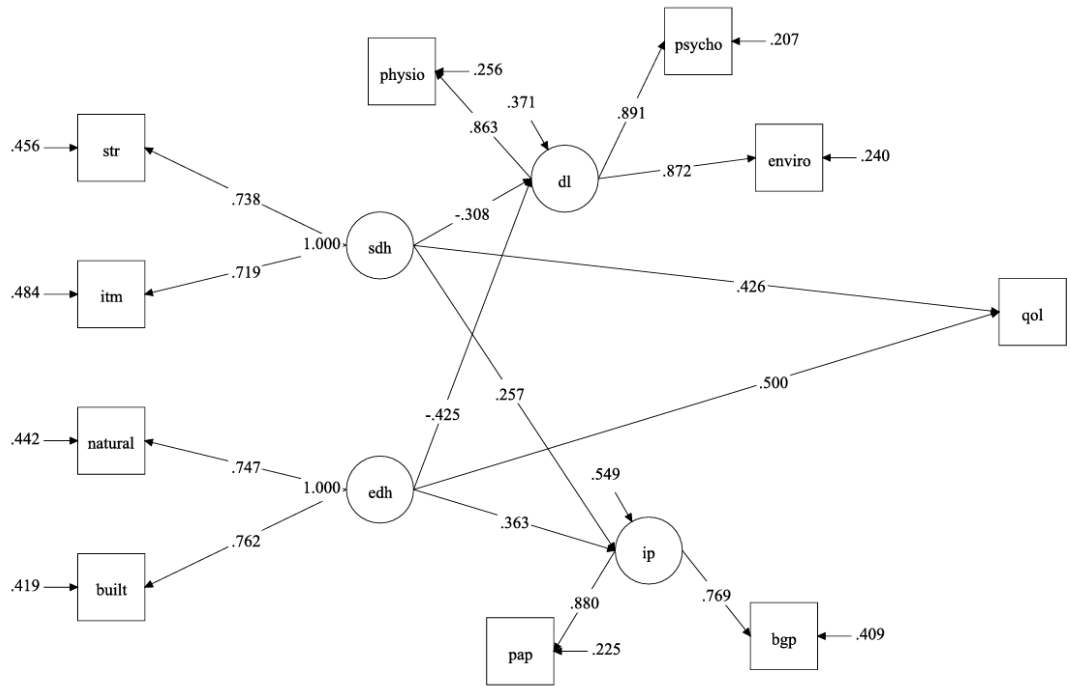

Figure 7.7: Multigroup SEM model of the relationship between SDH, EDH, DL, IP, and QOL (USM health campus Malaysian students)

Note: SDH = social determinants of health, STR = structural determinants, ITM = intermediary determinants, EDH = environmental determinants of health, DL = demands of life, Physio = physiological demands, Psycho = psychosocial demands, Enviro = environmental demands, IP = individual potential, BGP = biologically given potential, PAP = personally acquired potential, QOL = quality of life.

CHAPTER 8

DISCUSSION

8.1 Introduction

This chapter presented a comprehensive overview of the study findings across Phases I through III, along with comparisons to existing literature. The study was designed to address 11 specific objectives: Phase I addressed three specific objectives, Phase II covered four specific objectives, and Phase III covered another four specific objectives. The primary aim was to develop and validate four holistic health questionnaires targeting social determinants of health (SDH), environmental determinants of health (EDH), demands of life (DL), and individual potentials (IP) among participants from Nigeria and Malaysia. Subsequently, the study explored the structural relationships between these holistic health variables (SDH, EDH, DL, and IP) along with healthy diet (HD), physical activity (PA), and quality of life (QOL). Finally, we compared the hypothesized final models for the questionnaires and structural models across the Nigerian and Malaysian samples to evaluate their cross-cultural applicability and consistency.

Moreover, the study's limitations, strengths, and methodological challenges were thoroughly examined and discussed with supporting evidence from the literature. The chapter is structured to align with the specific objectives outlined in Chapter 1, ensuring each objective is addressed comprehensively and appropriately.

8.2 The study response rate

For the qualitative study, we invited a total of 12 experts, 6 from Nigeria and 6 from Malaysia, to assess the content validity of the newly developed holistic health questionnaires (SDHQ, EDHQ, DLQ, and IPQ), and all 12 experts responded, yielding a 100% response rate. Also, we invited a total of 20 undergraduate students, 10 from Nigeria and 10 from Malaysia, to assess the face validity of the newly developed holistic health questionnaires, and all 20 students responded, yielding a 100% response rate.

For the quantitative study, a total of 2600 students (1300 from Nigeria and 1300 from Malaysia) responses were collected via Google Form. Out of the 1300 samples for Nigerian students, the first 300 were used for exploratory factor analysis (EFA), the second 430 for confirmatory factor analysis (CFA), and the remaining 570 for structural equation modelling (SEM). Similarly, of the 1300 samples for Malaysian students, the first 300 were used for EFA, the second 430 for CFA, and the remaining 570 for SEM.

8.3 General characteristics of the study participants

For the Nigerian sample, the EFA sample comprised 55.7% males and 44.3% females, with a mean age of 21.1 years (SD = 3.00). The majority of participants were Hausa (70.7%), and 43.7% were medical students, with most in their first year (43.7%). The CFA sample included 54.0% males and 46.0% females, with a mean age of 22.4 years (SD = 2.43). More than half of the participants were Hausa (70.9%), medical students (53.4%), and the majority were in their third year (70.0%). The SEM sample consisted of 56.8% males and 43.2% females, with a mean age of 21.8 years (SD = 2.43). Most participants were Hausa (70.9%), about half were medical students (49.9%), and a higher percentage of them were in their third year (39.8%).

The EFA sample comprises a larger proportion of first-year students, while the CFA and SEM samples include a higher proportion of third-year students. Despite this variation, the samples are considered homogenous due to the relative consistency in other characteristics, such as mean age, gender distribution, ethnicity, and field of study. Although using undergraduate students as a sample has limitations, such as potential biases and limited generalizability, their convenience, availability, and homogeneity make them suitable for research (Ashraf & Merunka, 2017; Wheeler et al., 2014). Also, their familiarity with academic settings and research procedures increases adherence to study protocols. As a result, undergraduate students remain a valuable resource for exploring research questions and testing hypotheses (Ashraf & Merunka, 2017).

The mean age of Nigerian students in our study aligns with the expected range; a recent systematic review and meta-analysis of Nigerian students reported mean ages across 18 studies varying between 19.09 and 26.3 years (Cui et al., 2022). Male students make up a larger percentage than female students across all the Nigerian samples. The study by Olawole et al. (2021) reported that during the study period, Nigerian higher education enrolment was gender unequal, favouring males. In addition, in Nigeria's public universities, students come from diverse regions across the country, reflecting the nation's rich cultural and ethnic tapestry (Udo, 2023). Universities thus attempt to preserve balance in the student body by admitting applicants from various states and areas in an effort to foster inclusivity and diversity (Udo, 2023). Therefore, the present study sample is considered to reflects the diverse regional representation of Nigerian students.

For the Malaysian sample, the EFA sample comprised 44.3% males and 55.7% females, with a mean age of 21.5 years (SD = 1.58). About half of participants were Malays (49.3%), studying health science courses (52.0%), and in their second year of study (46.0%). The CFA sample included 37.4% males and 62.6% females, with a mean age of 21.4 years (SD = 1.47). About half of the participants were Malays

(54.7%), studying health science courses (45.3%), and in their second year of study (52.1%). The SEM sample consisted of 40.9% males and 59.1% females, with a mean age of 21.7 years (SD = 1.49). The highest proportion of the participants were Malays (58.6%), studying health science courses (50.5%), and in their second year of study (43.9%).

The three independent samples of Malaysian students are considered homogenous due to the relative consistency in all the characteristics, including mean age, gender distribution, study years, ethnicity, and field of study. The mean age of Malaysian students in our study aligns with the expected range; previous studies conducted among Malaysian university students reported mean ages varying between 20.2 to 20.4 years (Kuan et al., 2020; Sabo et al., 2020; Sabo et al., 2022). In addition, there were more female students than male students in each of the three Malaysian student samples. The majority of Malaysia's public universities currently have an overrepresentation of female students, and in recent years, female students have surpassed male students in school-level exams, making them eligible for university admission (Ismail, 2015). As expected, the annual disparity between the number of male and female students attending universities is becoming a significant issue (Ismail, 2015). The Department of Statistics Malaysia reports that in 2010, there were 64.8% more female students enrolled in public universities than male students (35.2%) (Ismail, 2015).

In Malaysia, a diverse and multicultural nation, certain ethnic groups face challenges in accessing higher education due to economic status, geographic location, or language barriers. Marginalized groups—such as those defined by caste, gender, age, culture, religion, disability, or minority status—often experience additional difficulties (Elhadary & Samat, 2023; Harun & Ibrahim, 2022). Rural children and

Bumiputeras, a group that includes the indigenous people of Peninsular Malaysia (Orang Asli), Malays, and the indigenous people of Sabah and Sarawak, have received special attention (Sirat et al., 2020). The introduction of a quota system has played a critical role in narrowing disparities between Bumiputeras and other ethnic groups. This system allows Orang Asli students to more easily access higher education and has expanded over time to prioritize low-income households, impoverished families, and people with disabilities, regardless of ethnicity (Elhadary & Samat, 2023). The Eleventh Malaysia Plan (2016–2020) prioritized higher education opportunities for students from households earning approximately RM 2,537.00 (USD 600) (Elhadary & Samat, 2023). Efforts to enhance diversity and tolerance significantly altered the ethnic composition of Malaysian state universities in 1983, reflecting a commitment to equitable access and inclusion (Elhadary & Samat, 2023).

8.4 Objective 1: development of holistic health questionnaires

The newly developed questionnaires include the Social Determinants of Health Questionnaire (SDHQ), Environmental Determinants of Health Questionnaire (EDHQ), Demands of Life Questionnaire (DLQ), and Individual Potential Questionnaire (IPQ). The constructs and items for these tools were generated through an extensive literature review, expert consultations from Nigeria and Malaysia, and in-depth interviews with undergraduate students from the College of Medicine and Allied Medical Sciences at FUD, Nigeria, and the Health Campus at USM, Malaysia.

The SDHQ contained 20 items measuring two underlying constructs, namely, the structural determinants of the SDH (10 items) and the intermediary determinants of the SDH (10 items). The items under SDH structural determinants assess a range of factors that create or reinforce social stratification in society and define individuals' socioeconomic position using a Likert option ranging from 1 (totally unsatisfied) to 5 (totally satisfied). These factors are typically determined by government policies or inheritance (Artiga & Hinton, 2018; Baer et al., 2015; Lucyk & McLaren, 2017; WHO CSDH, 2008). The intermediary determinants of SDH evaluate various factors associated with psychosocial conditions, the individual's environment, and the health care system, employing a Likert scale from 1 (extremely poor) to 5 (excellent). These intermediary determinants of SDH are also referred to as individual-level mediators of health inequities that shape health outcomes (Artiga & Hinton, 2018; Baer et al., 2015; Lucyk & McLaren, 2017; WHO CSDH, 2008).

Recently, a brief self-report measure of SDH called the social determinants of health, the Steps to Better Health Questionnaire (STBH-Q), was developed and validated among the Australian adult population (Oster et al., 2022). The STBH-Q, which consists of 16 items and five underlying constructs, was created to assess multiple factors that influence SDH at the individual level. These factors include: access (six items); employment, finances, and education (three items); safety at home and in the community (two items); physical and mental health (three items); and family and childhood (two items) (Oster et al., 2022). However, the main limitation of their study is the many cross-loadings of the items in the EFA, and some factors had only two items. We believe that the SDHQ effectively addresses these limitations, as its items have been streamlined into two factors in accordance with the CSDH framework (WHO CSDH, 2008).

Environmental health has been described as the area of public health that addresses all external physical, chemical, and biological parameters that affect a person's health and quality of life, as well as any associated factors that have an impact on behaviours (Prüss-Üstün et al., 2016; Prüss-Ustün et al., 2017). Public health and planning professionals are increasingly recognizing the built and natural environments as fundamental health determinants (Bird et al., 2018; Northridge et al., 2003). Hence, in the present study, the EDHQ was developed as a brief self-report measure for evaluating the perceived level of EDH comprising two factors (the natural environment and the built environment) among university undergraduate students. The EDHQ had five rating options, ranging from 1 (strongly disagree), 2 (disagree), 3 (somewhat agree), 4 (agree), and 5 (strongly agree). The natural environment reflects essential factors at the macro level, including natural resources (Ashcraft et al., 2024; Northridge et al., 2003; Schulz & Northridge, 2004). The built environment reflects physical factors that safeguard and support chances for a living, positive health and sustainable development, at the level of the community (Ashcraft et al., 2024; Northridge et al., 2003; Schulz & Northridge, 2004).

In the current study, the perceived natural environment reflects physical exposures, such as extreme weather conditions, the quality and accessibility of drinking water and food, exposure to air pollutants, and ensuring a secure work environment. On the other hand, the perceived built environment reflects an evaluation of diverse factors such as housing, land use, infrastructure, transportation, public spaces, schools, and health care facilities. Previous studies indicated that perceived environmental health refers to individuals' subjective evaluations or opinions concerning the quality, safety, and influence of their immediate surroundings on their holistic well-being (Castaldo et al., 2018; Castilla et al., 2017; Gabriel et al., 2021). Individuals' assessments of environmental cleanliness, safety, and susceptibility to environmental risks can have a direct bearing on their physical health. Moreover, perceptions of poor air quality, contaminated water sources, and exposure to pollutants or toxins can exacerbate respiratory ailments, cardiovascular conditions, and various other health concerns, thereby affecting overall quality of life (Bircher, 2020; Castaldo et al., 2018).

Studies related to school environments have revealed that environmental comfort factors profoundly influence the learning process (Saraiva, Almeida, et al., 2019; Saraiva, da Silva, et al., 2019; Saraiva et al., 2018). Undoubtedly, the physical learning environment significantly shapes students' learning outcomes and motivation, influencing their willingness to engage actively in academic activities (Baafi, 2020). Moreover, recent studies have integrated the subjective aspect, considering students' perceptions regarding classroom attributes and their potential impact on performance or satisfaction (Castilla et al., 2017; Saraiva, da Silva, et al., 2019). For instance, Brink et al. (2021) explored student perceptions of higher education classrooms and elucidated how classroom attributes affect both student satisfaction and performance.

The Meikirch model (Bircher, 2020; Bircher & Kuruvilla, 2014) served as the basis for identifying DLQ constructs, which includes: physiological demands, psychosocial demands, and environmental demands. Efforts are underway to develop integrated approaches that simultaneously promote health, sustainable development, and human rights. Health outcomes throughout life depend on an individual's abilities and the adequacy of social and environmental resources to meet life's demands (Bircher, 2020). These demands, which can be physiological, psychosocial, or environmental, differ among individuals and situations (Bircher, 2020; Bircher & Kuruvilla, 2014). Consequently, the ability of an individual to effectively address and adapt to these challenges determines their health (Bircher, 2020; Bircher & Kuruvilla, 2014; Bircher & Wehkamp, 2011).

The DLQ contains a total of 18 items, with each construct having 6 items, evaluated using five rating options, ranging from 1 (not at all), 2 (rarely), 3 (few times), 4 (often), and 5 (very often). Each construct has a minimum total score of 6 and a maximum total score of 30. In the physiological domain, lower scores suggest a perception of adequate physiological needs while higher scores suggest a perception of inadequate physiological needs. In the psychosocial domain, lower scores suggest a perception of adequate psychosocial needs while higher scores suggest a perception of inadequate psychosocial needs. Also, in the environmental domain, lower scores suggest a perception of adequate environmental needs, while higher scores suggest a perception of inadequate environmental needs. However, items 17 (How frequently do you wake up in the morning or fall asleep at your scheduled time?) and 18 (How often do you eat all your meals on time?) are scaled in the positive direction; as such, these items must be reverse coded before computing the total score for this domain. This serves to mitigate response bias, wherein participants tend to uniformly agree or disagree with all items without duly considering their content. By incorporating items that necessitate responses in the opposite direction, participants are prompted to engage in a more attentive and thoughtful evaluation of each item's content.

Research involving undergraduate students offers valuable insights into psychological and physiological processes as well as environmental demands that may extend to broader populations (Ashraf & Merunka, 2017; Bircher, 2020). Understanding the psychosocial and physiological health of university students can inform institutional and governmental policies, particularly regarding nutrition programs, physical education requirements, mental health services, and other initiatives to promote holistic well-being (Bonell et al., 2013; John-Akinola & Nic Gabhainn, 2015). Numerous theories suggest that psychosocial circumstances significantly influence psychological well-being (Bircher, 2020). The psycho-educational model provides a robust framework for examining and fostering psychological and physiological aspects of individuals such as social skills, empathy, identity formation, anxiety management, and emotional regulation (Hidalgo et al., 2016; Hidalgo et al., 2010; Schofield & Chambers, 2015; Toerien et al., 2020). Moreover, demanding schedules and intensive work commitments are among the key contributors to unhealthy sleep and eating patterns (Loft & Cameron, 2014; Pinho et al., 2018b). Individuals with high-demanding jobs often suffer with the emotional and professional burdens associated with their roles, which can disrupt essential relaxation and restorative processes, including quality sleep (Loft & Cameron, 2014).

The Meikirch model (Bircher, 2020; Bircher & Kuruvilla, 2014) inspired the identification of the IPQ constructs, which are: biologically given potential and personally acquired potential. Potentialities that stem from both biological inheritance and individual cultivation are not delineated by distinctions between body and mind. Numerous aspects of personally developed potential also manifest within the body, despite the presence of biologically endowed potential reflected in one's physical makeup (Bircher, 2020). Individuals who engaged in physical activity during childhood tend to possess more active musculoskeletal systems compared to those who predominantly dedicated their youth to reading or computer activities. Anatomical and physiological variances illustrate disparities in personally acquired potentials, as demonstrated in this and various other instances (Bircher, 2020; Bircher & Kuruvilla, 2014).

The IPQ was developed with a total of 14 items, with 6 items reflecting the biologically given potential and 8 items reflecting the personally acquired potential. The items were assessed using four rating options, ranging from 1 (none) to 4 (severe) for biologically given potential and from 1 (not at all) to 4 (very often) for personally acquired potential. The scoring range for biologically given potential falls between 6 (minimum) and 24 (maximum), while for personally acquired potential, it ranges from 8 (minimum) to 32 (maximum). Lower scores in the biologically given potential domain indicate a perception of satisfactory health status, whereas higher scores indicate a perception of inadequate health. Conversely, in the personally acquired potential domain, lower scores suggest a lower sense of coherence, while higher scores indicate a higher sense of coherence. To compute the total score for this domain, reverse code the following items: 8 (Do you feel that the changes in the past have made your situation unpleasant?), 9 (When you are in an unfamiliar situation, does it affect your normal activities?), 11 (Do you believe that your state of happiness may be affected by pain or health issues?), 12 (How often do you experience regret over your past?), and 13 (How often do you feel bad about your future?), which are scaled in the negative direction.

The perceived biologically given potentials investigate an individual's perception of their present health status and its potential impact on their daily functioning. When individuals evaluate their own health, they rely on information that holds significant predictive value (Schnittker & Bacak, 2014). Previous studies have shown that how healthy someone thinks they are can accurately predict many outcomes, such as their chances of getting chronic diseases (Bamia et al., 2017), getting better from illnesses (Latham & Peek, 2013), losing their ability to do things (Heiland et al., 2019), and needing medical services (Mahmoudi et al., 2020). This holds true even when considering more objective health indicators (Mahmoudi et al., 2020; Singh, 2021). The biologically given potential begins to decline shortly after birth and eventually reaches zero at the time of death (Bircher, 2020). Every somatic disorder, injury, or anomaly diminishes our biologically given potentials, either temporarily or permanently (Bircher, 2020).

The perceived personally acquired potential items evaluate an individual's sense of coherence across past, present, and future contexts. These items encompass various facets of an individual's physical, intellectual, and social resources. While the advancement of personal potential may decelerate in adulthood, it remains capable of growth as long as individuals are motivated to actively foster their development and reside in a social environment supportive of their well-being (Bircher, 2020). Cultivating positive emotions can enhance well-being and extend one's lifespan (Dantas, 2007; Eriksson & Lindström, 2005). Additionally, Antonovsky (1987) view suggests that individuals with a heightened sense of coherence often perceive their circumstances as manageable, meaningful, and comprehensible.

8.5 Objective 2: Content validity and face validity of the newly developed questionnaires among experts and undergraduate students in Nigeria

For SDHQ, the content validity results show that the I-CVI of all 20 items ranged from 0.83 to 1, and the S-CVIs were 0.93 (for structural determinants of SDH) and 0.95 (for intermediary determinants of SDH). For face validity, the results reveal that the I-FVI values ranged from 0.90 to 1, and the S-FVIs were 0.98 (for structural determinants of SDH) and 1 (for intermediary determinants of SDH). These results indicate acceptable content validity and face validity (DeVon et al., 2007; Marzuki et al., 2018; Polit & Beck, 2006; Polit et al., 2007; Yusoff, 2019b). The relationship between health and health behaviours from adolescence to adulthood is significant; therefore, how these social determinants impact adolescent health is critical for both the general population's health and the growth of nations' economies (Patton et al., 2016). Additionally, the transition from adolescence to adulthood affects how people develop in terms of their health and quality of life. Both social and economic factors within nations influence these changes, leading to inequalities (Patton et al., 2016).

For EDHQ, the results of content validity reveal that the I-CVIs and S-CVIs of all 18 items were 1. For face validity, the results reveal that the I-FVI values ranged from 0.90 to 1, and the S-FVIs were 0.99 (for natural environment) and 1 (for built environment). These results indicate sufficient content validity and face validity (DeVon et al., 2007; Marzuki et al., 2018; Polit & Beck, 2006; Polit et al., 2007; Yusoff, 2019b). The development of economies across countries and the overall well-being of the population rely on the impact of these environmental determinants on the health of adolescents (Northridge & Freeman, 2011; Sawyer et al., 2018). This is because there is a strong correlation between health and health behaviours throughout adolescence and adulthood. The transition from adolescence to adulthood also impacts the way individuals develop in regard to their well-being and quality of life (Sawyer et al., 2018). The environmental and financial factors that exist in each nation have an impact on these changes (Amuasi et al., 2020).

For DLQ, the outcomes of the content validity assessment indicate that the I-CVIs fall within the range of 0.83 to 1, and the S-CVIs were 1 for physiological demands, 0.97 for psychosocial demands, and 1 for environmental demands. The face validity assessment yielded I-FVIs and S-FVIs of 1. These findings affirm adequate content validity and face validity (DeVon et al., 2007; Marzuki et al., 2018; Polit & Beck, 2006; Polit et al., 2007; Yusoff, 2019b). In addition, four items were modified by the experts, and no item was recommended for removal. The alterations were implemented on items 1 (How frequently do you experience respiratory issues, such as difficulty in breathing?), 8 (How often do you feel satisfied with your interactions with colleagues (e.g., their support of you, and/or your support towards them?), 15

(How frequently do you miss classes because you're too busy?), and 16 (How frequently do you rush to get to school in the mornings?). For instance, item 1 now includes supplementary information like "such as difficulty in breathing," while item 8 incorporates the phrase "e.g., their support of you and/or your support towards them." Furthermore, item 15 now incorporates the term "class," and item 16 includes the term "school."

For, IPQ, The results of the content validity assessment reveal that the I-CVIs fall within the range of 0.83 to 1. and the S-CVIs/Ave were 1 for biologically given potential and 0.98 for personally acquired potential. Similarly, the face validity assessment yielded I-FVIs and S-FVIs of 1. These findings confirm satisfactory content validity and face validity (DeVon et al., 2007; Marzuki et al., 2018; Polit & Beck, 2006; Polit et al., 2007; Yusoff, 2019b). In addition, none of the items were modified by the experts and students, and no item was recommended for removal. Hence, we anticipate that these tools will contribute to efforts to improve health outcomes and address the complex interplay of factors influencing holistic health care.

8.6 Objective 3: Content validity and face validity of the newly developed questionnaires among experts and undergraduate students in Malaysia

For SDHQ, the content validity results show that the I-CVI of all 20 items ranged from 0.83 to 1, and the S-CVIs were 0.97 (for structural determinants of SDH) and 0.98 (for intermediary determinants of SDH). For face validity, the results reveal that the I-FVI and S-FVI values were all equal to 1. These results indicate that acceptable content validity and face validity (DeVon et al., 2007; Marzuki et al., 2018; Polit & Beck, 2006; Polit et al., 2007; Yusoff, 2019b). Additionally, the SDHQ received similar content and face validity ratings from both Malaysian and Nigerian experts and students.

For EDHQ, the results of content validity reveal that the I-CVIs and S-CVIs of all 18 items ranged from 0.83 to 1, and the S-CVIs were 1 (for natural environment) and 0.95 (for built environment). For face validity, the results reveal that the I-FVI values ranged from 0.90 to 1, and the S-FVIs were 1 (for natural environment) and 0.99 (for built environment). These results indicate sufficient content validity and face validity (DeVon et al., 2007; Marzuki et al., 2018; Polit & Beck, 2006; Polit et al., 2007; Yusoff, 2019b). Additionally, the EDHQ received similar content and face validity ratings from both Malaysian and Nigerian experts and students.

For DLQ, the outcomes of the content validity assessment indicate that the I-CVIs fall within the range of 0.83 to 1, and the S-CVIs were 1 for physiological demands, 1 for psychosocial demands, and 0.97 for environmental demands. The face validity assessment yielded I-FVIs and S-FVIs of 1. These findings affirm adequate content validity and face validity (DeVon et al., 2007; Marzuki et al., 2018; Polit & Beck, 2006; Polit et al., 2007; Yusoff, 2019b). Additionally, the DLQ received similar content and face validity ratings from both Malaysian and Nigerian experts and students.

For, IPQ, The results of the content validity assessment reveal that the I-CVIs fall within the range of 0.83 to 1. and the S-CVIs/Ave were 1 for biologically given potential and 0.98 for personally acquired potential. Similarly, the face validity assessment yielded I-FVIs and S-FVIs of 1. These findings confirm satisfactory content validity and face validity (DeVon et al., 2007; Marzuki et al., 2018; Polit & Beck, 2006; Polit et al., 2007; Yusoff, 2019b). Additionally, the DLQ received similar content and face validity ratings from both Malaysian and Nigerian experts and students.

The fact that the CVI ratings from both Nigerian and Malaysian experts exceeded the 0.83 threshold confirms that the developed items demonstrated strong content validity across both contexts. However, Malaysian experts assigned higher ratings to the SDH-Q items, while Nigerian experts rated the SDH-Q items more highly. This points to the influence of local perspectives, sociocultural factors, and contextual health challenges in shaping expert judgments. For example, Malaysian experts may have placed greater emphasis on certain aspects of social determinants due to differences in public health priorities, policy frameworks, or societal structures, whereas Nigerian experts may have higher concern with EDH factors that are more pressing within the Nigerian health context. These findings reveal the importance of cross-cultural validation in ensuring that holistic health measures remain both globally applicable and locally relevant. They also suggest that while a core set of items may be universally valid, slight adaptations or contextual considerations may be necessary to maximize the tool's applicability and accuracy in different cultural or national settings.

8.7 Objective 4: Construct validity of the of the newly developed questionnaires using EFA and CFA among undergraduate students in FUD, Nigeria

During the EFA, we extracted two factors (structural determinants of SDH and intermediary determinants of SDH) from the SDHQ, each comprising 10 items (KMO = 0.899; p-value < 0.001). All the items loaded satisfactorily on their respective constructs, with factor loading above 0.40 and no cross-loading. In a previous study, the EFA extracted the SDHQ with five underlying constructs comprising 16 items (Oster et al., 2022). The constructs were: access; employment, finances, and education; family and childhood; physical and mental health; and safety at home and in the community. However, cross-loading of items occurred throughout their EFA process

(Oster et al., 2022). We believe that this might happen because of the similarities between the constructs. Therefore, the current study resolves these issues by creating a similar scale with two constructs, namely, structural determinants of health and intermediary determinants of SDH, which is in line with the WHO's CSDH work (WHO CSDH, 2008). Furthermore, Patton et al. (2016) emphasized that, while safe and supportive relationships with families, schools, and peers are critical to assisting young people in developing to their full potential, structural factors such as national wealth, financial inequality, and access to education are the strongest determinants of health worldwide.

Subsequently, the CFA results confirmed the final 20-item, 2-factor model of the new SDHQ, with all the items retained. The final model showed adequate fit indices, and all the items had acceptable factor loading on their respective constructs. Also, the two constructs had acceptable discriminant validity ($r < 0.85$). These demonstrate that the SDHQ has adequate psychometric properties and can be applied to assess individuals perceived SDH (Brown, 2015; Byrne, 2013; Fornell & Larcker, 1981; Kline, 2013). In addition, 13 pairs of error covariances were added between items within the same construct (7 for structural determinants of SDH and 6 for intermediary determinants of SDH). These residual covariances were added based on the MI values reported in Mplus output after taking into account sufficient theoretical backing. When residual covariances have important meaning in social psychological studies, they can be included in the model (Enders & Tofighi, 2007). As such, these covariances were added for the subsequent CFAs in the current study.

For the EDHQ, two factors (natural environment and built environment) were identified during the EFA (KMO = 0.937; p-value < 0.001), containing all 18 items with satisfactory factor loadings (above 0.50) on their respective constructs. The EFA model was further tested using the CFA. The final model showed adequate fit indices, and all the items had sufficient factor loading on their respective constructs. The two constructs had acceptable discriminant validity ($r < 0.85$). Overall, the results show that the EDHQ has sufficient psychometric properties and may be used to evaluate individuals perceived environmental determinants of health (Brown, 2015; Byrne, 2013; Fornell & Larcker, 1981; Kline, 2013). In addition, four pairs of error covariances were included in the final model (2 for the natural environment and 2 for the built environment) after taking enough theory into account.

For DLQ, three factors (physiological, psychosocial, and environmental) were identified (KMO = 0.842; p-value < 0.001), retaining all 18 items with satisfactory factor loadings (above 0.50) on their respective constructs. The EFA model was further tested using the CFA. The final model showed adequate fit indices, and all the items had sufficient factor loading on their respective constructs (above 0.4). The three constructs demonstrated acceptable discriminant validity ($r < 0.85$). Overall, the results affirm that the DLQ possesses acceptable psychometric properties and can effectively assess individuals' perceived demands of life (Brown, 2015; Byrne, 2013; Fornell & Larcker, 1981; Kline, 2013). Additionally, three pairs of error covariances were incorporated into the final model (1 for physiological, 1 for psychosocial, and 1 for environmental) with careful consideration of relevant theory.

Furthermore, for the IPQ, two factors were identified in the EFA analysis, with all 14 items retaining satisfactory factor loadings (above 0.50) on their respective constructs (KMO = 0.905; p-value < 0.001). Researchers further tested the EFA model using the CFA. The final model showed adequate fit indices, and all the items had sufficient factor loading on their respective constructs (above 0.5). The two constructs demonstrated acceptable discriminant validity (< 0.85). Overall, the results confirm that the IPQ possesses acceptable psychometric properties and can effectively assess an individual's potential (Brown, 2015; Byrne, 2013; Fornell & Larcker, 1981; Kline, 2013). With careful consideration of relevant theory, we incorporated six pairs of error covariances into the final model (1 for biologically given potential and 5 for personally acquired potential).

8.8 Objective 5: Reliability of the newly developed questionnaires using Cronbach's alpha, composite reliability, and test re-test (ICC) among undergraduate students in FUD, Nigeria

The reliability of the SDHQ, EDHQ, DLQ, and IPQ were investigated using internal consistency reliability and test-retest reliability analysis. Internal consistency estimates how effectively a collection of items captures the intended construct and its reliability (Kline, 2023). The coefficient most frequently reported in the literature is Cronbach's alpha (Kline, 2023). However, when residual covariances are included in the model, composite reliability (CR) yields a more accurate estimate (Raykov & Marcoulides, 2016). In this study, we presented both Cronbach's alpha and CR, as residual covariances were added for all the models. The recommended cutoff values were ≥ 0.50 for Cronbach's alpha (Enders & Tofighi, 2007) and ≥ 0.60 for CR (Raykov & Marcoulides, 2016). The test-retest reliability reflects the variation in measurements taken by an instrument on the same subject under the same conditions at different points in time (Koo & Li, 2016). The intraclass correlation coefficient (ICC) is a widely used index for reliability in test-retest, and ICC values between 0.75 and 0.9 indicate good reliability, and values greater than 0.90 indicate excellent reliability (Koo & Li, 2016). Additionally, we examined the test-retest reliability with a subsample of 70 Nigerian students at a 7-day interval for this objective.

This study's SDHQ model has sufficient internal consistency. The two constructs have Cronbach's alpha values of 0.917 and 0.939, which are higher than the recommended cutoff point of 0.50 (Enders & Tofighi, 2007). Every item contributed to the measurement of its core factor, as all the item-total correlation values were more than 0.30, indicating that the scales have adequate internal reliability (Nunnally & Bernstein, 1994). The two constructs' respective CR scores of 0.797 and 0.794 are higher than the recommended cutoff value of 0.60 (Raykov & Marcoulides, 2016). The recently published study on self-reported social determinants of health questionnaires in Australia revealed that the Cronbach's alpha ranged from 0.561 to 0.827 for the five scales (Oster et al., 2022). The SDHQ scale has excellent stability above 0.90 (Koo & Li, 2016), according to the study's test-retest reliability ICC values of 0.938 and 0.941.

This study's EDHQ model has sufficient internal consistency. The two constructs have Cronbach's alpha values of 0.918 and 0.935 which are higher than the recommended cutoff point of 0.50 (Enders & Tofighi, 2007). Every item contributed to the measurement of its core factor, as all the item-total correlation values were more than 0.30, indicating that the scales have adequate internal reliability (Nunnally & Bernstein, 1994). The two constructs' respective CR scores of 0.845 and 0.854 are higher than the recommended cutoff value of 0.60 (Raykov & Marcoulides, 2016). The EDHQ scale has excellent stability above 0.90 (Koo & Li, 2016), according to the study's test-retest reliability ICC values of 0.976 and 0.970.

This study's DLQ model has sufficient internal consistency. The three constructs have Cronbach's alpha values of 0.858-0.870, which are higher than the recommended cutoff point of 0.50 (Enders & Tofighi, 2007). Every item contributed to the measurement of its core factor, as all the item-total correlation values were more than 0.30, indicating that the scales have adequate internal reliability (Nunnally &

Bernstein, 1994). The three constructs' respective CR scores of 0.760-0.848 are higher than the recommended cutoff value of 0.60 (Raykov & Marcoulides, 2016). The DLQ scale has excellent stability above 0.90 (Koo & Li, 2016), according to the study's test-retest reliability ICC values of 0.921-0.972.

This study's IPQ model has sufficient internal consistency. The two constructs have Cronbach's alpha values of 0.928 and 0.925 which are higher than the recommended cutoff point of 0.50 (Enders & Tofighi, 2007). Every item contributed to the measurement of its core factor, as all the item-total correlation values were more than 0.30, indicating that the scales have adequate internal reliability (Nunnally & Bernstein, 1994). The two constructs' respective CR scores of 0.878 and 0.909 are higher than the recommended cutoff value of 0.60 (Raykov & Marcoulides, 2016). The IPQ scale has excellent stability above 0.90 (Koo & Li, 2016), according to the study's test-retest reliability ICC values of 0.976 and 0.953.

8.9 Objective 6: Construct validity of the of the newly developed questionnaires using EFA and CFA among undergraduate students in USM, health campus, Malaysia

Similar to the EFA we did with the Nigerian students above, we extracted two factors for SDHQ among the Malaysian students (KMO = 0.909; p-value < 0.001): structural determinants of SDH and intermediary determinants of SDH. Also, each factor had 10 items consistent with the Nigerian sample. All the items loaded satisfactorily on their respective constructs, with factor loading above 0.40 and no cross-loading.

Subsequently, the CFA results confirmed the final 20-item, 2-factor model of the new SDHQ, with all the items retained. The final model showed adequate fit indices, and all the items had acceptable factor loading on their respective constructs.

Also, the two constructs had acceptable discriminant validity (r < 0.85). These show that the SDHQ possesses sufficient psychometric properties, enabling its application among Malaysian undergraduate students to evaluate their perceived SDH (Brown, 2015; Byrne, 2013; Fornell & Larcker, 1981; Kline, 2013). In addition, 16 pairs of error covariances were added between items within the same construct (8 for structural determinants of SDH and 8 for intermediary determinants of SDH).

Similar to the EFA we did with the Nigerian students above, we extracted two factors for EDHQ among the Malaysian students (KMO = 0.934; p-value < 0.001): natural environment and built environment. Also, the natural environment construct comprises 8 items, and the built environment construct comprises 18 items, consistent with the Nigerian sample. All the items loaded satisfactorily on their respective constructs, with factor loading above 0.40 and no cross-loading. Subsequently, the CFA results confirmed the final 18-item, 2-factor model of the new EDHQ, with all the items retained. The final model showed adequate fit indices, and all the items had acceptable factor loading on their respective constructs. Also, the two constructs had acceptable discriminant validity (r < 0.85). These show that the EDHQ possesses sufficient psychometric properties, enabling its application among Malaysian undergraduate students to evaluate their perceived EDH (Brown, 2015; Byrne, 2013; Fornell & Larcker, 1981; Kline, 2013). In addition, six pairs of error covariances were included in the final model (3 for the natural environment and 3 for the built environment) after taking enough theory into account.

Furthermore, in line with the EFA we did with the Nigerian students above, we extracted three factors for DLQ among the Malaysian students (KMO = 0.826; p-value < 0.001): physiological demands, psychosocial demands, and environmental demands. These three constructs comprises 6 items each, consistent with the Nigerian sample.

Each item loaded satisfactorily on its respective construct, with factor loading above 0.40 and no cross-loading. The EFA model was further tested using the CFA. The final model showed adequate fit indices, and all the items had sufficient factor loading on their respective constructs (above 0.4). The three constructs demonstrated acceptable discriminant validity ($r < 0.85$). Overall, the results affirm that the DLQ possesses acceptable psychometric properties among the Malaysian university students, and can effectively assess their perceived demands of life (Brown, 2015; Byrne, 2013; Fornell & Larcker, 1981; Kline, 2013). Additionally, five pairs of error covariances were included into the final model (2 for physiological, 1 for psychosocial, and 2 for environmental) with careful consideration of relevant theory.

Finally, in line with the EFA we did with the Nigerian students above, we extracted two factors for IPQ among the Malaysian students (KMO = 0.864; p-value < 0.001): biologically given potential and personally acquired potential. Also, the biologically given potential construct comprises 6 items, and the personally acquired potential construct comprises 8 items, consistent with the Nigerian sample. Each item loaded satisfactorily on its respective construct, with a factor loading above 0.40 and no cross-loading. We further tested the EFA model using the CFA. The final model showed adequate fit indices, and all the items had sufficient factor loading on their respective constructs (above 0.4). The two constructs demonstrated acceptable discriminant validity (< 0.85). Overall, the results confirm that the IPQ possesses acceptable psychometric properties and can effectively assess Malaysian university students individual potential (Brown, 2015; Byrne, 2013; Fornell & Larcker, 1981; Kline, 2013). With careful consideration of relevant theory, we incorporated eight pairs of error covariances into the final model (2 for biologically given potential and 6 for personally acquired potential).

8.10 Objective 7: Reliability of the newly developed questionnaires using Cronbach's alpha, composite reliability, and test re-test (ICC) among undergraduate students in USM health campus, Malaysia

In this objective, we also examined the reliability of the SDHQ, EDHQ, DLQ, and IPQ using internal consistency and test-retest reliability analysis among the Malaysian sample. The recommended cutoff values were ≥ 0.50 for Cronbach's alpha (Enders & Tofighi, 2007) and ≥ 0.60 for CR (Raykov & Marcoulides, 2016). The ICC values between 0.75 and 0.9 indicate good reliability, and values greater than 0.90 indicate excellent reliability (Koo & Li, 2016). Additionally, we examined the test-retest reliability with a subsample of 70 Malaysian students at a 7-day interval for this objective.

The SDHQ tested among Malaysian students also has sufficient internal consistency. The two constructs have Cronbach's alpha values of 0.943 and 0.944, which are higher than the recommended cutoff point of 0.50 (Enders & Tofighi, 2007). Every item contributed to the measurement of its core factor, as all the item-total correlation values were more than 0.30, indicating that the scales have adequate internal reliability (Nunnally & Bernstein, 1994). The two constructs' respective CR scores of 0.894 and 0.909 are higher than the recommended cutoff value of 0.60 (Raykov & Marcoulides, 2016). The SDHQ scale has good stability above 0.75 (Koo & Li, 2016), according to the study's test-retest reliability ICC values of 0.780 and 0.799.

The EDHQ tested among Malaysian students also has sufficient internal consistency. The two constructs have Cronbach's alpha values of 0.945 and 0.932 which are higher than the recommended cutoff point of 0.50 (Enders & Tofighi, 2007). Every item contributed to the measurement of its core factor, as all the item-total correlation values were more than 0.30, indicating that the scales have adequate internal reliability (Nunnally & Bernstein, 1994). The two constructs' respective CR scores of 0.893 and 0.906 are higher than the recommended cutoff value of 0.60 (Raykov & Marcoulides, 2016). The EDHQ scale has good stability above 0.75 (Koo & Li, 2016), according to the study's test-retest reliability ICC values of 0.765 and 0.836.

The DLQ tested among Malaysian students also has sufficient internal consistency. The three constructs have Cronbach's alpha values of 0.815-0.909, which are higher than the recommended cutoff point of 0.50 (Enders & Tofighi, 2007). Every item contributed to the measurement of its core factor, as all the item-total correlation values were more than 0.30, indicating that the scales have adequate internal reliability (Nunnally & Bernstein, 1994). The three constructs' respective CR scores of 0.815-0.826 are higher than the recommended cutoff value of 0.60 (Raykov & Marcoulides, 2016). The DLQ scale has good to excellent stability (Koo & Li, 2016), according to the study's test-retest reliability ICC values of 0.776-0.985.

The IPQ tested among Malaysian students also has sufficient internal consistency. The two constructs have Cronbach's alpha values of 0.848 and 0.895 which are higher than the recommended cutoff point of 0.50 (Enders & Tofighi, 2007). Every item contributed to the measurement of its core factor, as all the item-total correlation values were more than 0.30, indicating that the scales have adequate internal reliability (Nunnally & Bernstein, 1994). The two constructs' respective CR scores of 0.950 and 0.909 are higher than the recommended cutoff value of 0.60 (Raykov & Marcoulides, 2016). The IPQ scale has good to excellent stability (Koo & Li, 2016), according to the study's test-retest reliability ICC values of 0.854 and 0.987.

8.11 Objective 8: Structural relationship between SDH, EDH, DL, IP, healthy diet, physical activity, and quality of life among undergraduate students in FUD, Nigeria

The Meikirch model of holistic health (Bircher & Kuruvilla, 2014) served as the theoretical foundation for the hypothesized SEM model in this study. This model conceptualizes health as comprising four dimensions: SDH, EDH, DL, and IP. The Meikirch model posits that individuals must meet life's demands with their biologically inherent and personally acquired potentials, closely linked to their social and environmental surroundings, to achieve health (Bircher, 2020; Bircher & Kuruvilla, 2014). This dynamic and adaptive system allows individuals to develop and maintain a personal identity throughout their lifespan. In this objective, the structural relationships among perceived SDH, EDH, DL, and IP were evaluated to understand their role in enhancing perceived quality of life (QOL) among Nigerian undergraduate students. Additionally, healthy diet and physical activity were incorporated into the model due to their strong relationship with QOL (Ho et al., 2019; Omorou et al., 2013; Regan et al., 2022; Wu et al., 2019).

In the current objective, the initially hypothesized SEM model proposes that both SDH and EDH will directly and indirectly influence QOL through DL and IP among the sample of Nigerian university students. This implies that a higher perceived level of SDH and EDH will be directly and indirectly associated with a higher perceived level of QOL through DL and IP. Also, the SEM model proposed that both HD and PA have a direct influence on QOL. This means that a higher perceived level of HD and PA will be associated with a higher perceived level of QOL.

The final Nigerian SEM model reveals that out of the 10 pathways, eight were supported by the data. The findings indicated that SDH was significant and positively associated with QOL ($\beta = 0.500$, p-value < 0.001). This demonstrates that a higher perceived level of SDH satisfaction will enhance an individual's perceived QOL. Dhand et al. (2022) highlighted that social determinants of health such as education, occupation, income, social support, lifestyle, medical history, and access to healthcare were significantly associated with various quality-of-life measures, particularly those related to physical and overall health outcomes.

In recent years, Nigeria has experienced an unprecedented level of insecurity, manifested through bombings, kidnappings, hostage-taking, property destruction, and other social issues that could negatively impact a person's quality of life (Ofole, 2022). Children and young people should have a minimum satisfactory QOL, according to the United Nations Children's Fund (UNICEF). This includes all human rights and freedoms, such as access to proper nutrition, health care, and education, as well as freedom from exploitation, abuse, and violence (United Nations International Children's Emergency Fund, 2019). For example, a previous study in Nigeria highlighted that factors such as insufficient income, poverty, low educational attainment, poor nutritional status, and limited access to social and environmental resources significantly diminish health-related quality of life (Odekina, 2015).

Another factor that may influence quality of life is the perception of social support (Ofole, 2022). People's perceptions of friends, family, and other people as resources that may offer them financial, emotional, and general help when they need it are known as perceived social support (Ofole, 2022). Research demonstrates a positive relationship between subjectively perceived QOL and social support in Nigeria (Akinboro et al., 2014). When people feel loved, cared for, and supported, they are more equipped to enjoy pleasant life experiences (Akinboro et al., 2014). According to Akinboro et al. (2014) respondents who were married or in a relationship had a better QOL in the social relationship domain than those who were separated, unmarried, or had lost their spouses. Having a family is recognized to offer security, safety, and financial assistance. Therefore, married people probably had more social support, more intimate connections, and more satisfying sex, all of which have a beneficial effect on quality of life (Algaralleh et al., 2020; Hassan, 2023).

The findings indicated that EDH was significant and positively associated with QOL ($\beta = 0.647$, p-value < 0.001). This illustrates that a higher perceived level of EDH satisfaction will enhance an individual's perceived QOL. Numerous research studies in Nigeria and around the world have demonstrated a positive relationship between residential environmental quality and individuals' QOL (Akinyemi et al., 2012; Gruebner et al., 2017; Mao et al., 2022; Nathaniel & Khan, 2020; Ohwo & Ejemeyovwi, 2023; Phan et al., 2021; Zhang et al., 2022). Clean air, safe drinking water, proper sanitation, and waste management are just a few of the environmental quality indicators that impact human health and well-being (Ohwo & Ejemeyovwi, 2023; Zhang et al., 2022). As a result, improving regional planning for the future sustainability of urban settings and better comprehending environmental pollution issues would result from taking into account the opinions of the local population (Herrera & Cabrera-Barona, 2022).

In Nigeria, various local environmental attributes have been associated with improved QOL among older adults (Oyeyemi et al., 2023). These findings are consistent with those of high-income countries, such as those by Garin et al. (2014) and Sugiyama et al. (2009), which demonstrated that built environment factors like safe parks, traffic safety, and lower street noise positively impact health-related QOL. Similarly, research in China, indicated that factors such as accessible walking paths, mixed land use, and traffic safety significantly enhance older adults' QOL (Yu et al., 2019). Oyeyemi et al. (2023) study in Nigeria specifically highlighted that proximity to diverse destinations (mixed land use) was positively associated with social relationships and physical health QOL. Furthermore, safe walking infrastructure and access to essential services enable older individuals to remain active in their communities, contributing to better physical and environmental health outcomes (Oyeyemi et al., 2023; Yu et al., 2019). Living in higher-density areas also supports physical health QOL by fostering increased opportunities for social interaction and community engagement (Oyeyemi et al., 2023).

The results also illustrated that SDH ($\beta = -0.258$, p-value < 0.001) and EDH ($\beta = -0.425$, p-value < 0.001) had a negative relationship with DL, and that both SDH and EDH were found to positively influence QOL indirectly through their impact on DL. In this study, higher scores on the DL scale represent inadequacies in physiological, psychosocial, and environmental needs, while lower scores indicate that these needs are adequately met. Therefore, the findings suggest that higher perceived levels of SDH and EDH are associated with meeting these needs (i.e., adequate DL), and this relationship, in turn, positively impacts the perceived level of QOL. Researchers have identified adequate social and environmental support as a significant predictor of various health outcomes. These include improved health status, reduced physical and stress-related psychological symptoms, lower levels of depression, enhanced role performance, greater adaptability to living conditions, better psychological adjustment, effective coping behaviours, stronger health beliefs, and increased engagement in health-promoting behaviours (Harandi et al., 2017; La Rosa et al., 2018; Yalcin, 2015). A recent study of pharmacy students in Nigeria found that while their overall QOL was fair, their physical and mental health, as well as their social and environmental determinants, were poor (Okoro et al., 2020).

It was discovered that the decline in the environment of Nigerian students was caused by a lack of leisure opportunities (Okoro et al., 2020). Lack of spare time to relax was one of the frequent issues influencing students' quality of life, according to a prior study conducted among nursing students in Brazil (Moura et al., 2016). For example, medical and health sciences students typically have a heavy academic load that takes up free time (Esan et al., 2019; Okoro et al., 2020). This conclusion suggests that in order to enhance students' environmental domain, their leisure demands must be met. On the other hand, an earlier study conducted among Iranian students studying educational science revealed that the environmental domain scored higher than the other domains (Tayyeba & Jahanian, 2014). Disparities in disciplines, student demographics, schools, and geographic locations may be the causes of this discrepancy.

According to Okoro et al. (2020) study, having a present sickness or health issue—like stress or malaria—had a detrimental impact on one's environment, physical and mental health, and general quality of life. Physical limitations and reliance on medical care might result from illness or health issues; negative emotions and financial limitations can also lower quality of life (Esan et al., 2019). Other researchers have linked dissatisfaction with life to psychological, social, and personal issues, as well as poor health outcomes (Moro-Egido et al., 2022; Younis et al., 2019). In addition to their healthcare education, students face additional stressors, which can lead to physical and mental health issues (Ribeiro et al., 2018). These issues could manifest as illness, learning impairments, or lower performance in school. These findings therefore urge the introduction of positive management of students' physiological, psychological, and environmental demands on both a social and environmental level, with the aim of improving their quality of life.

Furthermore, the findings of this study reveal that IP was significantly and positively associated with both SDH (β = 0.280, p-value < 0.001) and EDH (β = 0.304, p-value < 0.001). IP reflects the individuals biologically given potentials and personally acquired potentials that are essential to meeting the demands of life (Bircher, 2020). Consequently, these relationships illustrate that higher perceived levels of SDH and EDH are associated with individuals possessing sufficient IP to address physiological, psychosocial, and environmental challenges effectively. Consistent with the findings of this study, Rodriguez et al. (2017) observed that social isolation significantly impairs cognitive functioning across all age groups or educational backgrounds. Perceived social support has been shown to mitigate the adverse physiological effects of illness and enhance self-care behaviors among the elderly (Harandi et al., 2017). Prior studies (Goldstein et al., 2019; Pratt et al., 2020) further highlight the unique influence of perceived neighbourhood environments on health, suggesting that these subjective measures may serve as stronger health determinants than objective neighbourhood measures. Similarly, studies by Godhwani et al. (2019) showed that self-rated health and mental health symptoms are closely associated with perceived neighbourhood condition.

Lastly, the final SEM model among the Nigerian students reveals that PA had a significant and negative association with QOL (β = -0.207, p-value = 0.047). This illustrates that with a higher level of PA, one possesses a lower perceived QOL. Contrary to the findings of this study, various studies have reported a positive association between PA and QOL (Ho et al., 2019; Omorou et al., 2013; Puciato et al., 2017; Vagetti et al., 2014). A potential explanation for this variation could be that students with a lower perceived QOL may engage more actively in PA as a strategy to enhance their overall well-being and mitigate health concerns, given their awareness of PA's health benefits. According to a previous study, most Nigerians have a high level of knowledge and attitude regarding PA but possess poor PA practices (Offiong et al., 2019). For instance, a study in Western Nigeria revealed that while most participants had a positive attitude towards exercise and a good understanding of its advantages (73.65%), their exercise habits were poor (Odunaiya et al., 2011).

Frequent PA participation has been shown to help reduce feelings of depression, anxiety, and stress (Marquez et al., 2020). Exercise may be used as a coping mechanism to improve mental health in those with lower perceived QOL (Harandi et al., 2017; Omorou et al., 2013). PA is frequently recommended for rehabilitation after accidents or illnesses such as cardiovascular problems. This idea encourages people to participate in organized or unstructured PA in order to strengthen themselves and enhance their general health (Vagetti et al., 2014). Nigerian universities frequently organized health promotion initiatives that promote PA among their students, particularly those who have health challenges. So, the higher involvement rates of those with lower perceived QOL may result from this organized intervention. Furthermore, access to healthcare may be restricted in countries with minimal resources, such as Nigeria. As a result, people with perceived health problems are more likely to turn to self-management techniques, such as exercise, as affordable substitutes for medical treatment (WHO, 2019).

8.12 Objective 9: Structural relationship between SDH, EDH, DL, IP, healthy diet, physical activity, and quality of life among undergraduate students in USM health campus, Malaysia

Similar to objective 5 of the current study, the hypothesized SEM in this objective was based on the theoretical Meikirch model (Bircher, 2020; Bircher & Kuruvilla, 2014). The structural relationships among perceived SDH, EDH, DL, and

IP were evaluated to understand their role in enhancing perceived quality of life (QOL) among Malaysian undergraduate students. Additionally, healthy diet and physical activity were incorporated into the model due to their strong relationship with QOL (Ho et al., 2019; Omorou et al., 2013; Regan et al., 2022; Wu et al., 2019).

Also, in the current objective, the initially hypothesized SEM model proposes that both SDH and EDH will directly and indirectly influence QOL through DL and IP among the sample of Malaysian university students. This implies that a higher perceived level of SDH and EDH will be directly and indirectly associated with a higher perceived level of QOL through DL and IP. Also, the SEM model proposed that both HD and PA have a direct influence on QOL. This means that a higher perceived level of HD and PA will be associated with a higher perceived level of QOL.

The final Malaysian SEM model reveals that the data supported eight out of the 10 pathways. The findings indicated that SDH was significant and positively associated with QOL ($\beta = 0.599$, p-value < 0.001). This demonstrates that a higher perceived level of SDH satisfaction will enhance an individual's perceived QOL. Wan Puteh et al. (2019) study revealed that factors such as sociodemographic differences, socioeconomic conditions, and the presence of chronic illnesses influenced health-related QOL in Malaysia's low socioeconomic communities. Furthermore, external factors like economic stability, adequate health care services, and favorable health outcomes played a supportive role in enhancing the well-being and QOL of disadvantaged groups (Wan Puteh et al., 2019). These findings underscore the importance of addressing socioeconomic disparities and improving healthcare access to promote equitable health outcomes.

A number of factors, including low household income, social network, depression, and disability status, predicted adults' QOL in Malaysia (Lim et al., 2023). These findings were consistent with studies from Sri Lanka (Rathnayake & Siop, 2015) and Turkey (Bilgili & Arpacı, 2014). Tengku (2015) noted that older Malaysian women faced greater financial insecurity due to cumulative disadvantages throughout their lives, including limited access to education, employment opportunities, income, healthcare, and other resources. These factors significantly impacted their financial stability and QOL as they aged. The study illustrated that older women had lower QOL scores compared to their male counterparts (Tengku, 2015). Moreover, traditional Asian family roles, such as filial piety and caring for elderly parents, remained prevalent in Malaysia (Lim et al., 2023). Many studies indicated that most older Malaysians lived with adult children who provided financial and emotional support, contributing to their improved QOL (Hamid et al., 2019; Khan & Tahir, 2014; Tengku, 2015). As such, insufficient social support or a lack of social networks increased the risk of social isolation, psychosocial stress, depression, and feelings of loneliness and insecurity, which in turn lowers QOL (Ibrahim et al., 2013; Khan & Tahir, 2014; Teh et al., 2014).

Additionally, research revealed that perceived social support was one of the key factors affecting QOL among Malaysian university students (Lee et al., 2024). Low levels of social support were associated with poor overall QOL, and this relationship remained consistent across all QOL domains (Lee et al., 2024). On the other hand, people with high overall QOL reported low to moderate levels of perceived social support (Lee et al., 2024). A recent study conducted among Malaysian college students during COVID-19, confirms this result, revealing family social support as a strong predictor of QOL (Cahuas et al., 2023). In order to prevent stress, maintain psychological health, and improve general quality of life, social support is essential (Alsubaie et al., 2019; Helgeson, 2003).

The findings also indicated that EDH was significant and positively associated with QOL ($\beta = 0.925$, p-value < 0.001). This illustrates that a higher perceived level of EDH satisfaction will enhance an individual's perceived QOL. The environment undeniably plays a critical role in shaping an individual's life, whether as a student, teacher, or staff member (Hatcher et al., 2019; Mouratidis, 2021; Ramli et al., 2020). The final SEM model for the Malaysian sample in this study indicates that the EDH factor contributes the highest coefficient impacting the student's QOL. This finding aligns with a recent study conducted among University Malaysia Kelantan students, which demonstrated that access to infrastructure and services contributed the highest influence on students' QOL (Ramli et al., 2020).

According to Ramli et al. (2020) study, QOL mediates the relationship between infrastructure and services and academic performance. Similarly, many studies (Gilavand, 2016; Grineski et al., 2020; Harinarayanan & Pazhanivelu, 2018; Rafiq et al., 2022; Wolfe et al., 2021) have demonstrated a direct relationship between access to infrastructure and services and academic performance. However, Ramli et al. (2020) findings illustrated that access to environmental infrastructure and services does not directly influence academic performance but significantly impacts students' QOL, which in turn affects their academic outcomes. Access to adequate infrastructure and services allows students to live in comfort, thereby enhancing their QOL and creating a supportive environment for academic achievement (Rafiq et al., 2022; Ramli et al., 2020). These findings underscore the importance of prioritizing and continuously improving access to essential environmental infrastructure and services to foster students' well-being and educational success.

The QOL of university students is particularly vital for helping them navigate social, mental, and physical challenges (Rafiq et al., 2022; Ramli et al., 2020; Wolfe et al., 2021). Studies have shown that factors that contribute to student satisfaction include their perceptions of learning and instruction quality, the availability of resources such as computer centres, libraries, and laboratories, and supportive infrastructure such as lecture halls, social spaces, and campus buildings (Darawong & Sandmaung, 2019; Rafiq et al., 2022; Ramli et al., 2020). Additional amenities, such as medical clinics, cafeterias, and student housing, also play an important role, alongside external factors like transportation and financial stability (Darawong & Sandmaung, 2019; Ramli et al., 2020). Several environmental factors, such as water and waste management, noise, and air pollution, significantly affect students QOL (Wolfe et al., 2021). These environmental supports are essential in cultivating future leaders capable of contributing to developed nations (Faka, 2020; Ramli et al., 2020).

The results also illustrated that SDH ($\beta = -0.207$, p-value < 0.001) and EDH ($\beta = -0.460$, p-value < 0.001) had a negative relationship with DL. However, contrary to the Nigerian SEM model in this study, DL did not have a significant influence on QOL. Also, higher scores on the DL scale represent inadequacies in physiological, psychosocial, and environmental needs, while lower scores indicate that these needs are adequately met. Therefore, the findings suggest that higher perceived levels of SDH and EDH are associated with meeting these needs (i.e., adequate DL). Studies have shown that students who receive adequate social and environmental support are more likely to report positive psychosocial and physiological outcomes, such as lower levels of stress, anxiety, and depression, as well as healthier weight and overall well-being (Ibrahim et al., 2021; Lee et al., 2024; Pineda et al., 2022; Yusof et al., 2022). On the other hand, the accumulation of cumulative stress from unfavourable SDH and

EDH factors among students will lead to mental health problems and physical health decline (Lee et al., 2024; Yeo & Yap, 2023). For instance, Malaysian students who have access to a good educational system and stable finances tend to report a greater quality of life, which has a direct effect on their capacity to balance their personal and academic needs (Yusof et al., 2022). Furthermore, improved well-being has an association with the availability of environmental resources, including accessible medical facilities, public transit, and safe paths (Yusof et al., 2022).

Furthermore, the findings of this study reveal that IP was significantly and positively associated with both SDH ($\beta = 0.213$, p-value < 0.001) and EDH ($\beta = 0.392$, p-value < 0.001), and both SDH and EDH had an influence on QOL through IP. IP reflects the individuals biologically given potentials and personally acquired potentials that are essential to meeting the demands of life (Bircher, 2020). Contrary to the SEM model among the Nigerian sample in this study, IP had a significant and negative effect on QOL. Consequently, these relationships illustrate that higher perceived levels of SDH and EDH are associated with individuals possessing sufficient IP. Whereas a lower perceived level of IP was associated with a higher perceived QOL in this SEM model ($\beta = -0.162$, p-value < 0.001).

Similar to the findings of our study, students in Malaysia with adequate social and environmental support were found to have better positive perceived health ratings and a strong sense of coherence (Al-Naggar et al., 2013; Pitil et al., 2020). For instance, feeling safe in their surroundings and having access to social support fosters resilience and a positive attitude even in the face of difficulties among students (Al-Naggar et al., 2013). Students from higher socioeconomic backgrounds frequently report better self-rated health because they have greater access to resources for education, healthcare, and proper nutrition, (Hamid et al., 2021). Given the financial strain and obstacles to accessing healthcare services, students from lower socioeconomic backgrounds may report lower self-rated health (Hamid et al., 2021). In addition, perceived health ability is adversely affected by substandard living conditions, such as congested housing or exposure to environmental pollutants (Sugiyama et al., 2016). Whereas improved perceived health is improved by having access to recreational areas, clean air, and safe drinking water (Sugiyama et al., 2016).

The negative influence of IP on QOL as observed in this study contradicts our initial hypothesis, which anticipated a positive relationship. This expectation was based on findings from previous studies that have highlighted a positive association between IP and QOL (Bircher, 2020; Nabors et al., 2018; Ocampo, 2010). This result may be explained by the significant association between SDH and IP found in this study, which is corroborated by prior findings that, even in cases of poor health, strong social support from family, friends, or caregivers can improve perceived QOL by offering financial, emotional, and physical support (Ferrans et al., 2005; Yalcin, 2015). People frequently make psychological changes to cope with long-term illnesses or impairments, finding methods to find fulfilment and meaning in life in spite of their restrictions. This phenomenon, referred to as the disability paradox, occurs when people who face major health obstacles report having great quality of life (Albrecht & Devlieger, 1999). These results highlight the intricate, multifaceted nature of QOL, showing that it is influenced by a variety of factors, such as psychological, social, cultural, and physical dimensions.

Lastly, the final SEM model among the Malaysian students reveals that HD had a significant and negative association with QOL ($\beta = -0.579$, p-value = 0.021). This illustrates that with a lower score of HD, one possesses a higher perceived QOL. Contrary to the findings of this study, various studies have reported a positive association between HD and QOL (Bolton et al., 2016; Hadgkiss et al., 2015; Regan et al., 2022; Wu et al., 2019). Nonetheless, a recent study by Lee et al. (2023) among Malaysian healthcare university students revealed that none of the participants had a healthy diet and that only a small proportion of them consumed adequate fresh produce, such as fruits, vegetables, and dairy products, on a regular basis. Similarly, Ayob and Shukri (2020) reported that only 2% of Malaysian university students have a healthy diet, and few university students consume enough fruits and vegetables (Pengpid & Peltzer, 2021).

Eating disorders significantly impact body image perceptions, with obesity in young individuals negatively affecting their QOL (Jebeile et al., 2021). Adolescents with eating disorders often experience physical and psychological challenges that can negatively affect their mental health, subsequently lowering their overall QOL (Kumcagiz, 2017). During university years, students may continue to face these challenges due to exposure to various risk factors, including unhealthy eating behaviours, which could further diminish their QOL (Ortiz et al., 2016). In the Malaysian context, food plays a significant role in social and cultural values (Perry, 2017). Strict dietary practices can lead students to feel alienated from cultural traditions, especially communal or traditional meals (Perry, 2017). This, in turn, can diminish their perceived QOL, as food-related experiences often cultivate social connections and a sense of belonging in Malaysia (Perry, 2017). Hence, although a nutritious diet is undeniably advantageous for physical and mental health, cultural contexts can lead to subjective differences in how individuals perceive its impact on their well-being.

8.13 Objective 10: Measurement and structural invariance of the SDHQ, EDHQ, DLQ, and IPQ across Nigerian and Malaysian university students

In this objective, we compared the measurement and structural invariance of the newly developed social determinants of health questionnaire (SDHQ), environmental determinants of health questionnaire (EDHQ), demands of life questionnaire (DLQ), and individual potential questionnaire (IPQ) in order to investigate their applicability among the Nigerian and Malaysian university students. The fit indices of these scales (SDHQ, EDHQ, DLQ, and IPQ) for both the Nigerian university students and Malaysian university students samples model were within the recommended cutoff values (Brown, 2015; Byrne, 2013; Enders & Tofighi, 2007; Fornell & Larcker, 1981; Hair et al., 2010; Kline, 2013; Kline, 2023; Koo & Li, 2016; Raykov & Marcoulides, 2016). Hence, these two models were established with a similar number of constructs and items.

This study initially assessed the measurement invariance of the scales (SDHQ, EDHQ, DLQ, and IPQ) across Nigerian and Malaysian university students by applying the configural, weak, strong, and strict invariance models (Meredith & Teresi, 2006; Wang & Wang, 2019). The findings indicated that both groups of students possessed similar understandings and interpretations of the constructs and items (Meredith & Teresi, 2006; Wang & Wang, 2019). These findings are crucial for ensuring the validity and reliability of cross-country comparisons of these holistic health scales. Furthermore, the structural invariance of these scales was favourable for factor variance and covariance, and the factor means were invariant across the two samples. These findings reveal that the strength of relationships between the factors remains stable, and there was no significant mean difference in total scores for all the scales between the Nigerian and Malaysian university students (Meredith & Teresi, 2006;

Wang & Wang, 2019). Consequently, we established the models for both groups using the same number of constructs and items, proving their cross-cultural applicability.

8.14 Objective 11: Multigroup SEM comparison across Nigerian and Malaysian university students

Finally, in this objective, we conduct multigroup comparison of the SEMs across the Nigerian and Malaysian university students based on six shared path relationships between the two groups: 1) SDH was significantly associated with DL, 2) EDH was significantly associated with DL, 3) SDH was significantly associated with IP, 4) EDH was significantly associated with IP, 5) SDH was significantly associated with QOL, and 6) EDH was significantly associated with QOL. We removed HD and PA from this multigroup comparisons model because the two samples did not support them simultaneously. The multigroup SEM model shows adequate fit indices based on the six path relationships requiring no additional modification. This demonstrates that these six path relationships maintain their significance despite cultural differences.

The relationships outlined in the invariance SEM model align with the framework proposed by Bircher and Kuruvilla (2014) in their Meikirch model. This model posits that health is an emergent state of well-being, arising from dynamic and conducive interactions between an individual's potentials, the demands of life, and the influences of social and environmental determinants across different cultures. Also, SDH and EDH influence human basic needs regardless of cultural differences (Bircher, 2020). Addressing these factors ensures equitable health opportunities worldwide (Bircher, 2020). According to WHO CSDH, addressing SDH globally is essential to enhancing general health outcomes (WHO CSDH, 2008). Regardless of the region, investments in environmental health infrastructure, like urban planning and water sanitation, yield favorable health outcomes for everyone (Northridge & Freeman, 2011). Adequate social and environmental support, which transcends cultural barriers, greatly influences mental health, psychological resilience, and general well-being (Bircher, 2020; Schulz & Northridge, 2004).

8.15 Chapter summary

This chapter covers a discussion of the study results, relating them to previous findings. The chapter is structured according to each specific objective, beginning from the first three objectives, which is the development of new holistic health questions, including the SDHQ, EDHQ, DLQ, and IPQ and response process validity using content validity and face validity. Subsequently, we discussed the results of objectives 4 to 7, which cover the validation of the newly developed holistic health questionnaires (SDHQ, EDHQ, DLQ, and IPQ) using EFA, CFA, and reliability testing among independent samples of Nigerian and Malaysian university students. Lastly, we discussed the results obtained from objectives 8 to 11, which cover testing structural relationships, measurement and structural invariance, and multigroup SEM comparison across the Nigerian and Malaysian university students.

CHAPTER 9

CONCLUSION

9.1 Introduction

This chapter covers the summary of the study's main findings, the study's implications, the strength of the study, the limitations of the study, and recommendations for future research.

9.2 Summary of the study's main findings

The study was structured into three phases. It begins with phase I, which is the development of new holistic health questionnaires for assessing social determinants of health (SDH), environmental determinants of health (EDH), demands of life (DL), and individual potentials (IP) by extensive literature search and interviews with undergraduate students from Nigeria and Malaysia, as well as testing content validity and face validity among experts and undergraduate students from Nigeria and Malaysia. In phase II, we tested the psychometric properties of these newly developed questionnaires using exploratory factor analysis (EFA), confirmatory factor analysis (CFA), and reliability tests, including Cronbach's alpha, composite reliability (CR), and test-retest among independent samples of undergraduate students from FUD, Nigeria and USM health campus. Finally, in phase III we tested the structural relationships, measurement and structural invariance, and multigroup SEM comparison across the Nigerian and Malaysian university students.

In phase I, we drafted four questionnaires, including the social determinants of health questionnaire (SDHQ), environmental determinants of health questionnaire (EDHQ), demands of life questionnaire (DLQ), and individual potentials questionnaire

(IPQ). The SDHQ consisted of two constructs: the structural determinants of health (10 items) and the intermediary determinants of health (10 items). The EDHQ consisted of two constructs: the natural environment (8 items) and the built environment (10 items). The DLQ consisted of three constructs: physiological demands (6 items), psychosocial demands (6 items), and environmental demands (6 items). Lastly, the IPQ consisted of two constructs: the biologically given potentials (6 items) and the personally acquired potentials (8 items). Furthermore, 12 experts from Nigeria and Malaysia (6 each) gave ratings for content validity, and 20 undergraduate students from Nigeria and Malaysia (10 each) gave ratings for face validity.

In phase II, a total of 2600 undergraduate students from FUD, Nigeria (1300) and USM health campus (1300) were employed for the validation study. The final results demonstrated adequate psychometric properties for the underlying structures of the SDHQ, EDHQ, DLQ, and IPQ for both countries.

In phase III, The SEMs for the Nigerian and Malaysian students were established with eight significant pathways. However, the two SEMs shared six significant pathways in common. Both the SDHQ, EDHQ, DLQ, and IPQ demonstrated adequate measurement invariance (configural, weak, strong, and strict) and structural invariance (factor covariate invariance and factor means invariance). Moreover, the multigroup SEM comparison reveals that the six pathways were stable across the two samples. These findings illustrate that the newly developed scales for assessing SDH, EDH, DL, and IP can be used to make valid comparisons across Nigeria and Malaysia.

9.3 Implications of the study

The study created a novel self-report tools for evaluating perceived SDH, EDH, DL, and IP. These new holistic health questionnaires go beyond traditional measures, which frequently only concentrate on physical symptoms, to enable broader assessments and a more comprehensive understanding of the effects of social determinants, environmental determinants, people's demands, and potentials on overall well-being. By identifying each person's unique needs and difficulties, these measures can assist healthcare professionals in creating interventions that are specifically suited to their needs. Appropriate monitoring and assessment of interventions can be facilitated by the ability to track progress or identify gaps in well-being across time.

The study is the first to examine the structural relationships among holistic health variables based on the Meikirch model of health. This provides one of the first models to quantitatively examine the impact of recently discovered holistic health factors on quality of life and will open up new avenues for interdisciplinary research that examines the interrelationships between social, environmental, and individual determinants of health. The creation of a new holistic health model has revolutionary ramifications and propels the medical field toward patient-centred, integrative, and comprehensive care. It enhances health outcomes, contributes to evidence-based policy, and fosters equilibrium between the health of the person and the health of the community by tackling the larger determinants of health. In the end, a comprehensive approach guarantees sustainable health systems that meet changing requirements while also improving the quality of life of the population.

According to the measurement and structural invariance results, the newly developed scales were shown to be cross-culturally applicable, and their interrelationships were cross-cultural. The creation of cross-culturally valid questionnaires guarantees that they are applicable to a range of demographics, promoting inclusive healthcare practices. Regional treatments can result from the use of these types of methods to detect various health issues in various cultural or social and economic environments. Furthermore, in today's multicultural and globalized society, developing a cross-cultural holistic health model is crucial to addressing health holistically. It guarantees inclusive and culturally responsive healthcare, lowers health inequalities, and encourages fair solutions provided to the particular requirements of every population group. By encouraging synergy, directing policies, and empowering people and communities, such a model improves global health outcomes and eventually leads to increased well-being on a worldwide basis.

9.4 Strength of the study

The research utilized a combination of qualitative and quantitative methodologies. This offers a more extensive, reliable, and flexible approach to a research study. Measurable data and contextual knowledge can be combined by researchers to solve complex issues, validate results, and offer practical solutions. This combination improves research findings' broadness, accuracy and relevance, which makes it especially helpful for interdisciplinary studies and use in real life.

Secondly, the large sample size used added more strength to the study's findings. A study's quality is enhanced by using a large sample size since it increases statistical power, decreases bias, and improves the accuracy and generalizability of results. It helps researchers to detect small effects, examine subgroups, and generate results that are reliable and generalizable to larger populations, which strengthens and impacts the study.

Third, the study utilized data from two countries, Nigeria and Malaysia, which differ in culture and demographics. This approach promotes collaboration, minimizes cultural biases, and helps address both local and global challenges more effectively.

9.5 Limitations of the study

Despite the robustness of the current method and the positive results obtained, the study is not without some associated limitations. First, the study was conducted at a single university in both Nigeria and Malaysia, so the findings should be interpreted with caution. Nevertheless, universities in these countries generally represent a diverse demographic of the population.

Second, the study employed a cross-sectional study design, which may lead to limitations in establishing causality, changes over time, such as trends and progression of outcomes.

Third, the study relied on self-reported measures to evaluate the study variables, which may introduce some response bias and reduce the accuracy of the data obtained. However, all the participants were assured of the confidentiality of their information, encouraged to provide honest responses based on their true perceptions, and advised not to discuss their responses with others.

Fourth, the study employed the non-probability sampling technique in recruiting the study participants. This may yield a sample that is homogeneous, consequently making a study unable to reflect diverse perspectives and outcomes. While convenience sampling is practical, cost-effective, and fast, its findings should be interpreted with caution.

Lastly, it was not in the aim of the current study to develop comprehensive questionnaires for assessing the holistic health variables (i.e., SDH, EDH, DL, and IP). Instead, we focused on developing and validating brief measures for evaluating these variables. Consequently, it is possible that some constructs and items reflecting these variables may not have been fully captured in this study.

9.6 Recommendations for future study

Given the study's limitations highlighted above, we presented some recommendations for future research. This will demonstrate the study gaps, guide subsequent studies, and ensure the continuous advancement of knowledge, ultimately leading to more comprehensive and impactful research.

1. We recommend that future studies replicate this study and assess the psychometric properties of the SDHQ, EDHQ, DLQ, and IPQ in other universities across the world and also in diverse populations with wide sociodemographic characteristics differences, such as communities, hospital settings, and workplaces.
2. We recommend future studies employ a probability sampling approach and/or longitudinal studies in recruiting the study participants to remove the influence of other confounding variables and any bias that might influence the study findings.
3. We suggest that in addition to the subjective measures developed in this study, future research should develop and validate objective measures for empirically evaluating these holistic health indicators (i.e., SDH, EDH, DL, and IP). This will ensure a higher degree of accuracy compared to subjective measures, which rely on personal perceptions or self-reports, ultimately providing a more holistic understanding of complex phenomena.
4. We recommend that future studies develop more comprehensive measures for evaluating the SDH, EDH, DL, and IP by expanding each indicator to include additional constructs and items that better represent these holistic health variables.

5. Finally, we recommend testing the interrelationships of these holistic health variables (i.e., SDH, EDH, DL, and IP) across various populations with diverse demographics in order to enhance the understanding and accuracy of the Meikirch model in assessing holistic health within different settings.

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APPENDICES

## Appendix A		Interview Protocol Form

Introduction

We are conducting research on holistic health factors and their effect on quality of life among university undergraduate students in Malaysia and Nigeria. You have been selected to participate in this interview because you are one of the undergraduate students who meets the criteria for our study's inclusion. You should be aware that taking part in this interview is completely optional and that you are free to leave at any time. Your responses are also treated with confidentiality.

Interview subsection:

i. Social determinants of health.
ii. Environmental determinants of health.
iii. Demands of life.
iv. Individual potentials

Social determinants of health (SDH): The SDH are a range of factors that affect our quality of life and wellbeing through the conditions in which people are born, grow, live, work, and age. The scale consisted of two factors: 1) Structural determinants of social of health (also referred to as social determinants of health inequities): These are factors that create or reinforce social stratification in society and define individuals' socioeconomic position such as income, gender, occupation, social class, etc. and (2) Intermediary determinants of health: They refer to the individual-level mediators of the health inequities that shape health outcomes such as health system, support from family and friends, etc.

1: Briefly describe your understanding of social determinants of health.
2: List the factors that you think can influence the social determinants of health.
3: What improvements do you suggest can be made to these social determinants of health?

Environmental determinants of health (EDH): They refer to factors in the natural and built environments, like climate, water supply, land use, transportation systems, public resources, and buildings, that can have a direct effect on health. The scale consists of 2 domains: (1) Natural environment: They are essential factors at the macro level, like natural resources, air pollution, noise pollution, extreme weather etc. and (2) Built environment: They refer to the physical factors at the community level that protect and promote livelihood opportunities, health, and sustainable development such as land use, transportation systems, public services etc.

1: Briefly describe your understanding of environmental determinants of health.
2: List the factors that you think can influence the environmental determinants of health.
3: What improvements do you suggest can be made to these environmental determinants of health?

Demands of life (DL): They refer to the three main types of needs (i.e., physiological, psychosocial, and environmental demands) that are essential for a healthy life. (1) Physiological demands: Refers to the overall feelings regarding personal susceptibility to pain, discomfort, or other physical symptoms associated with one's respiratory ability, digestion and excretion of nutrients, as well as musculoskeletal discomfort that can affect their normal daily activities. (2) Psychosocial demands: Relate to individuals' personal development and social integration, such as positive mental attitudes toward oneself, relationships with others, the ability to resist social pressures, and a sense of ongoing development. (3) Environmental demands: They are the interindividual differences in the interface between people and the environmental demands of day-to-day events that they cope with through time management or coping skills such as how often people are busy every day.

1: Briefly describe your understanding of demands of life.
2: List the factors that you think can influence the demands of life.

3: What improvements do you suggest can be made to these demands of life?

Individual potentials (IP): They represent the biologically given and personally acquired potentials that individuals require to meet the demands of life both now and in the future. (1) Biologically given potentials: Represent a self-perceived health profile assessment that can be used to identify any somatic disease, injury, or defect that reduces or limits one's function temporarily or permanently. (2) Personally acquired potentials: They represent a sense of coherence in order to maintain or improve a specific level of health or disease. They also indicate one's perception of having sufficient resources to deal with and cope with difficult situations.

1: Briefly describe your understanding regarding the individual potentials.
2: List the factors that you think can influence the individual potentials.

3: What improvements do you suggest can be made to these individual potentials?

Thank you very much for your time and input.

Appendix B Invitation for content validation

Dear Professor, Associate Professor, Assistant Professor, Dr.,

We would like to invite you to participate in the content validity process for new instruments on holistic health based on your professional opinion. We need your professional judgement on the degree to which each item is relevant to its specific domain.

We aim to administer these new scales to undergraduate university students in Malaysia and Nigeria. There are total 70 questions on four questionnaires that look at different aspects of holistic health. The definition and relevant terms that were given to you should be the basis for your review.

Please evaluate each item using the rating scale below and fill out the space provided with your comments, if any.

Degree of relevancy (the extent to which each item relates to the aspect of the domain/subscale)"

1 The item is not relevant to the domain

2 The item is somewhat relevant to the domain

3 The item is relevant to the domain

4 The item is very relevant to the domain

1. Social Determinants of Health Questionnaire (SDHQ)

The social determinants of health (SDH) are a range of factors that affect our quality of life and wellbeing through the conditions in which people are born, grow, live, work, and age. The scale consisted of two domains:

(i) Structural determinants of health (also referred to as social determinants of health inequities): These are factors that create or reinforce social stratification in society and define individuals' socioeconomic position. According to the WHO Commission on Social Determinants of Health (CSDH), the most important indicators are income, education, occupation, gender, race or ethnicity, and social class. Also, these factors possess a dual meaning, referring to the determinants of health promotion and the processes underlying the unequal opportunities between these factors. We aim to assess this domain with the 10 items in the table below using a 5-point rating scale (totally unsatisfied, unsatisfied, somewhat satisfied, satisfied, and totally satisfied).

(ii) Intermediary determinants of health: They refer to the individual-level mediators of the health inequities that shape health outcomes. According to WHO CSDH, they include the health system, behavioural and biological factors, material conditions, psychosocial circumstances, and circumstances relating to the individual and their environment. We aim to assess this domain with the 10 items in the table below using a 5-point rating scale (very poor, poor, somewhat good, good, and very good).

No.	Items	Relevancy				Comments
	Structural determinants	1	2	3	4	
1	How satisfied are you with your gender?					
2	In terms of all the opportunities in your community, how would you evaluate gender equality?					
3	How satisfied are you with your ethnic background?					
4	In terms of all the opportunities in your community, how would you evaluate ethnic equality?					
5	How satisfied are you with your present financial income?					
6	How do you rate your financial opportunities in the future?					
7	How satisfied are you with your present education?					
8	How do you rate your employment opportunity in the future?					
9	How satisfied are you with your present standard of living?					
10	How do you rate the government's effort towards improving your standard of living?					
	Intermediary determinants					
1	How do you rate the state of your housing or accommodations?					
2	How do you rate the availability of healthy food or safe water in your neighbourhood?					
3	How do you rate the support you received from your family members?					
4	How do you rate the support you received from your friends?					
5	How do you rate the state of your mental health?					
6	How do you rate the state of your physical health?					
7	How would you rate your good lifestyle habits, such as healthy eating?					
8	How do you rate the quality of the health system services in your community?					
9	How do you rate your access to health services when needed?					
10	How do you rate the affordability of health services in your community?					

Other comment/suggestion :____

2. Environmental Determinants of Health Questionnaire (EDHQ)

They refer to factors in the natural and built environments, like climate, water supply, land use, transportation systems, public resources, and buildings, that can have a direct effect on health. The scale consists of 2 domains:

(i) Natural environment: They are essential factors at the macro level, like natural resources, air pollution, noise pollution, extreme weather, the quality of drinking water, and the availability of natural, healthy foods, that underlie and influence health and well-being via multiple pathways. We aim to use the 8-items in the table below and a 5-point scale rating (strongly disagree, disagree, somewhat agree, agree, and strongly agree) to evaluate this domain.

(ii) Built environment: They refer to the physical factors at the community level that protect and promote livelihood opportunities, health, and sustainable development. They include factors such as land use, transportation systems, public services, public resources, and infrastructures. We aim to use the 10-items in the table below and a 5-point scale rating (strongly disagree, disagree, somewhat agree, agree, and strongly agree) to evaluate this domain.

No.	Items	Relevancy				Comments
	Natural environment	1	2	3	4	
1	The weather is always favourable					
2	There is assistance available during extreme weather					
3	There is always safe drinking water available					
4	I always have access to clean drinking water					
5	Fresh, healthy foods are always available					
6	I can always afford fresh, healthy foods					
7	There is always fresh air without any sign of pollution					
8	The workplaces are very safe					
	Build environment					
1	There is appropriate land use protection for residential purposes in my neighbourhood					
2	There is appropriate land use protection for industrial purposes in my neighbourhood					
3	Transportation systems, either public or private, are always convenient					
4	There are sufficient locations to make purchases, including markets or shops					
5	There are sufficient banks or other places for cash transactions					
6	There are sufficient healthcare facilities in my neighbourhood					
7	In my neighbourhood, waste products are properly disposed					
8	Public places like parks, museums, or libraries are available for use					
9	The quality of the living environment is good in my neighbourhood					
10	The quality of the school environment is good in my neighbourhood					

Other comment/suggestion :____

3. Demands of Life Questionnaire (DLQ)

They refer to the three main types of needs (i.e., physiological, psychosocial, and environmental demands) that are essential for a healthy life. As a result, on this scale, we attempt to present items that reflect these three domains in order to illustrate the total demands of life using a 5-point rating scale (not at all, once per month, 1-2 times per week, 3-4 times per week, and almost every day).

(i) Perceived physiological demands: Refers to the overall feelings regarding personal susceptibility to pain, discomfort, or other physical symptoms associated with one's respiratory ability, digestion and excretion of nutrients, as well as musculoskeletal discomfort that can affect their normal daily activities.

(ii) Psychosocial demands: Relate to individuals' personal development and social integration, such as positive mental attitudes toward oneself, relationships with others, the ability to resist social pressures, and a sense of ongoing development.

(iii) Environmental demands: They are the interindividual differences in the interface between people and the environmental demands of day-to-day events that they cope with through time management or coping skills.

No.	Items	Relevancy				Comments
	Physiological demands	1	2	3	4	
1	How frequently do you experience respiratory issues, such as difficulty in breathing?					
2	How frequently do you have problems digesting and eliminating food or water?					
3	How often do you feel pain in your eyes either during or after your regular activities?					
4	How frequently do you have headaches when engaging in daily activities?					
5	How frequently do your hands and/or legs hurt during or after performing daily activities?					
6	How often does your neck, shoulder, or back hurt while performing your daily activities?					
	Psychosocial demands					
1	How frequently do you feel good about yourself considering your past and/or present circumstances?					
2	How often do you feel satisfied with your interactions with colleagues (e.g., their support of you, and/or your support towards them)?					
3	How often do you feel confident in your ability to make the right decisions for yourself?					
4	How frequently do you handle unforeseen circumstances in your environment calmly?					
5	How often do you think your life goals are on track?					
6	How frequently do you consider your life's progress?					
	Environmental demands					
1	On average, how often are you busy?					
2	How frequently do you feel like you have too much to do each day?					
3	How frequently do you miss classes because you're too busy?					
4	How frequently do you rush to get to school in the mornings?					
5	How frequently do you wake up in the morning or fall asleep at your scheduled time?					
6	How often do you eat all your meals on time?					

Other comment/suggestion :____

4. Individual Potentials Questionnaire (IPQ)

They represent the biologically given and personally acquired potentials that individuals require to meet the demands of life both now and in the future.

(i) Biologically given potentials: Represent a self-perceived health profile assessment that can be used to identify any somatic disease, injury, or defect that reduces or limits one's function temporarily or permanently. We aim to use the 6-items in the table below and a 4-point scale rating (none, mild, moderate, and severe) to evaluate this domain.

(ii) Personally acquired potentials: They represent a sense of coherence in order to maintain or improve a specific level of health or disease. They also indicate one's perception of having sufficient resources to deal with and cope with difficult situations. We aim to use the 8-items in the table below and a 4-point scale rating (not at all, rarely, often, and very often) to evaluate this domain.

No.	Items	Relevancy				Comments
	Biologically given potential	1	2	3	4	
1	Do you have any chronic health conditions that you developed as a child?					
2	During your early childhood, did you have any challenges because of your health condition?					
3	Do you have any health issues right now?					
4	Do you have any chronic conditions right now?					
5	Do you have any long-standing chronic conditions that have been present for at least six months?					
6	Do you have any chronic conditions that are limiting your daily activities?					
	Personally acquired potential					
1	Do you believe that you can accomplish your life goals regardless of the circumstances?					
2	Do you feel that the changes in the past have made your situation unpleasant?					
3	When you are in an unfamiliar situation, does it affect your normal activities?					
4	How well do you solve your issues when faced with a challenge?					
5	Do you believe that your state of happiness may be affected by pain or health issues?					
6	How often do you experience regret over your past?					
7	How often do you feel bad about your future?					
8	How often do you feel in control of the conditions in your life?					

Other comment/suggestion :____

Thank you for your time and expert assessment.

Appendix C Invitation for face validation

Dear student,

We would like to invite you to participate in the face validity process for new instruments on holistic health based on your own judgements about all the questions.

We need your opinion on the degree of clarity and comprehension of each item to assess the holistic health of undergraduate students. There are four sections that look at different aspects of holistic health. The definition and relevant terms that were given to you should be the basis for your review. Please use the options provided to rate each item, and if you have any comments, write them in the space provided.

Please evaluate each item using the rating scale below and fill out the space provided with your comments, if any.

Degree of clarity (the extent to which each item is clear and understandable to you)"

1 = the item is not clear and understandable

2 = the item is somewhat clear and understandable

3 = the item is clear and understandable

4 = the item is very clear and understandable

1. Social Determinants of Health Questionnaire (SDHQ)

No.	Items	Clarity and comprehension				Comments
	Structural determinants	1	2	3	4	
1	How satisfied are you with your gender?					
2	In terms of all the opportunities in your community, how would you evaluate gender equality?					
3	How satisfied are you with your ethnic background?					
4	In terms of all the opportunities in your community, how would you evaluate ethnic equality?					
5	How satisfied are you with your present financial income?					
6	How do you rate your financial opportunities in the future?					
7	How satisfied are you with your present education?					
8	How do you rate your employment opportunity in the future?					
9	How satisfied are you with your present standard of living?					
10	How do you rate the government's effort towards improving your standard of living?					
	Intermediary determinants					
1	How do you rate the state of your housing or accommodations?					
2	How do you rate the availability of healthy food or safe water in your neighbourhood?					
3	How do you rate the support you received from your family members?					
4	How do you rate the support you received from your friends?					
5	How do you rate the state of your mental health?					
6	How do you rate the state of your physical health?					
7	How would you rate your good lifestyle habits, such as healthy eating?					
8	How do you rate the quality of the health system services in your community?					
9	How do you rate your access to health services when needed?					
10	How do you rate the affordability of health services in your community?					

Other comment/suggestion :____

2. Environmental Determinants of Health Questionnaire (EDHQ)

No.	Items	Clarity and comprehension				Comments
	Natural environment	1	2	3	4	
1	The weather is always favourable					
2	There is assistance available during extreme weather					
3	There is always safe drinking water available					
4	I always have access to clean drinking water					
5	Fresh, healthy foods are always available					
6	I can always afford fresh, healthy foods					
7	There is always fresh air without any sign of pollution					
8	The workplaces are very safe					
	Build environment					
1	There is appropriate land use protection for residential purposes in my neighbourhood					
2	There is appropriate land use protection for industrial purposes in my neighbourhood					
3	Transportation systems, either public or private, are always convenient					
4	There are sufficient locations to make purchases, including markets or shops					
5	There are sufficient banks or other places for cash transactions					
6	There are sufficient healthcare facilities in my neighbourhood					
7	In my neighbourhood, waste products are properly disposed					
8	Public places like parks, museums, or libraries are available for use					
9	The quality of the living environment is good in my neighbourhood					
10	The quality of the school environment is good in my neighbourhood					

Other comment/suggestion :____

3. Demands of Life Questionnaire (DLQ)

No.	Items	Clarity and comprehension				Comments
	Physiological demands	1	2	3	4	
1	How frequently do you experience respiratory issues, such as difficulty in breathing?					
2	How frequently do you have problems digesting and eliminating food or water?					
3	How often do you feel pain in your eyes either during or after your regular activities?					
4	How frequently do you have headaches when engaging in daily activities?					
5	How frequently do your hands and/or legs hurt during or after performing daily activities?					
6	How often does your neck, shoulder, or back hurt while performing your daily activities?					
	Psychosocial demands					
1	How frequently do you feel good about yourself considering your past and/or present circumstances?					
2	How often do you feel satisfied with your interactions with colleagues (e.g., their support of you, and/or your support towards them)?					
3	How often do you feel confident in your ability to make the right decisions for yourself?					
4	How frequently do you handle unforeseen circumstances in your environment calmly?					
5	How often do you think your life goals are on track?					
6	How frequently do you consider your life's progress?					
	Environmental demands					
1	On average, how often are you busy?					
2	How frequently do you feel like you have too much to do each day?					
3	How frequently do you miss classes because you're too busy?					
4	How frequently do you rush to get to school in the mornings?					
5	How frequently do you wake up in the morning or fall asleep at your scheduled time?					
6	How often do you eat all your meals on time?					

Other comment/suggestion :____

4. Individual Potentials Questionnaire (IPQ)

No.	Items	Clarity and comprehension				Comments
	Biologically given potential	1	2	3	4	
1	Do you have any chronic health conditions that you developed as a child?					
2	During your early childhood, did you have any challenges because of your health condition?					
3	Do you have any health issues right now?					
4	Do you have any chronic conditions right now?					
5	Do you have any long-standing chronic conditions that have been present for at least six months?					
6	Do you have any chronic conditions that are limiting your daily activities?					
	Personally acquired potential					
1	Do you believe that you can accomplish your life goals regardless of the circumstances?					
2	Do you feel that the changes in the past have made your situation unpleasant?					
3	When you are in an unfamiliar situation, does it affect your normal activities?					
4	How well do you solve your issues when faced with a challenge?					
5	Do you believe that your state of happiness may be affected by pain or health issues?					
6	How often do you experience regret over your past?					
7	How often do you feel bad about your future?					
8	How often do you feel in control of the conditions in your life?					

Other comment/suggestion :____

Thank you for your time.

Appendix D Study questionnaires

Socio-Demographic Data

Instruction: Please tick (√) in the appropriate box your response; and/or specify in the space provided.

SOCIAL DETERMINANTS OF HEALTH QUESTIONNAIRE

Instruction: This scale consists of 20 items that evaluate the perceived social determinants of health. Please rate each item by selecting the appropriate number. There are no right or wrong answers; we are only interested in how you feel about each question.

Structural determinants					
How satisfied are you with your gender?	1	2	3	4	5
In terms of all the opportunities in your community, how would you evaluate gender equality?	1	2	3	4	5
How satisfied are you with your ethnic background?	1	2	3	4	5
In terms of all the opportunities in your community, how would you evaluate ethnic equality?	1	2	3	4	5
How satisfied are you with your present financial income?	1	2	3	4	5
How do you rate your financial opportunities in the future?	1	2	3	4	5
How satisfied are you with your present education?	1	2	3	4	5
How do you rate your employment opportunity in the future?	1	2	3	4	5
How satisfied are you with your present standard of living?	1	2	3	4	5
How do you rate the government's effort towards improving your standard of living?	1	2	3	4	5
Intermediary determinants					
How do you rate the state of your housing or accommodations?	1	2	3	4	5
How do you rate the availability of healthy food or safe water in your neighbourhood?	1	2	3	4	5
How do you rate the support you received from your family members?	1	2	3	4	5
How do you rate the support you received from your friends?	1	2	3	4	5
How do you rate the state of your mental health?	1	2	3	4	5
How do you rate the state of your physical health?	1	2	3	4	5
How would you rate your good lifestyle habits, such as healthy eating?	1	2	3	4	5
How do you rate the quality of the health system services in your community?	1	2	3	4	5
How do you rate your access to health services when needed?	1	2	3	4	5
How do you rate the affordability of health services in your community?	1	2	3	4	5

Note:
Factors and items

1) Structural determinants of social determinants of health: [rating: 1 = totally unsatisfied, 2 = unsatisfied, 3 = somewhat satisfied, 4 = satisfied, 5 = totally satisfied].
2) Intermediary social determinants of health: [rating: 1 = very poor, 2 = poor, 3 = somewhat good, 4 = good, 5 = very good].

ENVIRONMENTAL DETERMINANTS OF HEALTH QUESTIONNAIRE

Instruction: This scale consists of 18 items that evaluate perceived environmental determinants of health. Please rate each item by selecting the appropriate number. There are no right or wrong answers; we are only interested in how you feel about each question.

	Strongly disagree	Disagree	Somewhat disagree	Agree	Strongly agree
The weather is always favourable	1	2	3	4	5
There is appropriate land use protection for residential purposes in my neighbourhood	1	2	3	4	5
There is assistance available during extreme weather	1	2	3	4	5
There is appropriate land use protection for industrial purposes in my neighbourhood	1	2	3	4	5
There is always safe drinking water available	1	2	3	4	5
Transportation systems, either public or private, are always convenient	1	2	3	4	5
I always have access to clean drinking water	1	2	3	4	5
There are sufficient locations to make purchases, including markets or shops	1	2	3	4	5
Fresh, healthy foods are always available	1	2	3	4	5
There are sufficient banks or other places for cash transactions	1	2	3	4	5
I can always afford fresh, healthy foods	1	2	3	4	5
There are sufficient healthcare facilities in my neighbourhood	1	2	3	4	5
There is always fresh air without any sign of pollution	1	2	3	4	5
In my neighbourhood, waste products are properly disposed	1	2	3	4	5
The workplaces are very safe	1	2	3	4	5
Public places like parks, museums, or libraries are available for use	1	2	3	4	5
The quality of the living environment is good in my neighbourhood	1	2	3	4	5
The quality of the school environment is good in my neighbourhood	1	2	3	4	5

Note:

Factors and items

1) Natural environment: 1, 3, 5, 7, 9, 11, 13, 15
2) Built environment: 2, 4, 6, 8, 10, 12, 14, 16, 17, 18

DEMANDS OF LIFE QUESTIONNAIRE

Instruction: This scale consists of 18 items that evaluate basic demands in life that are essential for a healthy life. Please rate each item by selecting the appropriate number. There are no right or wrong answers; we are only interested in how you feel about each question.

	Not at all	1/month	1-2 times/week	3-4/week	Almost Everyday
How frequently do you experience respiratory issues, such as difficulty in breathing?	1	2	3	4	5
How frequently do you feel good about yourself considering your past and/or present circumstances?	1	2	3	4	5
On average, how often are you busy?	1	2	3	4	5
How frequently do you have problems digesting and eliminating food or water?	1	2	3	4	5
How frequently do you feel like you have too much to do each day?	1	2	3	4	5
How often do you feel pain in your eyes either during or after your regular activities?	1	2	3	4	5
How frequently do you have headaches when engaging in daily activities?	1	2	3	4	5
How often do you feel satisfied with your interactions with colleagues (e.g., their support of you, and/or your support towards them)?	1	2	3	4	5
How frequently do you handle unforeseen circumstances in your environment calmly?	1	2	3	4	5
How frequently do you miss classes because you're too busy?	1	2	3	4	5
How frequently do your hands and/or legs hurt during or after performing daily activities?	1	2	3	4	5
How frequently do you rush to get to school in the mornings?	1	2	3	4	5
How often do you feel confident in your ability to make the right decisions for yourself?	1	2	3	4	5
How frequently do you wake up in the morning or fall asleep at your scheduled time?	1	2	3	4	5
How often does your neck, shoulder, or back hurt while performing your daily activities?	1	2	3	4	5
How often do you eat all your meals on time?	1	2	3	4	5
How often do you think your life goals are on track?	1	2	3	4	5
How frequently do you consider your life's progress?	1	2	3	4	5

Note:
Factors and items

1) Physiological demands: 1, 4, 6, 7, 11, 15
2) Psychosocial demands: 2, 8, 9, 13, 17, 18
3) Environmental demands: 3, 5, 10, 12, 14, 16

INDIVIDUAL POTENTIALs QUESTIONNAIRE (IPQ)

Instruction: This scale consists of 14 items that evaluate perceived individual potentials required to meet the demands of life both now and in the future. Please rate each item by selecting the appropriate number. There are no right or wrong answers; we are only interested in how you feel about each question.

Biologically given potential				
Do you have any chronic health conditions that you developed as a child?	1	2	3	4
During your early childhood, did you have any challenges because of your health condition?	1	2	3	4
Do you have any health issues right now?	1	2	3	4
Do you have any chronic conditions right now?	1	2	3	4
Do you have any long-standing chronic conditions that have been present for at least six months?	1	2	3	4
Do you have any chronic conditions that are limiting your daily activities?	1	2	3	4
Personally acquired potential				
Do you believe that you can accomplish your life goals regardless of the circumstances?	1	2	3	4
Do you feel that the changes in the past have made your situation unpleasant?	1	2	3	4
When you are in an unfamiliar situation, does it affect your normal activities?	1	2	3	4
How well do you solve your issues when faced with a challenge?	1	2	3	4
Do you believe that your state of happiness may be affected by pain or health issues?	1	2	3	4
How often do you experience regret over your past?	1	2	3	4
How often do you feel bad about your future?	1	2	3	4
How often do you feel in control of the conditions in your life?	1	2	3	4

Note:

Factors and items

1) Biologically given potential: [rating: 1 = none, 2 = mild, 3 = moderate, 4 = severe].
2) Personally acquired potential: [rating: 1 = not at all, 2 = rarely, 3 = often, 4 = very often].

Appendix E Human Research Ethics Committee, Ministry of Health, Jigawa State, Nigeria

MINISTRY OF HEALTH

Block B - Q2/23, Ground & 1st Floors, New Secretariat Complex,
P.M.B. 1003 Dutse, Jigawa State, Nigeria
E-mail:smoh_jigawa@yahoo.com.uk

Our Ref:MOH/SEC/1.S/745/V1/1----- Your Ref:---------------------------------- Date:02h 02/2023

Notice of Full Approval after full Committee Review

Re:Latent Variable Strutural Equation Modelliing in a Cross-Cultural Study on Holistc Good Health among Malaysian and Nigerian University Student."

Health Research Committee assigned number:JGHREC/2023/151

Name: of Principal Investigator: **Abdulwali Sabo Abdulrahman,**
Address: of Principal Investigator (MMC No. if applicable): Abdulwali Sabo Abdulrahman
Co-reseachers: Dr Kueh Yee Cheng (PPSP. USM). AP Dr Garry Kuan Pei Ern (PPSK. USM).

Date of the meeting when the final determination of research was made: 13/02/2023
This is to inform you that the research described in the submitted protocol, the consent forms, advertisements, and other participant information materials have been reviewed and given full approval by the Jigawa State Health Research Ethics Committee. This approval dates from 13/03/2023 to 13/03/2024. If there is a delay in starting the research, please inform the HREC so that the dates of approval can be adjusted accordingly. Note that no participant accrual or activity related to this research may be conducted outside of these dates. All informed consent forms used in this study must carry the HREC assigned number and duration of HREC approval of the study. In multiyear research, endeavor to submit your annual report to the HREC early in order to obtain renewal of your approval and avoid disruption of your study.

The National Code for Health Research Ethics requires you to comply with all institutional guidelines, rules, and regulations and with the tenets of the Code, including ensuring that all adverse events are reported promptly to the HREC. No changes are permitted in the research without prior approval by the HREC except in the circumstances outlined in the Code. The HREC reserves the right to conduct a compliance visit to your research site without previous notification.

Sincerely,

Dr Kabiru Ibrahim
Chairman, JGHREC
For: Honorable Commissioner

Appendix F JEPEM's approval letter

Jawatankuasa Etika
Penyelidikan Manusia USM (JEPeM)

Human Research Ethics Committee USM (HREC)

Universiti Sains Malaysia
Kampus Kesihatan
16150 Kubang Kerian, Kelantan, Malaysia.
Tel. : +609 - 767 3000/2354/2362
Fax. : + 609 - 767 2351
Email : jepem@usm.my
Laman Web : www.jepem.kk.usm.my
www.usm.my

2nd April 2023

Mr. Abdulwali Sabo Abdulrahman
Biostatistics and Research Methodology Unit
School of Medical Sciences
Universiti Sains Malaysia
16150 Kubang Kerian, Kelantan.

JEPeM Code : USM/JEPeM/22110695
Protocol Title : Latent Variable Structural Equation Modelling in Cross-cultural Study on Holistic Good Health among Malaysian and Nigerian University Students.

Dear Mr.,

We wish to inform you that your study protocol has been reviewed and is hereby granted approval for implementation by the Jawatankuasa Etika Penyelidikan Manusia, Universiti Sains Malaysia (JEPeM-USM). Your study has been assigned study protocol code **USM/JEPeM/22110695**, which should be used for all communications to JEPeM-USM in relation to this study. This ethical approval is valid from **2nd April 2023** until **1st April 2024.**

Study Site: Health Campus, Universiti Sains Malaysia and College of Medicine and Allied Medical Sciences, Federal University Dutse (FUD), Nigeria.

The following researchers are also involved in this study:
1. Dr. Kueh Yee Cheng
2. Assoc. Prof. Dr. Garry Kuan Pei Ern
3. Assoc. Prof. Dr. Sarimah Abdullah
4. Dr. Kuay Hue San

The following documents have been approved for use in the study.
1. Research Proposal

In addition to the abovementioned documents, the following technical documents were included in the review on which this approval was based:
1. Participant Information Sheet and Consent Form (English version)
2. Questionnaire (English version)

The list of JEPeM-USM members present during the full board meeting reviewing your protocol is attached.

While the study is in progress, we request you to submit to us the following documents:
1. Application for renewal of ethical approval 60 days before the expiration date of this approval through submission of **JEPeM-USM FORM 3(B) 2019: Continuing Review Application Form.**
2. Any changes in the protocol, especially those that may adversely affect the safety of the participants during the conduct of the trial including changes in personnel, must be submitted or reported using **JEPeM-USM FORM 3(A) 2019: Study Protocol Amendment Submission Form.**
3. Revisions in the informed consent form using the **JEPeM-USM FORM 3(A) 2019: Study Protocol Amendment Submission Form.**
4. Reports of adverse events including from other study sites (national, international) using the **JEPeM-USM FORM 3(G) 2019: Adverse Events Report.**

JAWATANKUASA ETIKA PENYELIDIKAN MANUSIA

5. Notice of early termination of the study and reasons for such using **JEPeM-USM FORM 3(E) 2019.**
6. Any event which may have ethical significance.
7. Any information which is needed by the JEPeM-USM to do ongoing review.
8. Notice of time of completion of the study using **JEPeM-USM FORM 3(C) 2019: Final Report Form.**

Please note that forms may be downloaded from the JEPeM-USM website: **www.jepem.kk.usm.my**

JEPeM-USM is in compliance with the Declaration of Helsinki, International Conference on Harmonization (ICH) Guidelines, Good Clinical Practice (GCP) Standards, Council for International Organizations of Medical Sciences (CIOMS) Guidelines, World Health Organization (WHO) Standards and Operational Guidance for Ethics Review of Health-Related Research and Surveying and Evaluating Ethical Review Practices, EC/IRB Standard Operating Procedures (SOPs), and Local Regulations and Standards in Ethical Review.

Thank you.

"MALAYSIA MADANI"

"BERKHIDMAT UNTUK NEGARA"

Sincerely,

DR. NOOR AMAN A. HAMID
Deputy Chairperson
Jawatankuasa Etika Penyelidikan (Manusia), JEPeM
Universiti Sains Malaysia

Appendix G JEPEM's extension approval letter

UNIVERSITI SAINS MALAYSIA APEX

Jawatankuasa Etika Penyelidikan Manusia USM (JEPeM)

Human Research Ethics Committee USM (HREC)

Universiti Sains Malaysia
Kampus Kesihatan
16150 Kubang Kerian, Kelantan, Malaysia.
Tel. : +609 - 767 3000/2354/2362
Fax. : + 609 - 767 2351
Email : jepem@usm.my
Laman Web : www.jepem.kk.usm.my
www.usm.my

19th May 2024

Mr. Abdulwali Sabo Abdulrahman
Biostatistics and Research Methodology Unit
School of Medical Sciences
Universiti Sains Malaysia
16150 Kubang Kerian, Kelantan.

JEPeM USM Code : USM/JEPeM/22110695
Study Protocol Title : Latent Variable Structural Equation Modelling in Cross-cultural Study on Holistic Good Health among Malaysian and Nigerian University Students.

Dear Mr.,

We wish to inform you that the Jawatankuasa Etika Penyelidikan Manusia, Universiti Sains Malaysia (JEPeM-USM) acknowledged receipt of the Continuing Review Application dated 07th March 2024.

Upon review of JEPeM-USM Form 3(B) 2021: Continuing Review Application Form, the committee **AGREED** for the **EXTENSION OF APPROVAL (commencing from 02nd April 2024 to 01st April 2025)**. The document is included in the protocol file.

Thank you for your continuing compliance with the requirements of the JEPeM-USM.

"MALAYSIA MADANI"

"BERKHIDMAT UNTUK NEGARA"

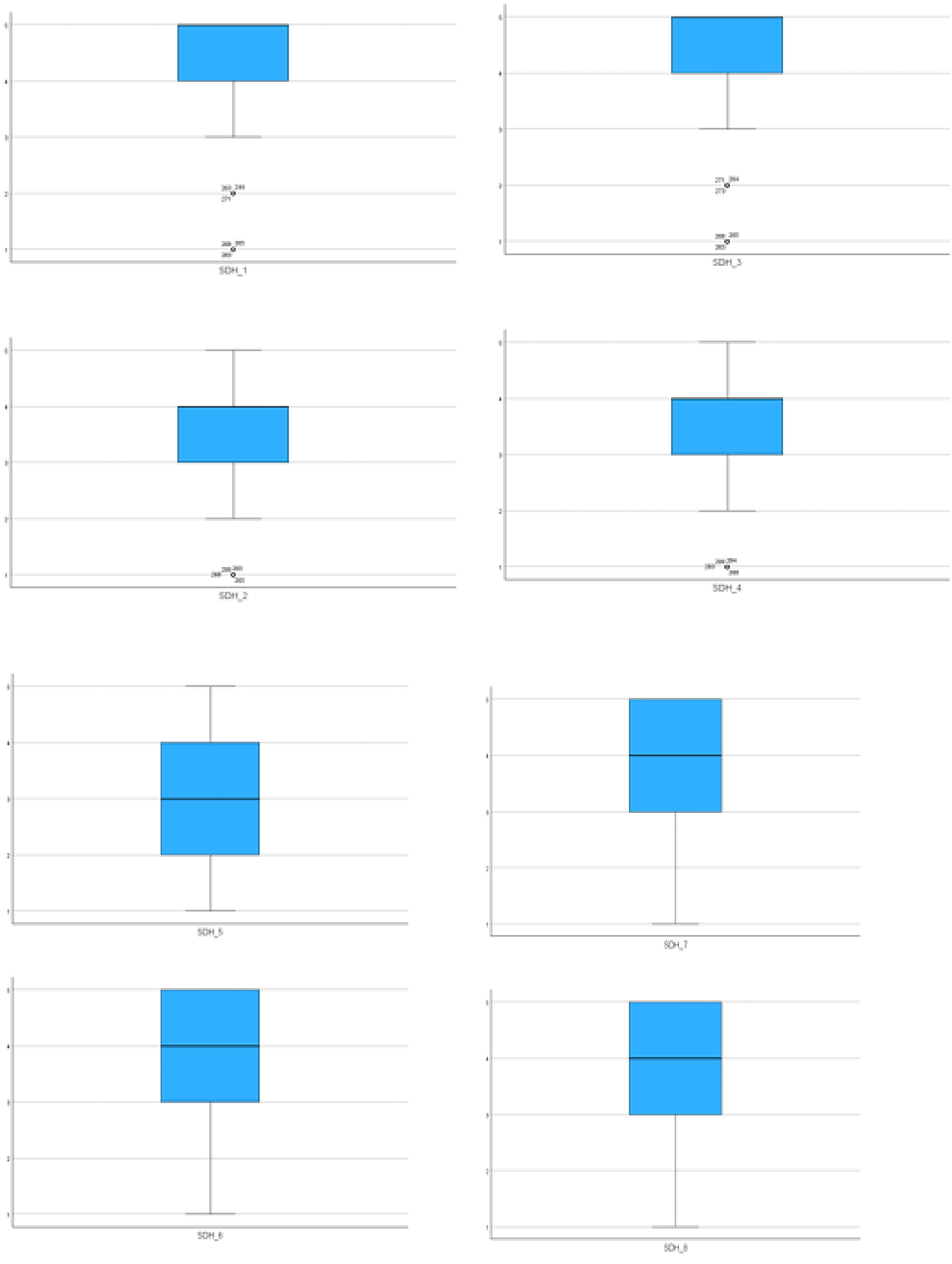
Sincerely,

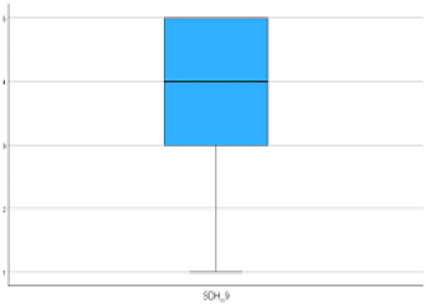
ASSOC. PROF. DR. AZLAN HUSIN
Chairperson
Jawatankuasa Etika Penyelidikan (Manusia), JEPeM
Universiti Sains Malaysia

c.c Secretary
Jawatankuasa Etika Penyelidikan (Manusia), JEPeM
Universiti Sains Malaysia

JEPeM
JAWATANKUASA ETIKA PENYELIDIKAN MANUSIA

Appendix H Boxplot for EFA assumption checking of Nigerian sample

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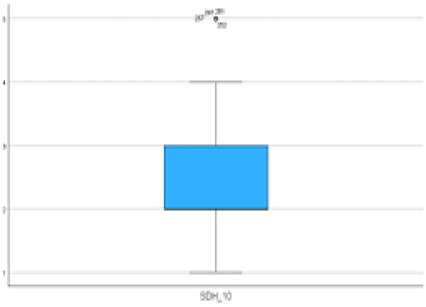
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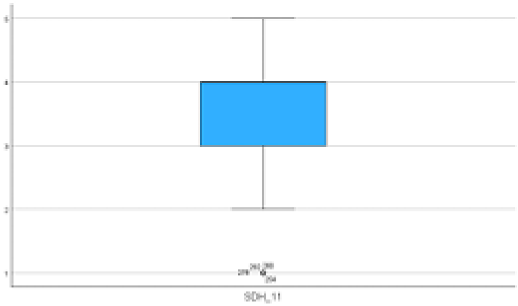
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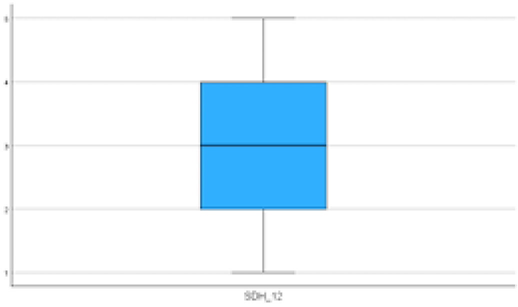
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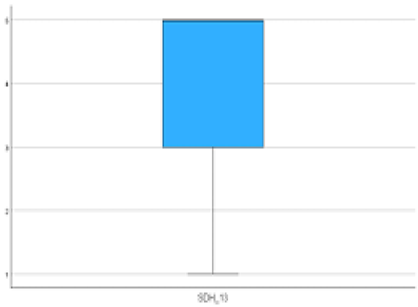
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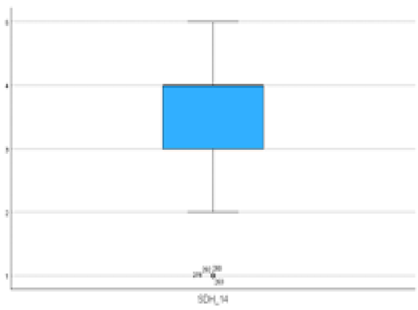
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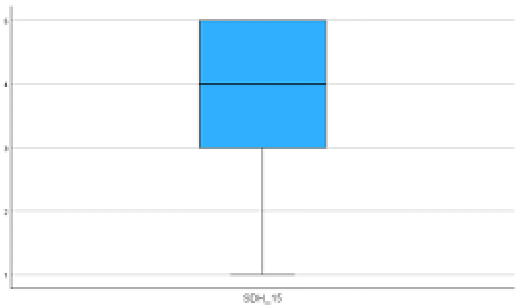
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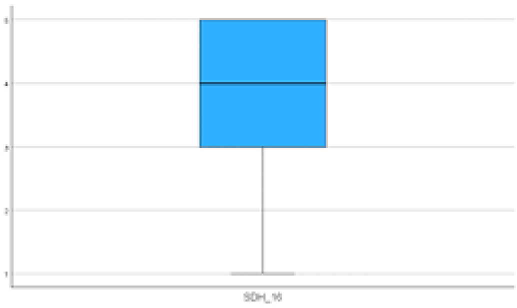
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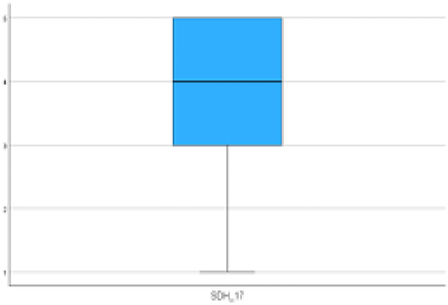
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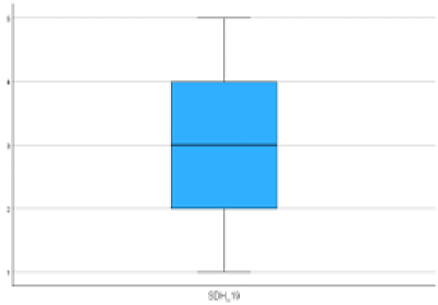
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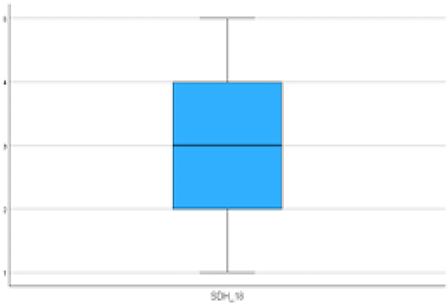
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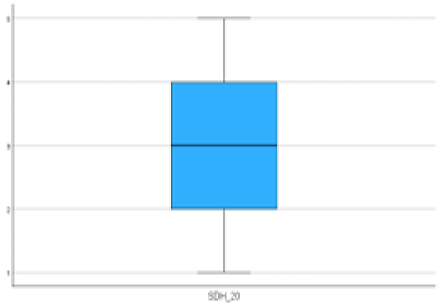
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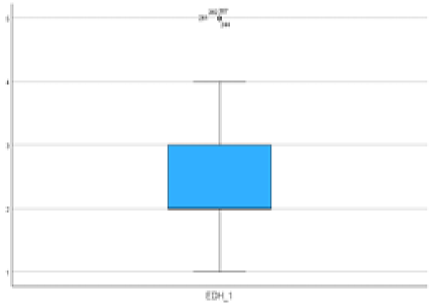
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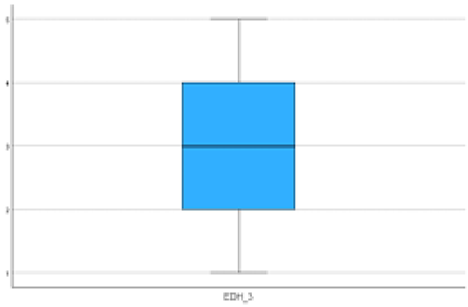
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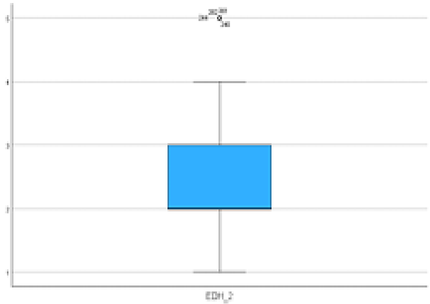
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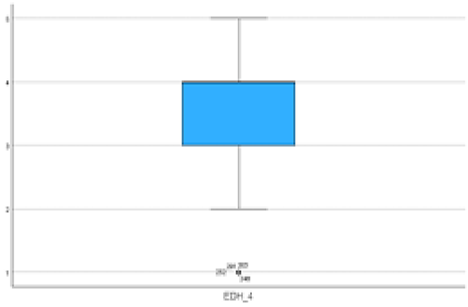
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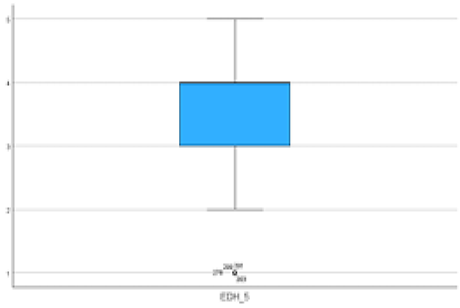
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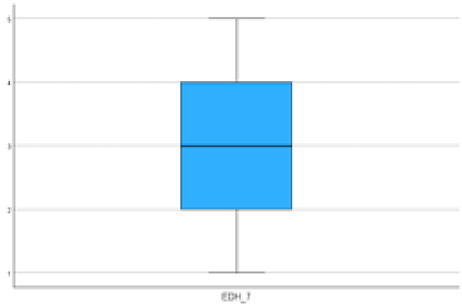
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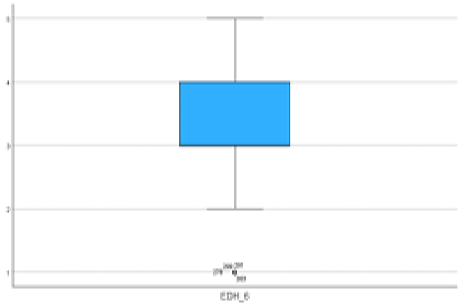
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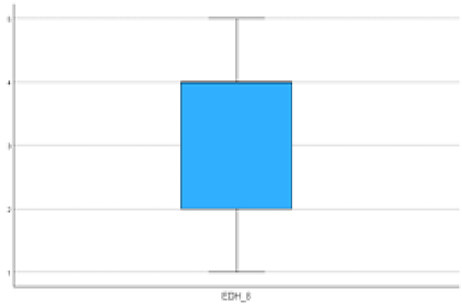
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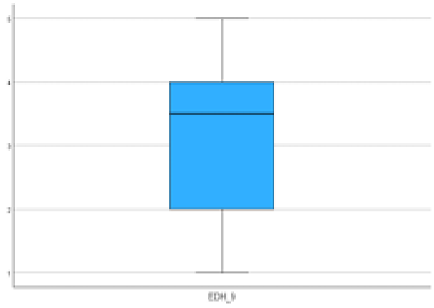
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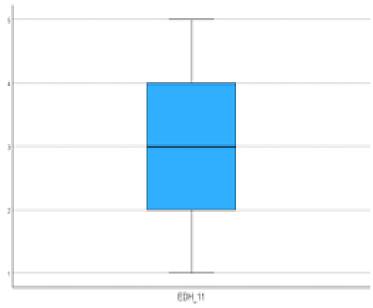
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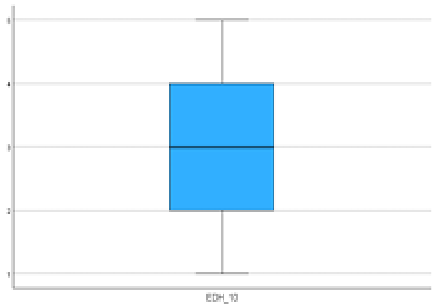
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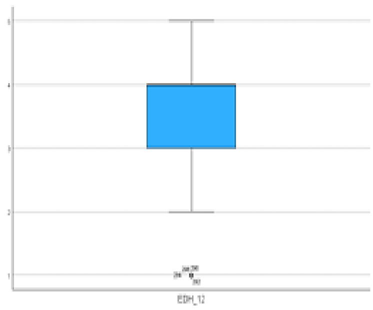
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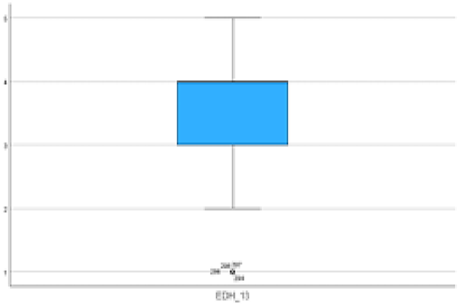
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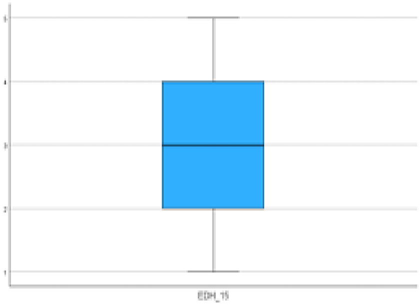
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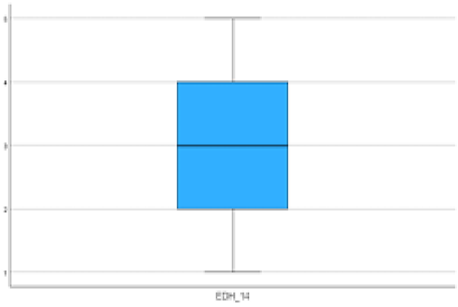
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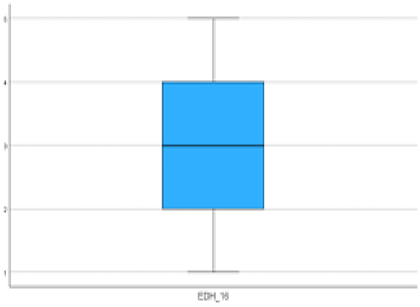
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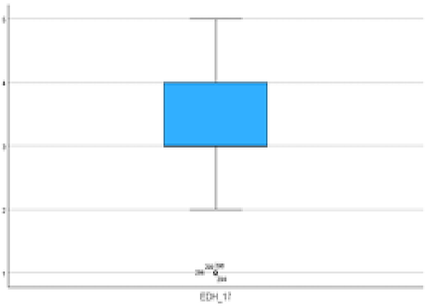
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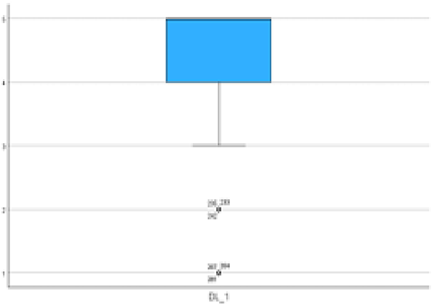
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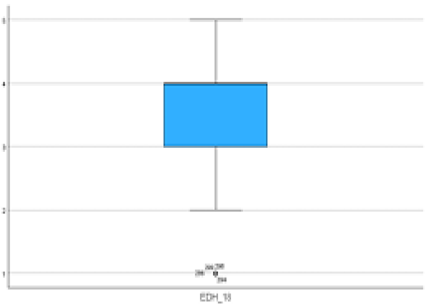
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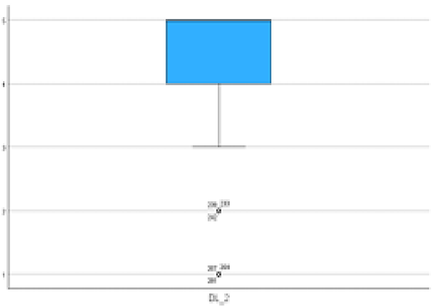
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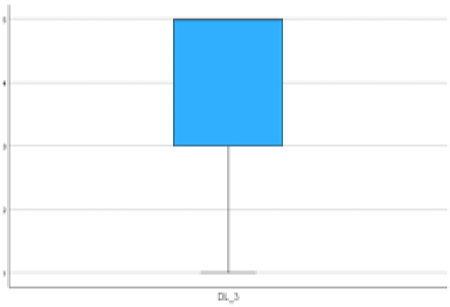
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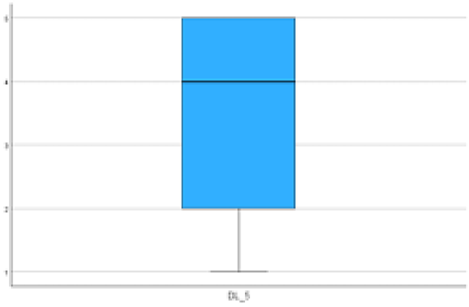
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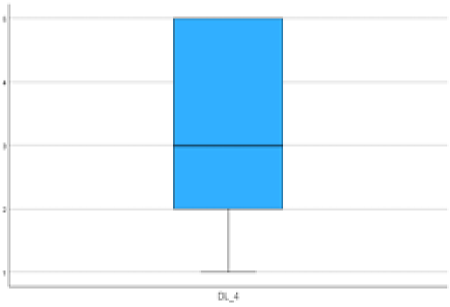
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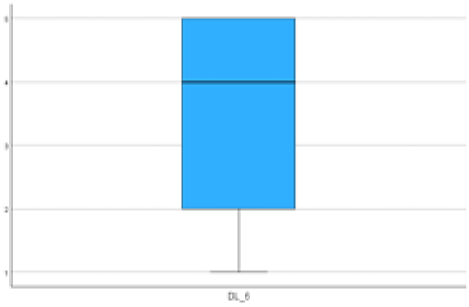
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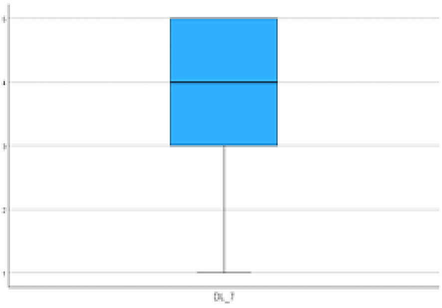
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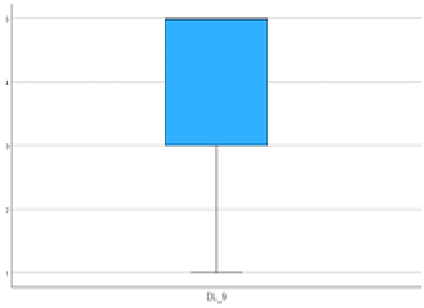
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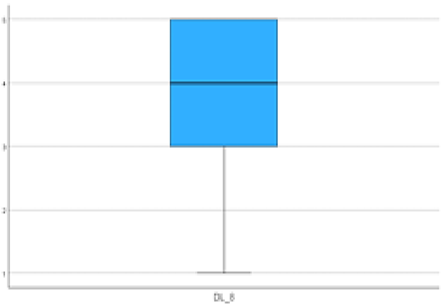
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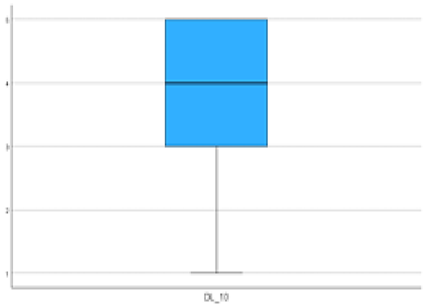
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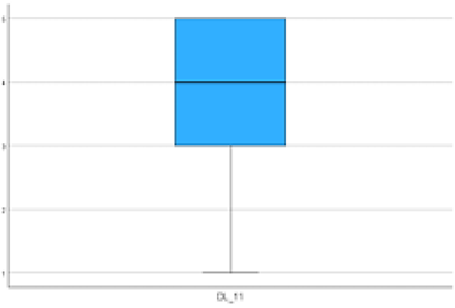
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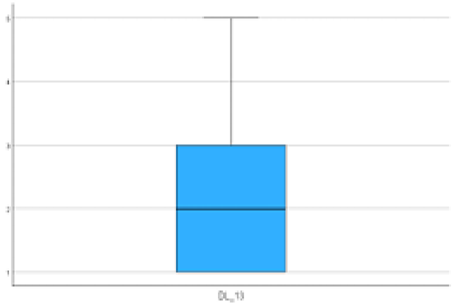
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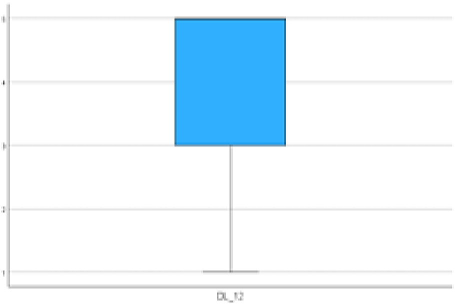
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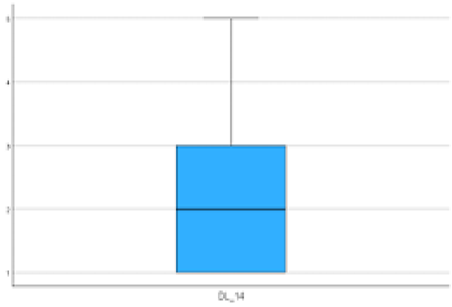
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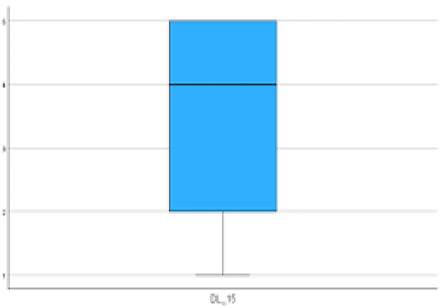
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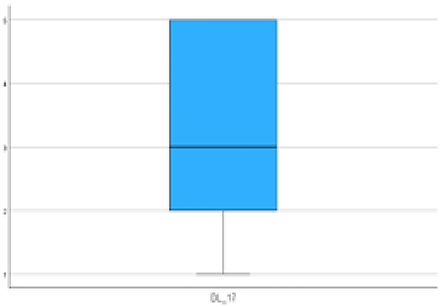
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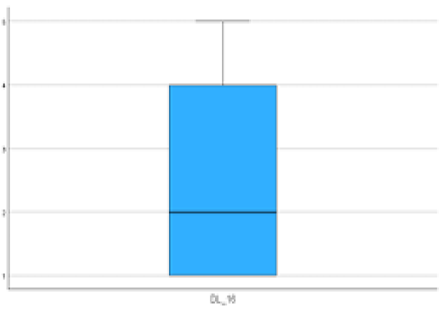
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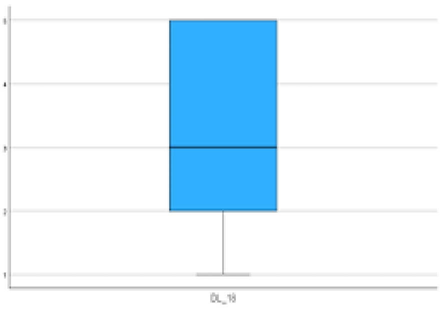
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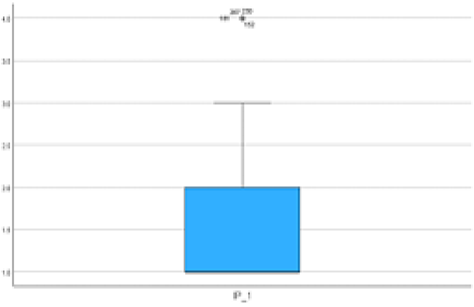
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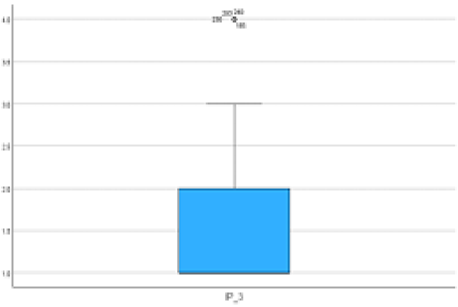
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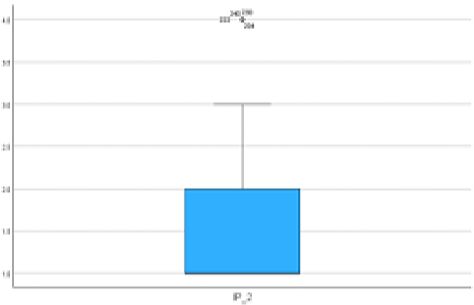
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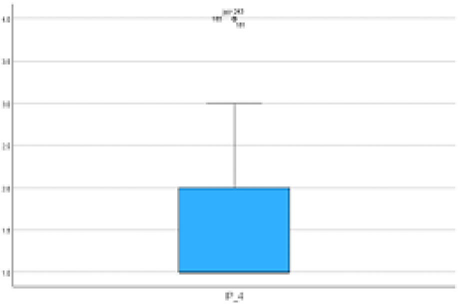
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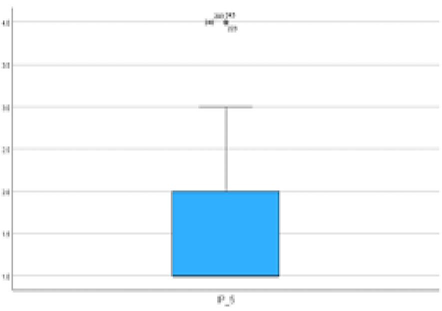
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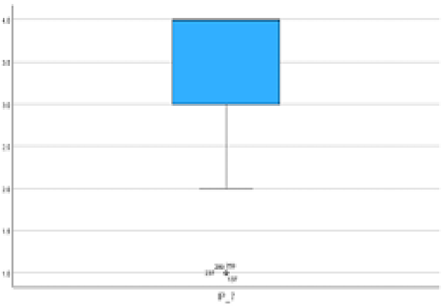
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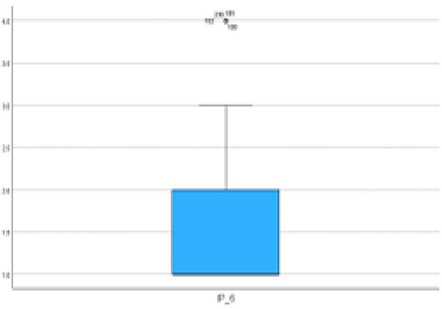
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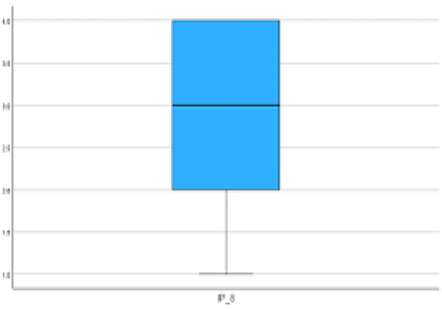
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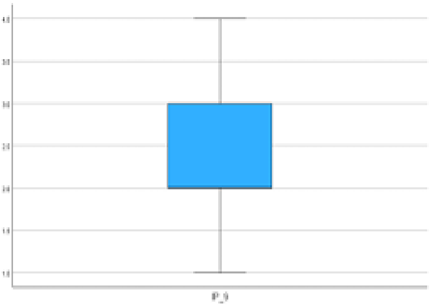
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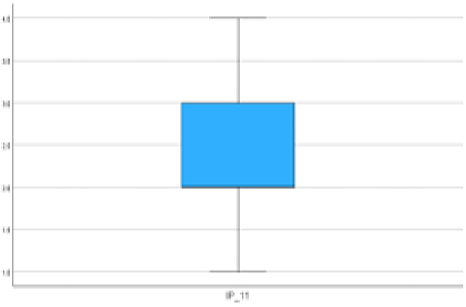
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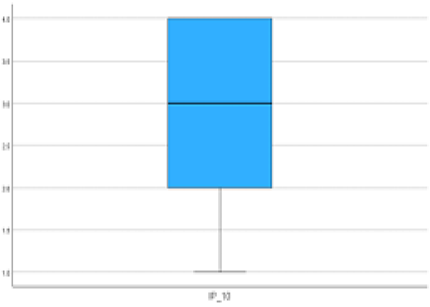
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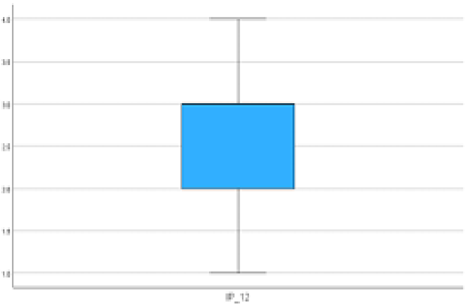
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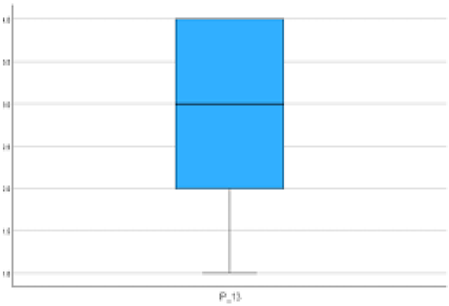
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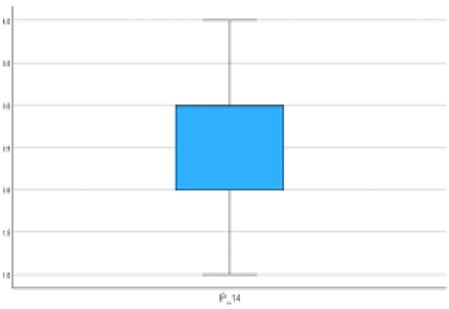
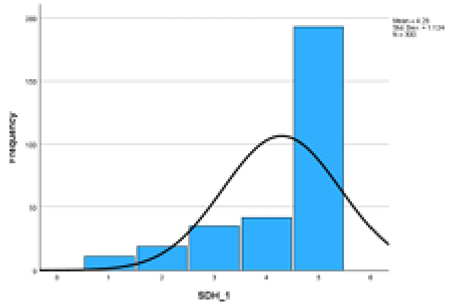
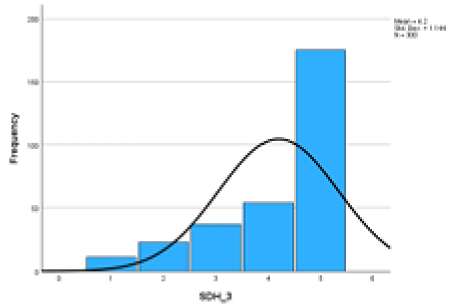
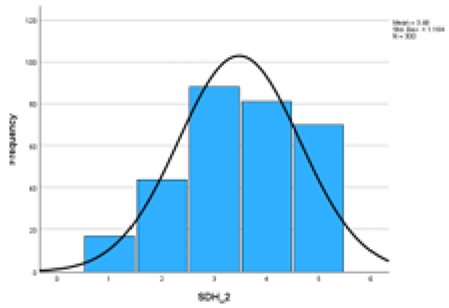
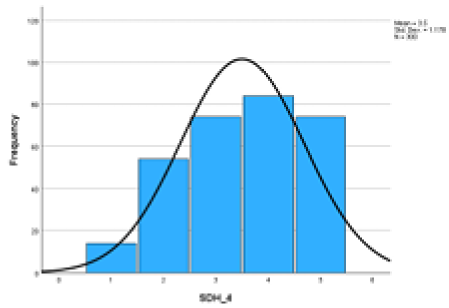

IP_14

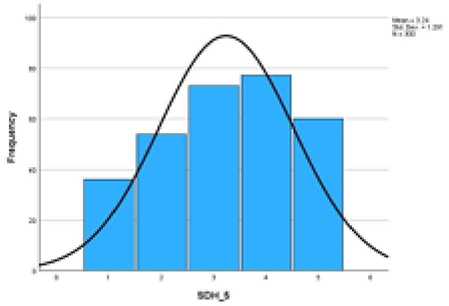
Appendix I Histogram plot for EFA assumption checking of Nigerian sample

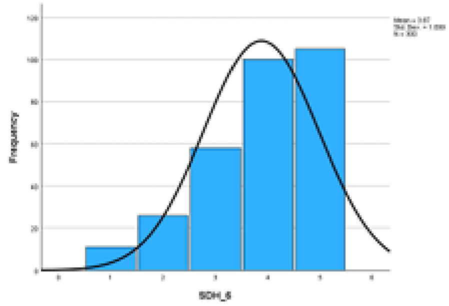


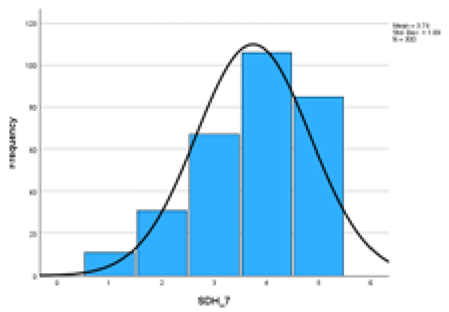


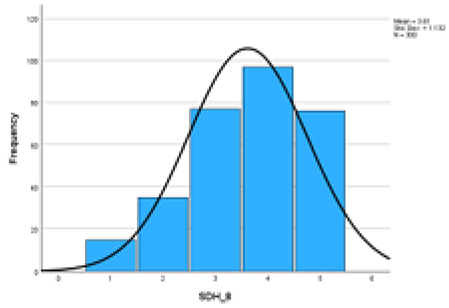


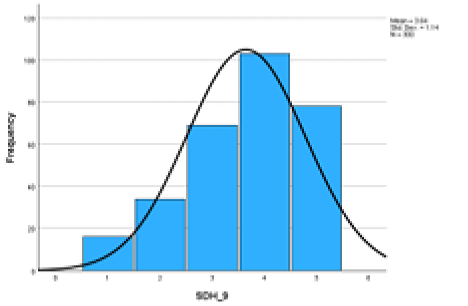








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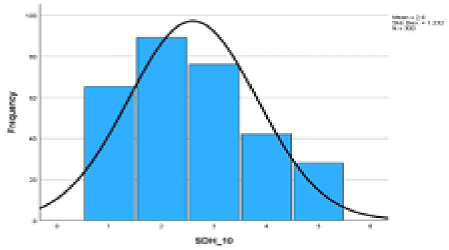
SDH_9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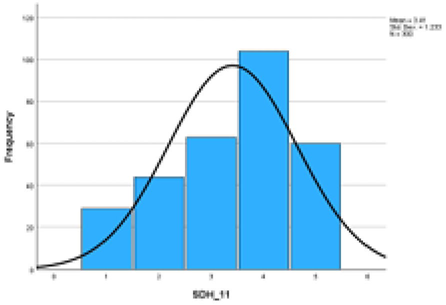
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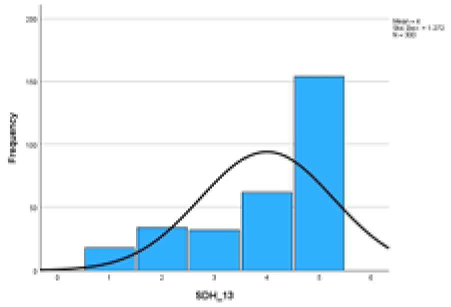
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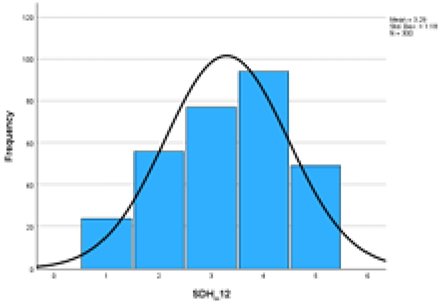
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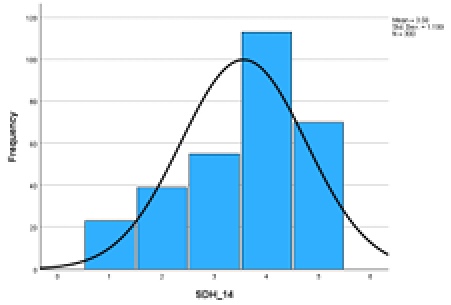
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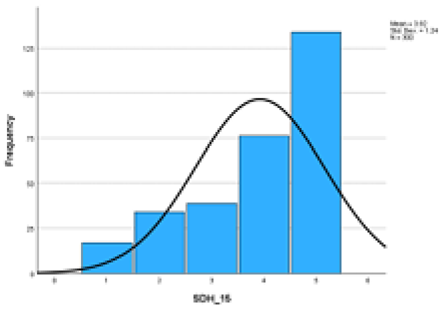
Frequency
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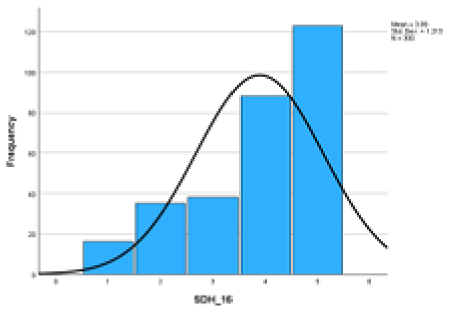
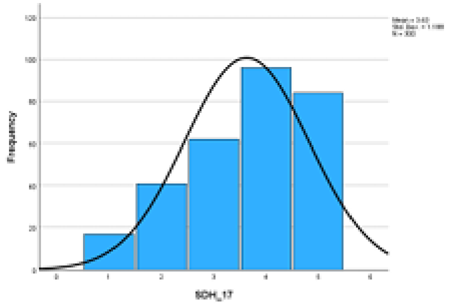
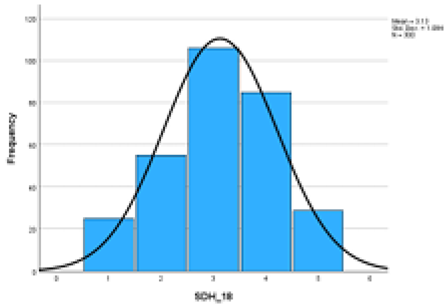
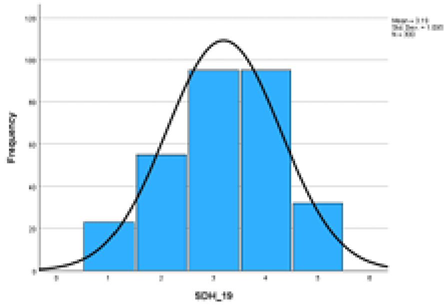
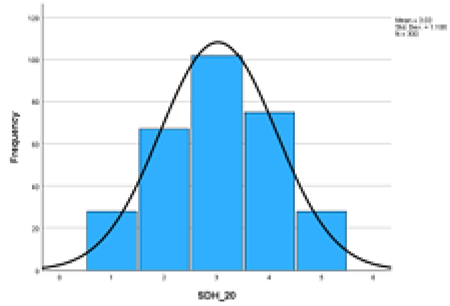
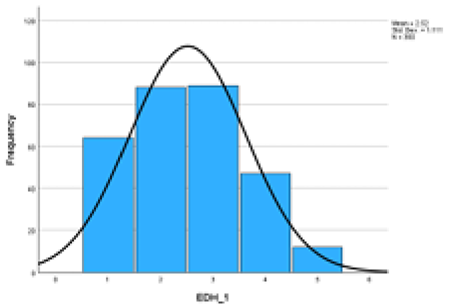

Frequency
SDH_16

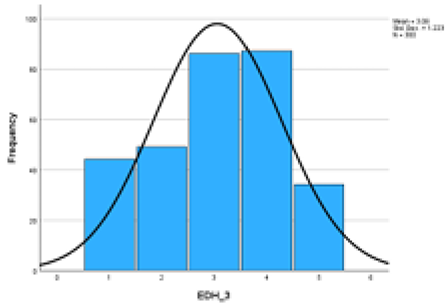

Frequency
SDH_17

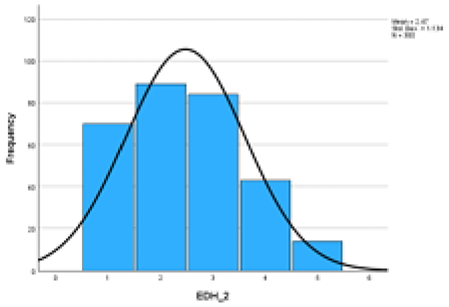

Frequency
SDH_18

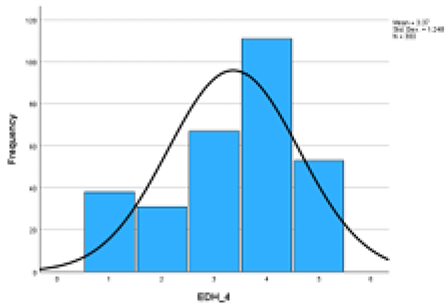

Frequency
SDH_19

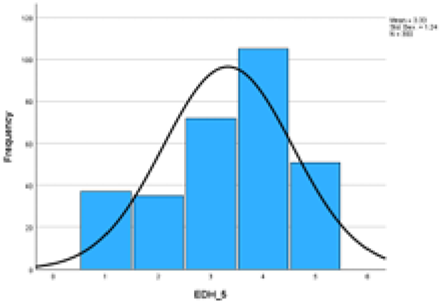

Frequency
SDH_20

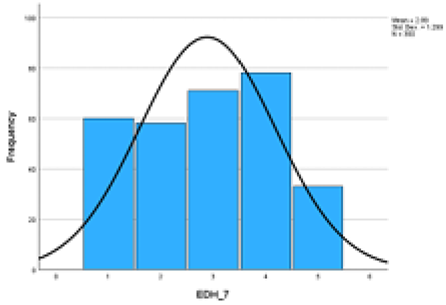

Frequency
EDH_1

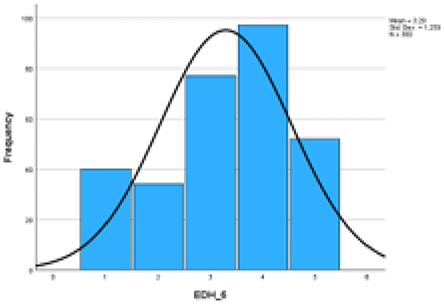

Frequency
EDH_3

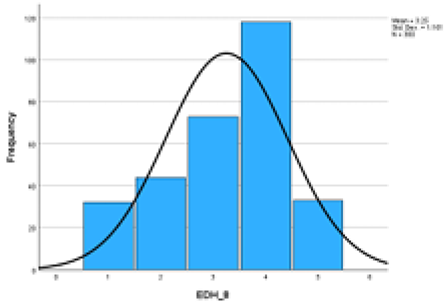

Frequency
EDH_2

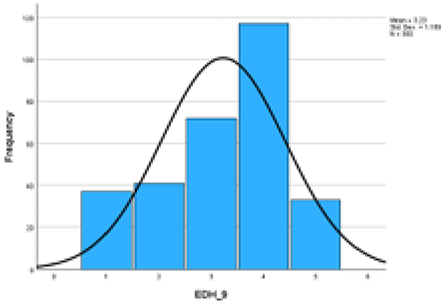

Frequency
EDH_4

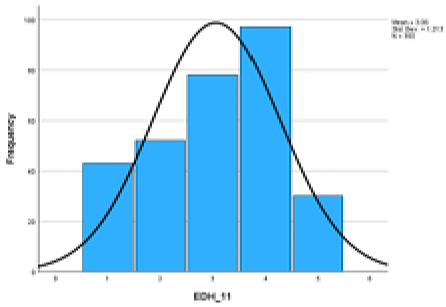

Frequency
EDH_5

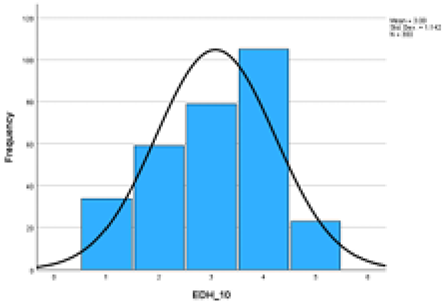

Frequency
EDH_7

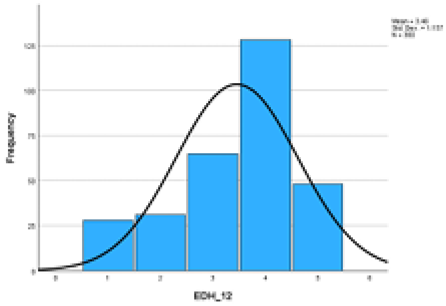

Frequency
EDH_6

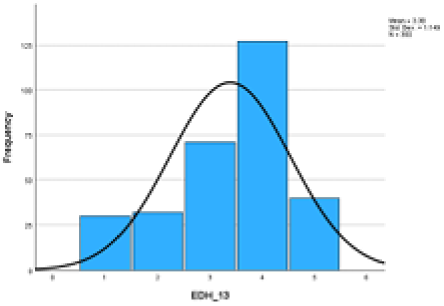

Frequency
EDH_8

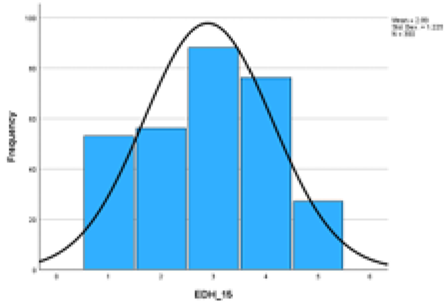

Frequency
EDH_9

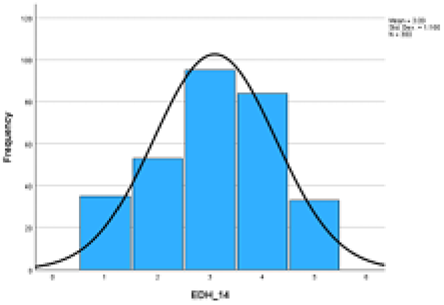

Frequency
EDH_11

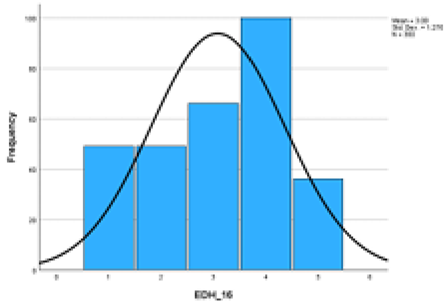

Frequency
EDH_10

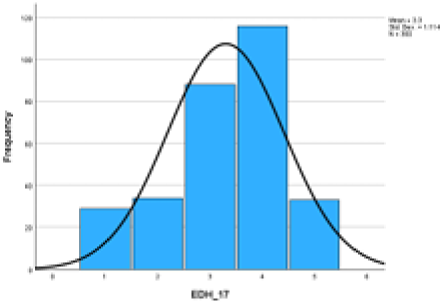

Frequency
EDH_12

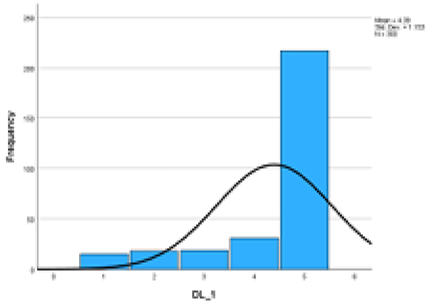

Frequency
EDH_13

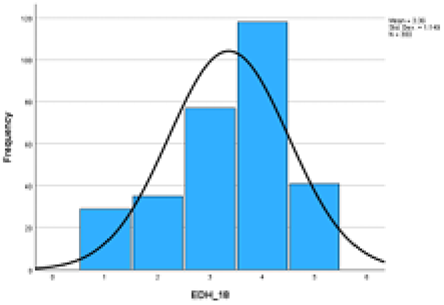

Frequency
EDH_15

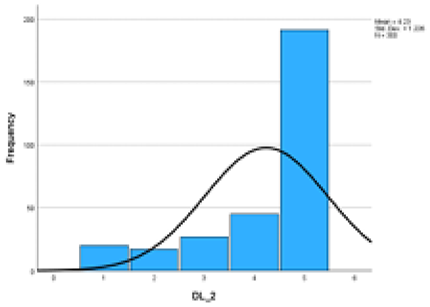

Frequency
EDH_14

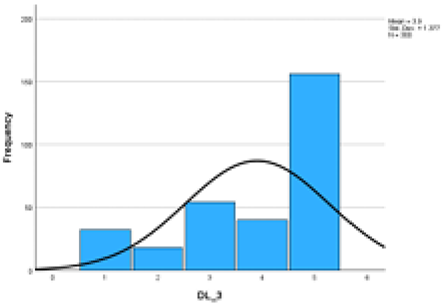

Frequency
EDH_16

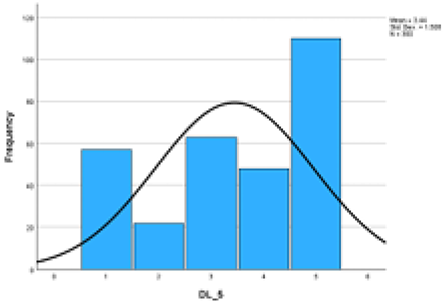

Frequency
EDH_17

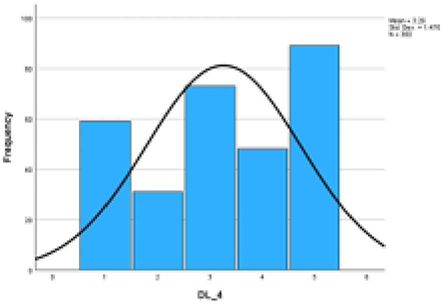

Frequency
DL_1

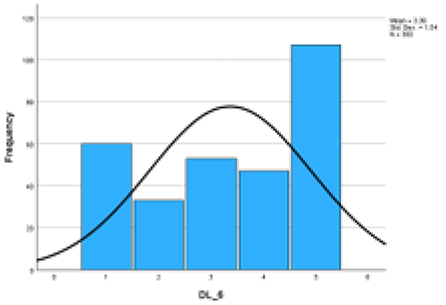

Frequency
EDH_18

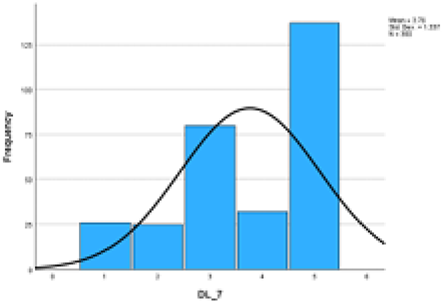

Frequency
DL_2

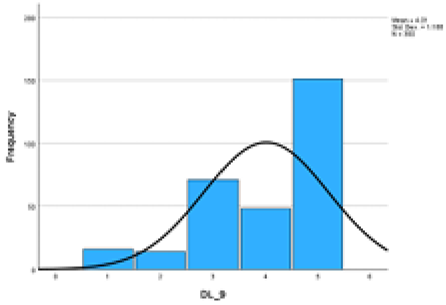

Frequency
DL_3

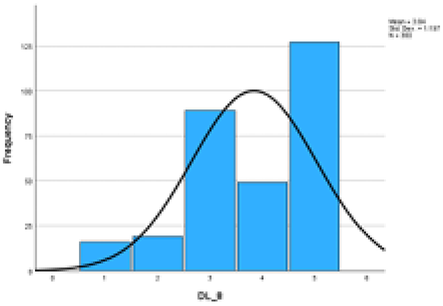

Frequency
DL_5

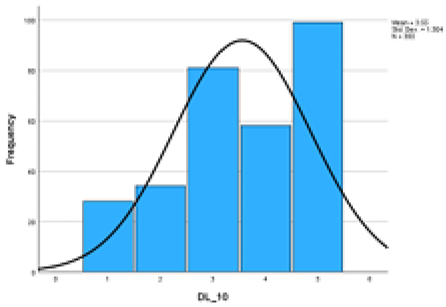

Frequency
DL_4

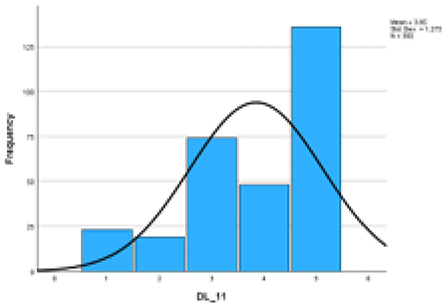

Frequency
DL_6

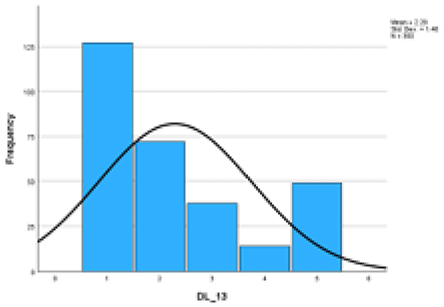

Frequency
DL_7

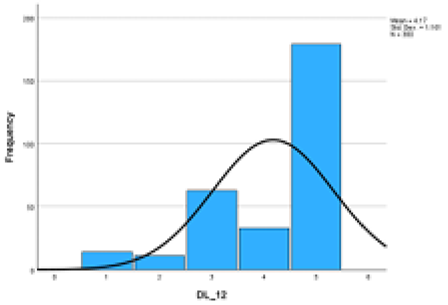

Frequency
DL_9

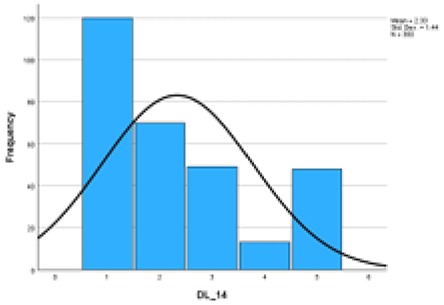

Frequency
DL_8

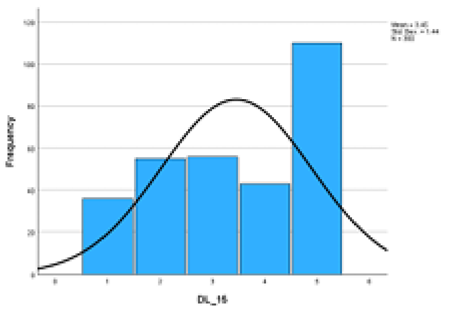

Frequency
DL_10

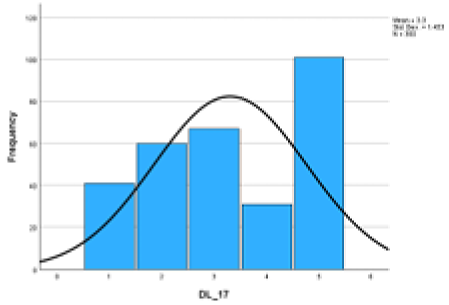

Frequency
DL_11

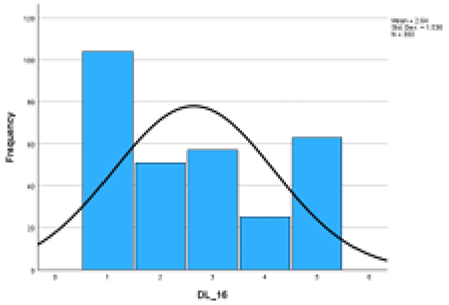

Frequency
DL_13

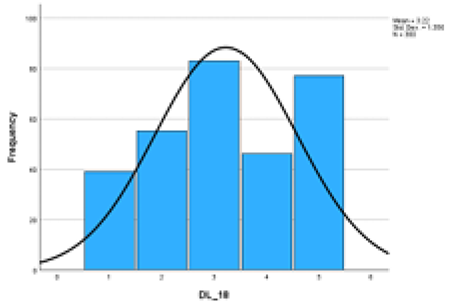

Frequency
DL_12

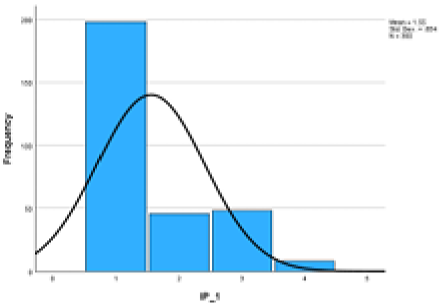

Frequency
DL_14

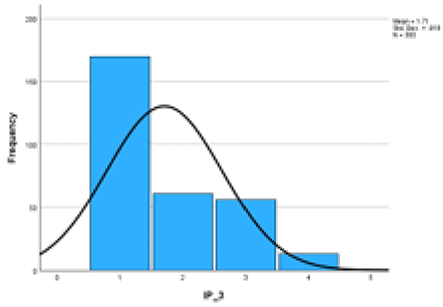

Frequency
DL_15

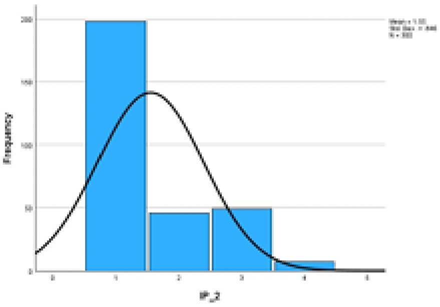

Frequency
DL_17

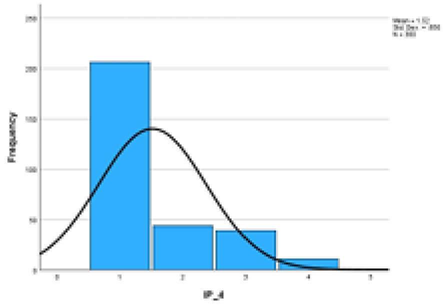

Frequency
DL_16

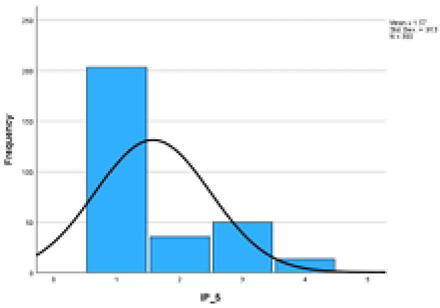

Frequency
DL_18

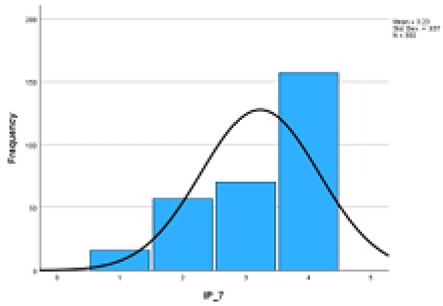

Frequency
IP_1

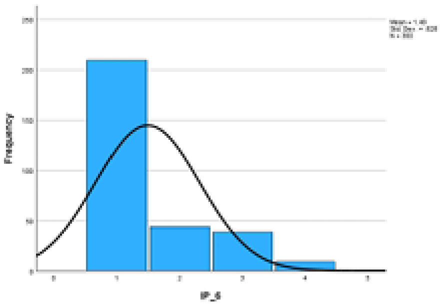

Frequency
IP_3

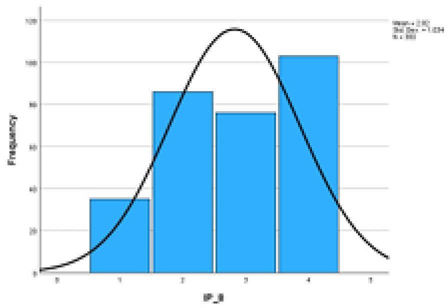

Frequency
IP_2

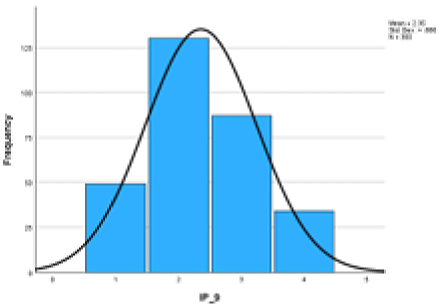

Frequency
IP_4

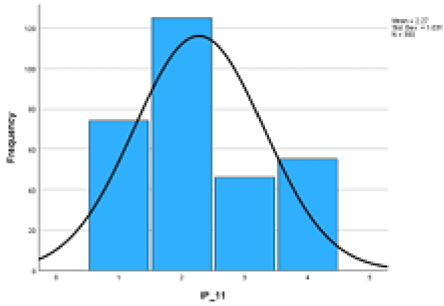

Frequency
IP_5

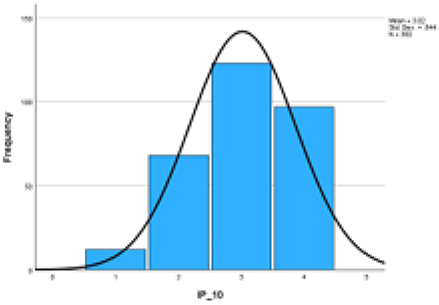

Frequency
IP_7

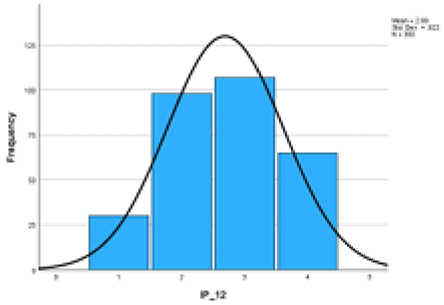

Frequency
IP_6

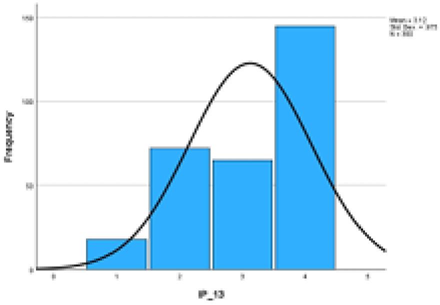

Frequency
IP_8

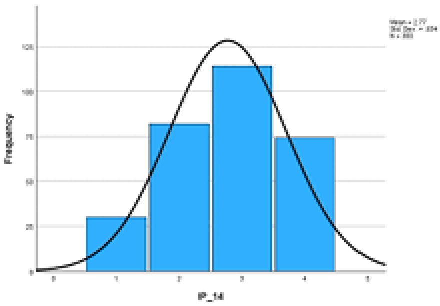

Frequency
IP_9


Frequency
IP_11


Frequency
IP_10


Frequency
IP_12


Frequency
IP_13


Frequency
IP_14

Appendix J Univariate normality of skewness and kurtosis tests, Nigerian sample

SDHQ Model

UNIVARIATE SKEW AND KURTOSIS TESTS OF FIT

Variable	Sample Value	Mean	Standard Deviation	P-Value
TWO-SIDED UNIVARIATE SKEW TESTS OF FIT				
SDH1	-1.835	0.012	0.121	0.0000
SDH2	-0.178	-0.003	0.118	0.1200
SDH3	-1.441	-0.008	0.115	0.0000
SDH4	-0.292	-0.001	0.112	0.0000
SDH5	-0.148	0.003	0.113	0.1800
SDH6	-0.450	0.009	0.115	0.0000
SDH7	-0.978	-0.001	0.123	0.0000
SDH8	-0.396	0.001	0.113	0.0000
SDH9	-0.686	0.004	0.111	0.0000
SDH10	-0.018	0.000	0.115	0.8700
SDH11	-0.503	-0.006	0.105	0.0000
SDH12	-0.515	0.012	0.114	0.0000
SDH13	-1.297	0.013	0.117	0.0000
SDH14	-0.886	-0.006	0.118	0.0000
SDH15	-0.649	0.007	0.124	0.0000
SDH16	-0.210	-0.006	0.111	0.1000
SDH17	0.002	-0.005	0.112	0.9000
SDH18	-0.435	-0.007	0.105	0.0000
SDH19	-0.848	0.018	0.125	0.0000
SDH20	-0.750	0.005	0.121	0.0000

TWO-SIDED UNIVARIATE KURTOSIS TESTS OF FIT

SDH1	2.433	-0.029	0.230	0.0000
SDH2	-0.645	-0.044	0.209	0.0000
SDH3	2.172	-0.047	0.214	0.0000
SDH4	-0.817	-0.008	0.244	0.0000
SDH5	-0.423	-0.022	0.229	0.0100
SDH6	-0.202	-0.038	0.201	0.3900
SDH7	0.751	-0.032	0.229	0.0000
SDH8	-0.533	-0.029	0.225	0.0000
SDH9	0.105	-0.034	0.230	0.5400
SDH10	-0.395	-0.049	0.232	0.1000
SDH11	0.263	-0.027	0.251	0.2900
SDH12	-0.390	-0.024	0.210	0.0500
SDH13	1.209	-0.023	0.207	0.0000
SDH14	0.722	-0.005	0.243	0.0100
SDH15	-0.014	-0.016	0.239	0.8700
SDH16	-0.516	-0.009	0.246	0.0100
SDH17	-0.654	-0.024	0.223	0.0000
SDH18	0.277	-0.054	0.210	0.1100
SDH19	1.203	0.008	0.237	0.0100
SDH20	0.761	-0.017	0.210	0.0000

EDHQ Model

UNIVARIATE SKEW AND KURTOSIS TESTS OF FIT

Variable	Sample Value	Mean	Standard Deviation	P-Value
TWO-SIDED UNIVARIATE SKEW TESTS OF FIT				
EDH1	-0.006	0.003	0.122	0.8800
EDH2	0.025	0.010	0.115	0.9100
EDH3	-0.476	0.012	0.116	0.0000
EDH4	-0.737	0.014	0.122	0.0000
EDH5	-0.611	0.006	0.107	0.0000
EDH6	-0.685	0.013	0.108	0.0000
EDH7	-0.036	0.011	0.115	0.7600
EDH8	-0.496	0.010	0.113	0.0000
EDH9	-0.729	-0.006	0.115	0.0000
EDH10	-0.674	0.013	0.114	0.0000
EDH11	-0.603	0.010	0.116	0.0000
EDH12	-0.982	0.005	0.118	0.0000
EDH13	-1.017	-0.001	0.116	0.0000
EDH14	-0.804	0.005	0.121	0.0000
EDH15	-0.431	0.017	0.111	0.0000
EDH16	-0.658	0.018	0.103	0.0000
EDH17	-0.979	0.010	0.111	0.0000
EDH18	-1.010	-0.007	0.113	0.0000
TWO-SIDED UNIVARIATE KURTOSIS TESTS OF FIT				
EDH1	-0.567	-0.014	0.255	0.0100
EDH2	-0.739	-0.019	0.277	0.0000
EDH3	-0.522	-0.054	0.210	0.0100
EDH4	-0.100	-0.049	0.216	0.9400
EDH5	-0.200	-0.039	0.233	0.4700
EDH6	0.209	-0.016	0.244	0.3500
EDH7	-0.674	-0.028	0.248	0.0000
EDH8	-0.141	-0.027	0.228	0.6900
EDH9	0.134	-0.055	0.211	0.3700
EDH10	-0.250	-0.015	0.243	0.3400
EDH11	-0.366	-0.044	0.228	0.1400
EDH12	1.055	-0.019	0.231	0.0000
EDH13	0.883	-0.032	0.213	0.0000
EDH14	0.191	-0.009	0.242	0.3600
EDH15	-0.514	-0.042	0.238	0.0000
EDH16	-0.388	-0.046	0.224	0.0700
EDH17	0.938	-0.021	0.218	0.0000
EDH18	1.094	-0.028	0.209	0.0000

DLQ Model

UNIVARIATE SKEW AND KURTOSIS TESTS OF FIT

Variable	Sample Value	Mean	Standard Deviation	P-Value
TWO-SIDED UNIVARIATE SKEW TESTS OF FIT				
DL1	1.122	0.001	0.124	0.0000
DL2	0.720	0.021	0.117	0.0000
DL3	0.785	0.008	0.122	0.0000
DL4	0.149	-0.007	0.119	0.1700
DL5	0.360	0.004	0.104	0.0000
DL6	0.198	-0.009	0.121	0.1000
DL7	-0.163	-0.022	0.121	0.2000
DL8	-0.289	0.000	0.107	0.0200
DL9	-0.356	0.006	0.118	0.0100
DL10	0.034	0.007	0.107	0.9000
DL11	-0.203	-0.004	0.114	0.0600
DL12	-0.516	-0.007	0.121	0.0000
DL13	-0.527	0.000	0.113	0.0000
DL14	-0.434	0.010	0.114	0.0000
DL15	0.881	0.013	0.115	0.0000
DL16	-0.110	-0.005	0.114	0.3400
DL17	-0.026	0.010	0.112	0.7900
DL18	0.066	0.003	0.113	0.5800

TWO-SIDED UNIVARIATE KURTOSIS TESTS OF FIT

DL1	-0.312	-0.008	0.243	0.1400
DL2	-0.951	-0.024	0.242	0.0000
DL3	-0.886	-0.023	0.228	0.0000
DL4	-1.303	-0.022	0.239	0.0000
DL5	-1.285	-0.041	0.229	0.0000
DL6	-1.329	-0.012	0.250	0.0000
DL7	-1.321	-0.021	0.243	0.0000
DL8	-1.233	-0.049	0.237	0.0000
DL9	-1.213	-0.025	0.243	0.0000
DL10	-1.195	-0.027	0.235	0.0000
DL11	-1.341	-0.022	0.242	0.0000
DL12	-1.034	0.006	0.260	0.0000
DL13	-1.073	-0.054	0.261	0.0000
DL14	-1.205	-0.037	0.238	0.0000
DL15	-0.679	-0.062	0.210	0.0000
DL16	-1.477	-0.041	0.227	0.0000
DL17	-1.227	-0.014	0.248	0.0000
DL18	-1.173	-0.029	0.229	0.0000

IPQ Model

UNIVARIATE SKEW AND KURTOSIS TESTS OF FIT

Variable	Sample Value	Mean	Standard Deviation	P-Value
TWO-SIDED UNIVARIATE SKEW TESTS OF FIT				
IP1	0.302	0.003	0.123	0.0200
IP2	0.253	0.012	0.115	0.0300
IP3	0.232	-0.013	0.120	0.0100
IP4	0.274	-0.002	0.121	0.0100
IP5	0.279	-0.005	0.116	0.0300
IP6	0.179	0.008	0.125	0.2000
IP7	-0.278	0.016	0.112	0.0000
IP8	-0.169	0.027	0.109	0.0600
IP9	-0.021	0.012	0.111	0.7700
IP10	-0.015	0.021	0.120	0.8200
IP11	0.237	0.021	0.114	0.0500
IP12	-0.218	0.014	0.124	0.0900
IP13	-0.357	0.005	0.118	0.0100
IP14	-0.104	0.003	0.108	0.2700

TWO-SIDED UNIVARIATE KURTOSIS TESTS OF FIT

IP1	-1.656	-0.034	0.223	0.0000
IP2	-1.700	-0.045	0.238	0.0000
IP3	-1.620	-0.027	0.244	0.0000
IP4	-1.705	-0.020	0.241	0.0000
IP5	-1.646	-0.045	0.238	0.0000
IP6	-1.724	-0.023	0.227	0.0000
IP7	-1.002	-0.045	0.233	0.0000
IP8	-0.882	-0.029	0.239	0.0000
IP9	-0.663	-0.048	0.226	0.0000
IP10	-0.662	-0.026	0.232	0.0000
IP11	-1.048	-0.039	0.215	0.0000
IP12	-0.751	-0.029	0.232	0.0000
IP13	-0.929	-0.048	0.220	0.0000
IP14	-0.684	-0.022	0.225	0.0000

Appendix K **Multivariate normality using Mardia's multivariate normality tests, Nigerian sample**

SDHQ Model

```
TECHNICAL 13 OUTPUT


     SKEW AND KURTOSIS TESTS OF MODEL FIT

     TWO-SIDED MULTIVARIATE SKEW TEST OF FIT

          Sample Value                                        131.498
          Mean                                                 21.425
          Standard Deviation                                    0.826
          P-Value                                              0.0000

     TWO-SIDED MULTIVARIATE KURTOSIS TEST OF FIT

          Sample Value                                        664.493
          Mean                                                438.336
          Standard Deviation                                    2.720
          P-Value                                              0.0000
```

EDHQ Model

```
TECHNICAL 13 OUTPUT


     SKEW AND KURTOSIS TESTS OF MODEL FIT

     TWO-SIDED MULTIVARIATE SKEW TEST OF FIT

          Sample Value                                    57.632
          Mean                                            15.809
          Standard Deviation                               0.733
          P-Value                                         0.0000

     TWO-SIDED MULTIVARIATE KURTOSIS TEST OF FIT

          Sample Value                                   520.082
          Mean                                           358.643
          Standard Deviation                               2.625
          P-Value                                         0.0000
```

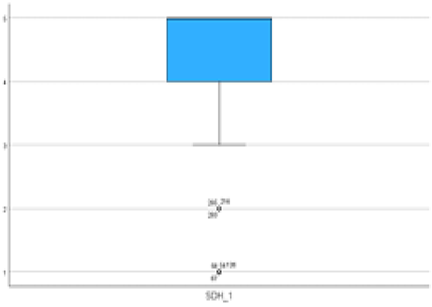
DLQ Model

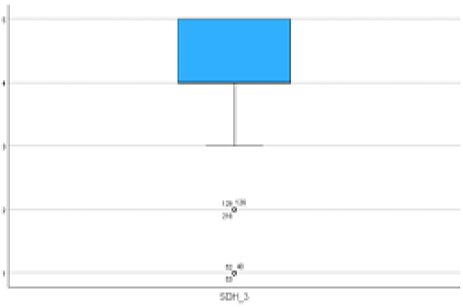
```
TECHNICAL 13 OUTPUT


     SKEW AND KURTOSIS TESTS OF MODEL FIT

     TWO-SIDED MULTIVARIATE SKEW TEST OF FIT

          Sample Value                                    29.834
          Mean                                            15.770
          Standard Deviation                               0.748
          P-Value                                         0.0000

     TWO-SIDED MULTIVARIATE KURTOSIS TEST OF FIT

          Sample Value                                   393.701
          Mean                                           358.457
          Standard Deviation                               2.502
          P-Value                                         0.0000
```

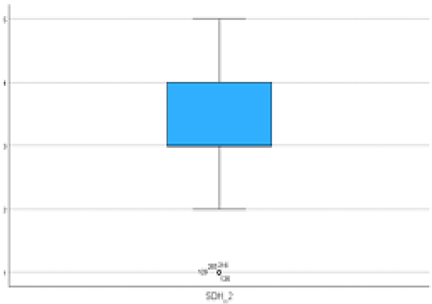
IPQ Model

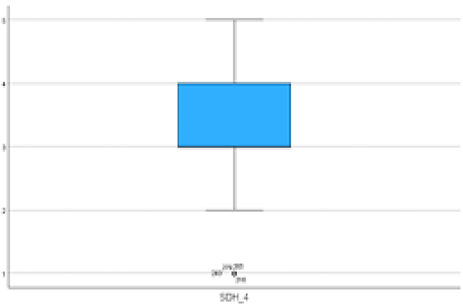
```
TECHNICAL 13 OUTPUT


     SKEW AND KURTOSIS TESTS OF MODEL FIT

     TWO-SIDED MULTIVARIATE SKEW TEST OF FIT

          Sample Value                                              27.928
          Mean                                                       7.779
          Standard Deviation                                         0.530
          P-Value                                                   0.0000

     TWO-SIDED MULTIVARIATE KURTOSIS TEST OF FIT

          Sample Value                                             292.481
          Mean                                                     223.039
          Standard Deviation                                         1.869
          P-Value                                                   0.0000
```

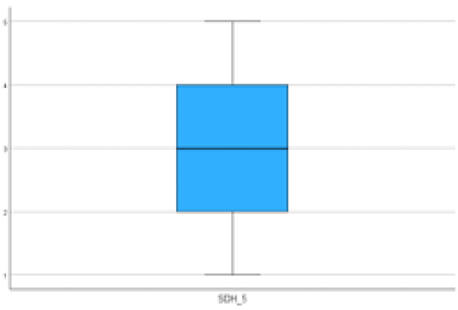
Appendix L Boxplot for EFA assumption checking of Malaysian sample

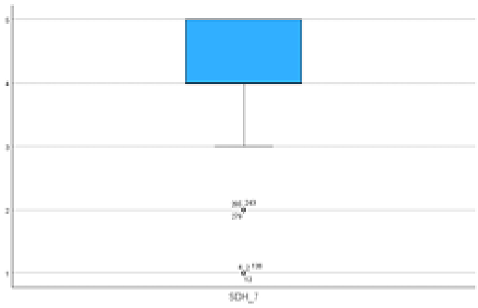


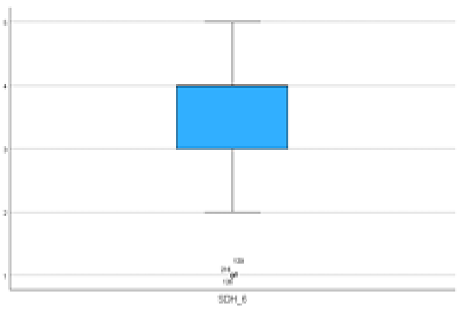


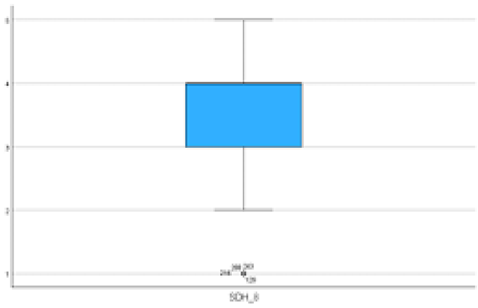


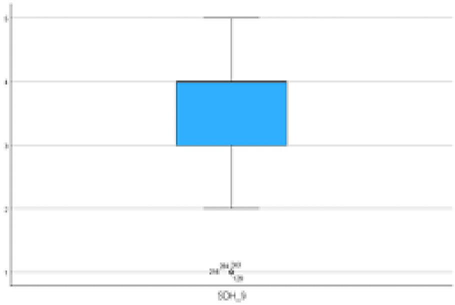


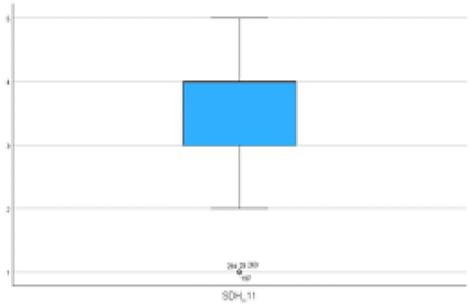


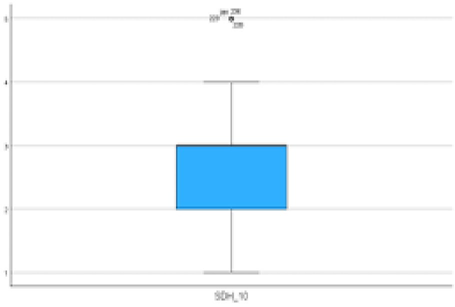


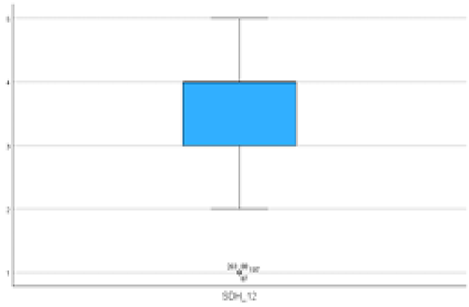


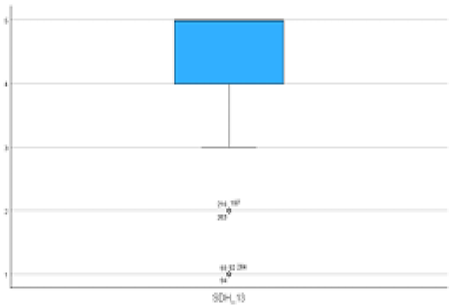


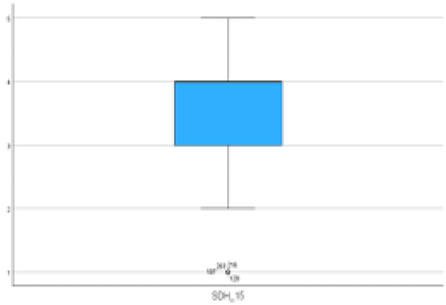

SDH_9


SDH_11


SDH_10


SDH_12


SDH_13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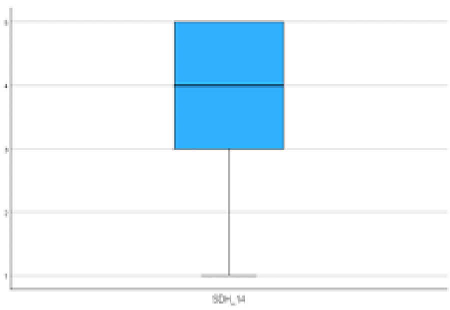
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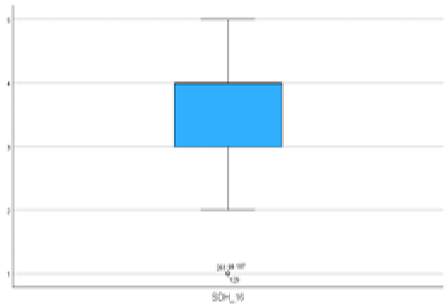
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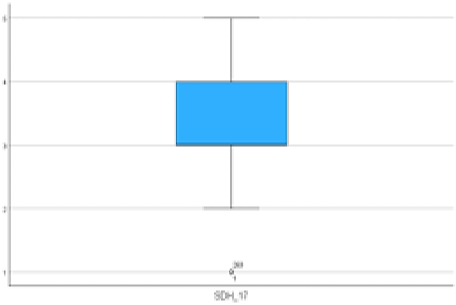
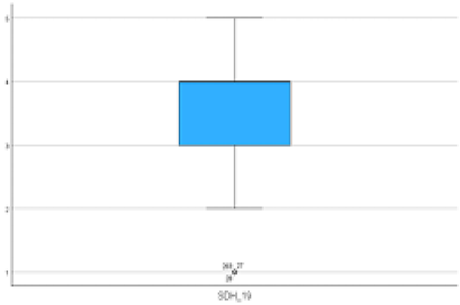

SDH_17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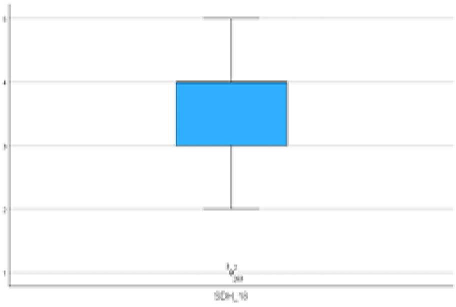
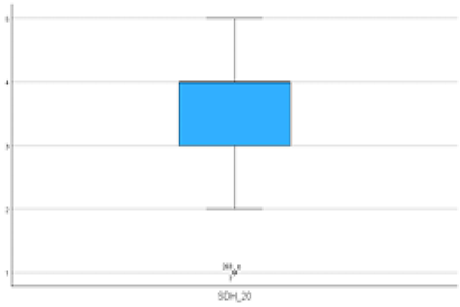
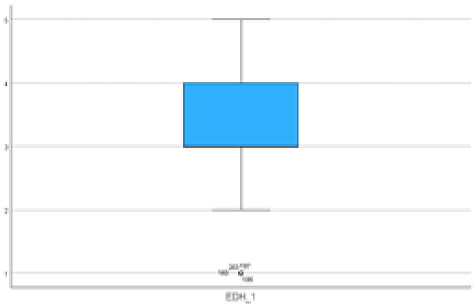
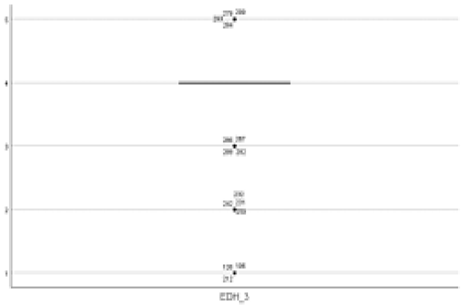
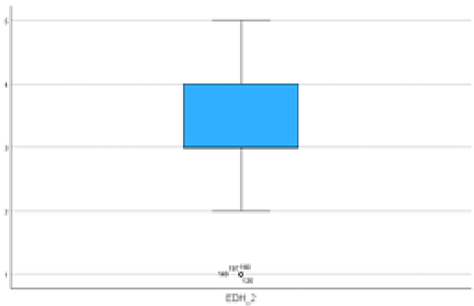
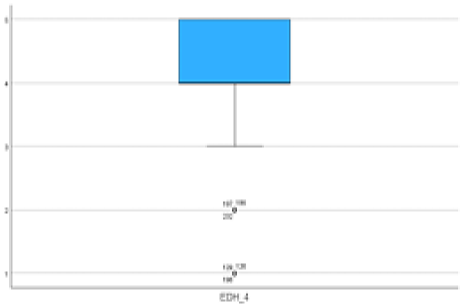

SDH_18

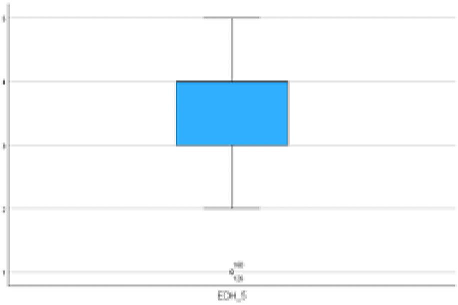

SDH_20

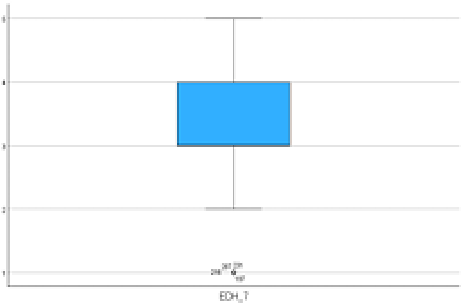

EDH_1

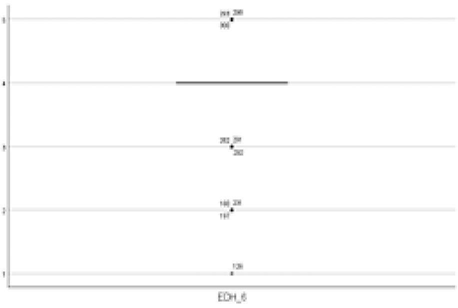

EDH_3

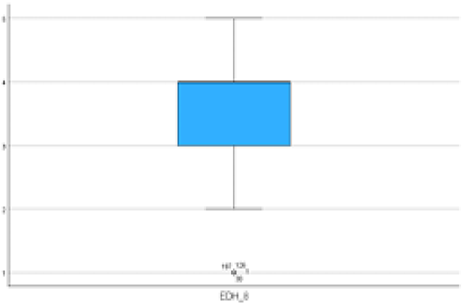

EDH_2

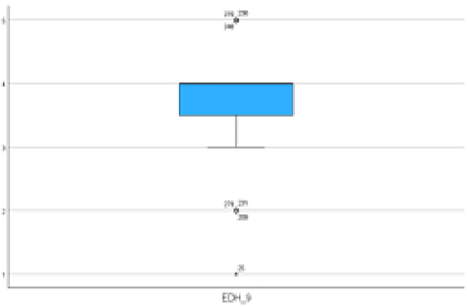

EDH_4

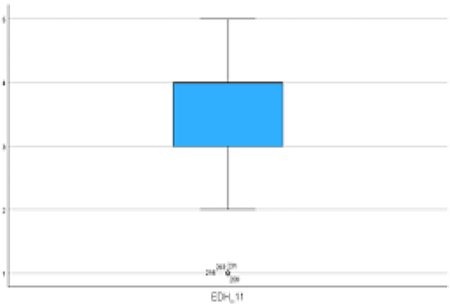

EDH_5

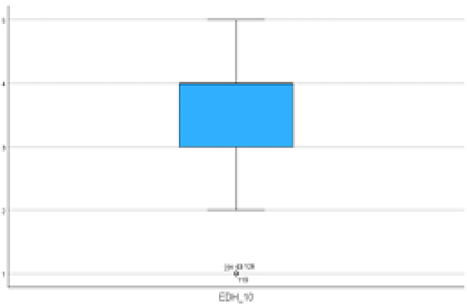

EDH_7

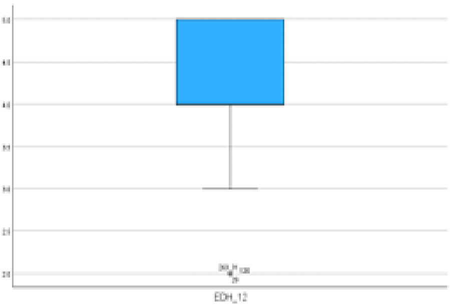

EDH_6

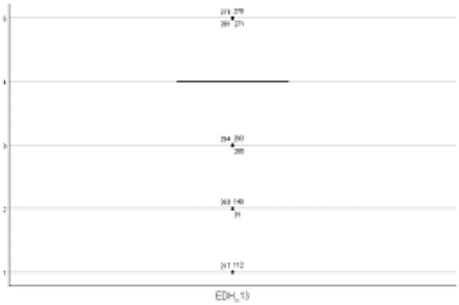

EDH_8

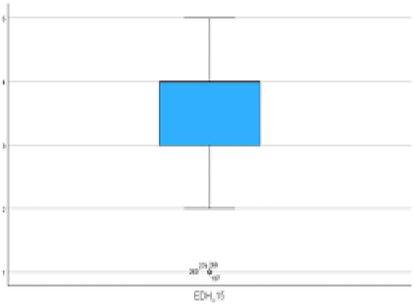

EDH_9

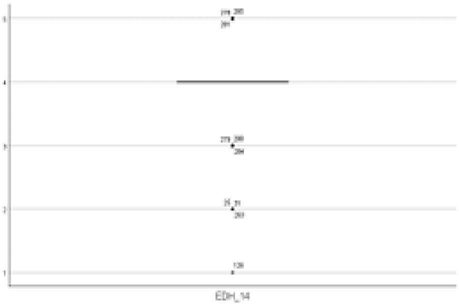

EDH_11

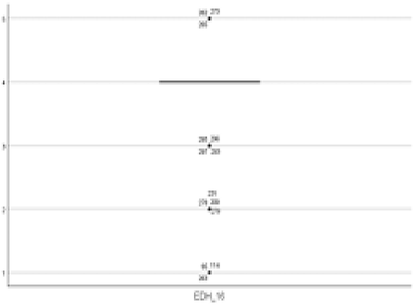

EDH_10


EDH_12


EDH_13


EDH_15


EDH_14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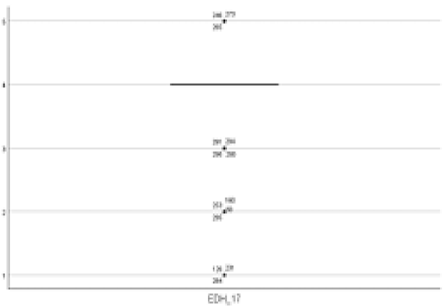
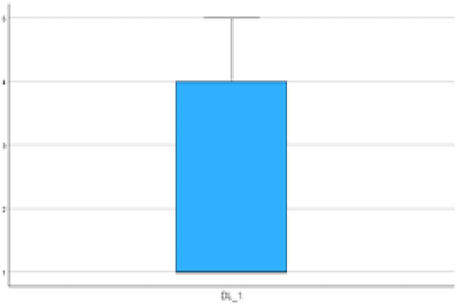
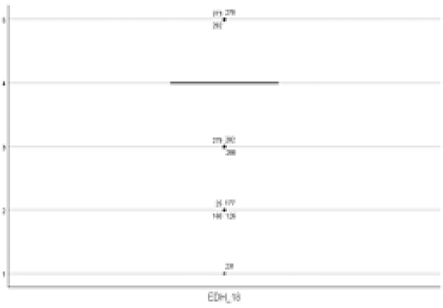
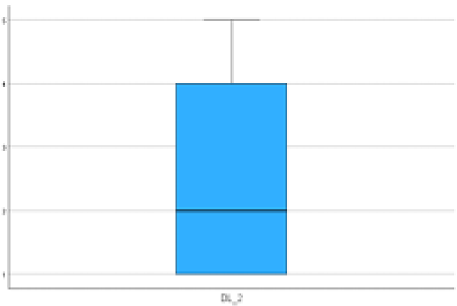
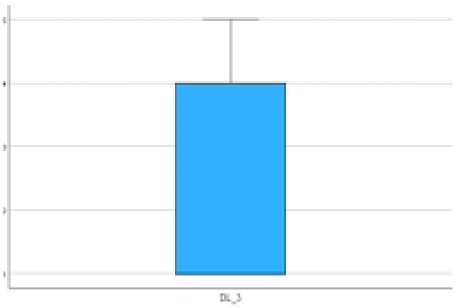
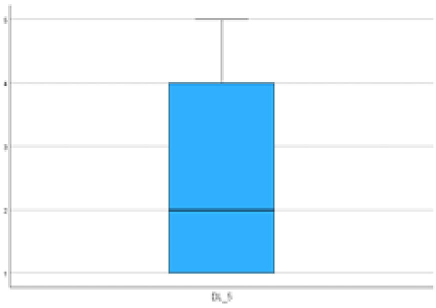

EDH_17

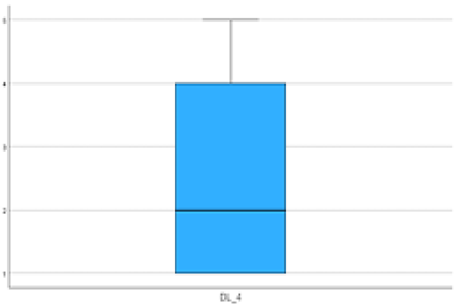

DL_1


EDH_18


DL_2


DL_3


DL_5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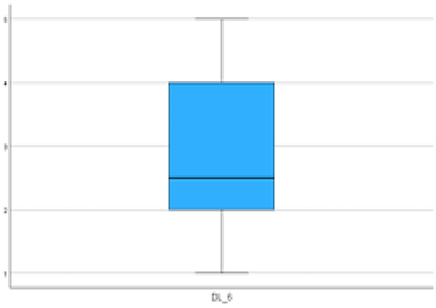
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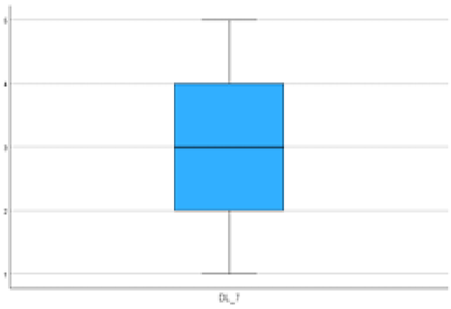
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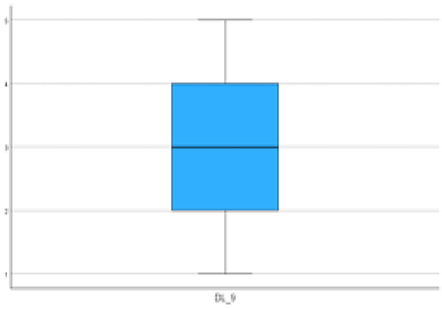
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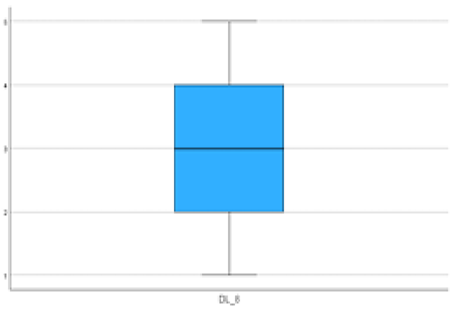
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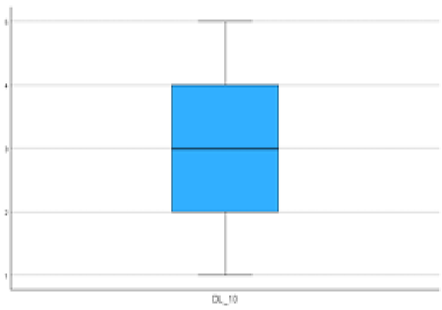
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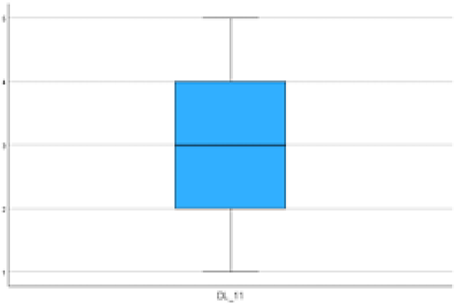
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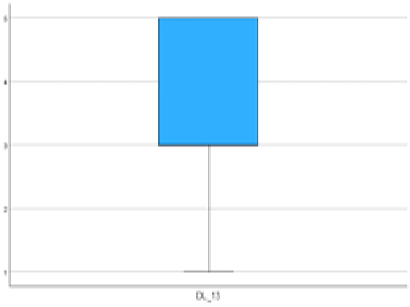
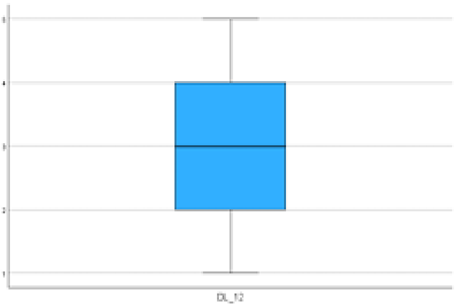
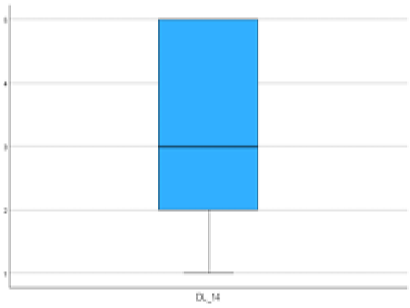

DL_13


DL_12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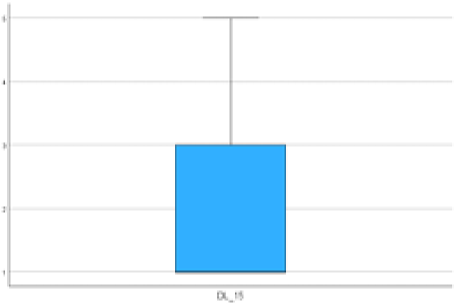
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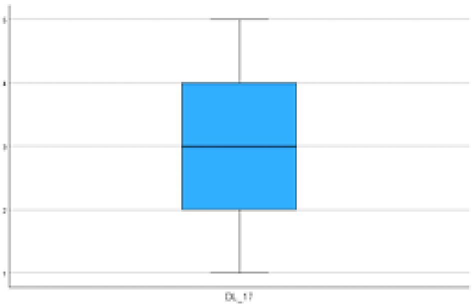
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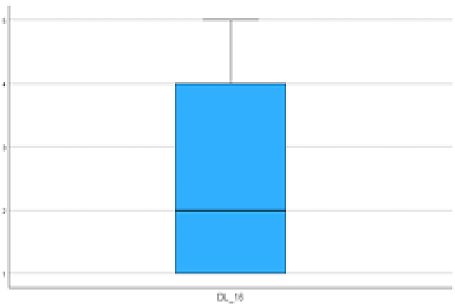
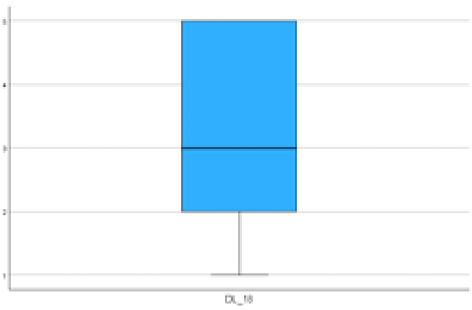

DL_16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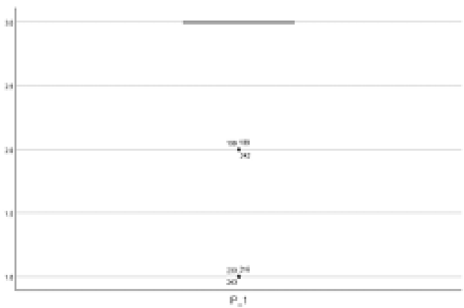
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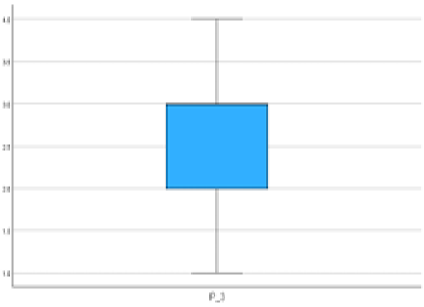
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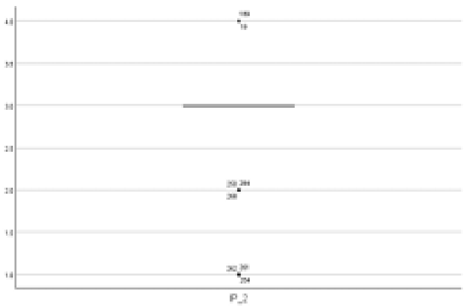
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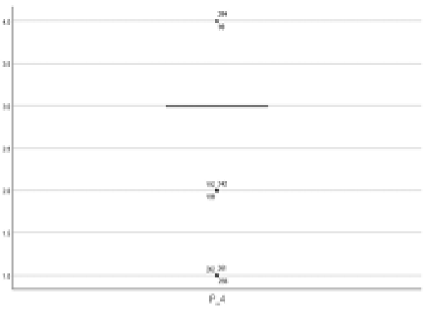
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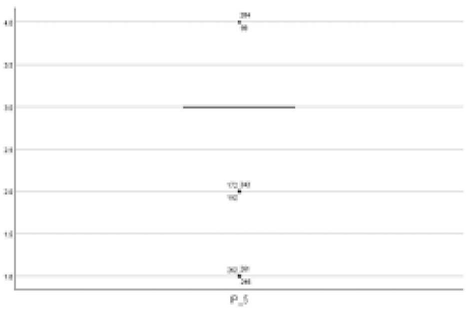
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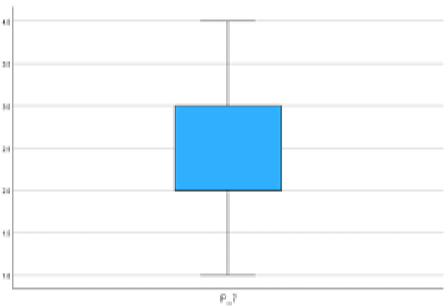
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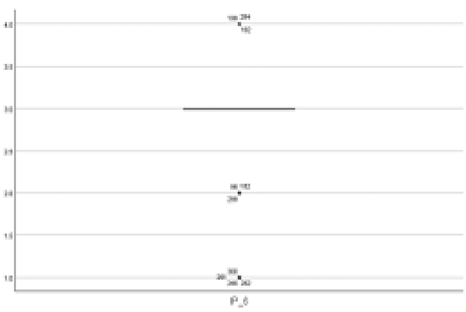
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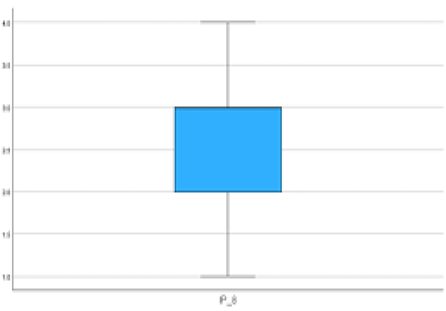
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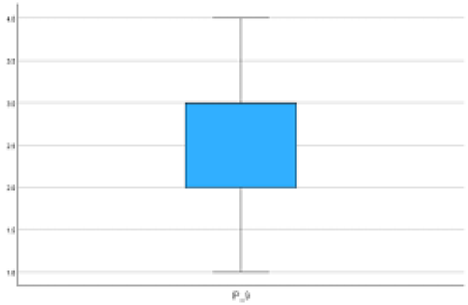
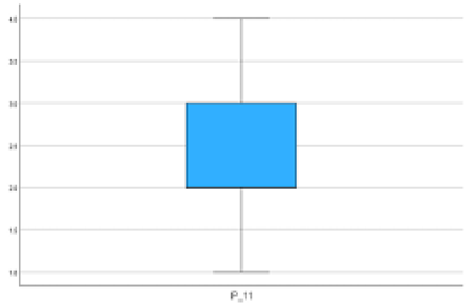

IP_9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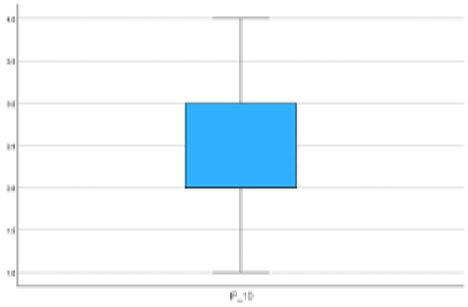
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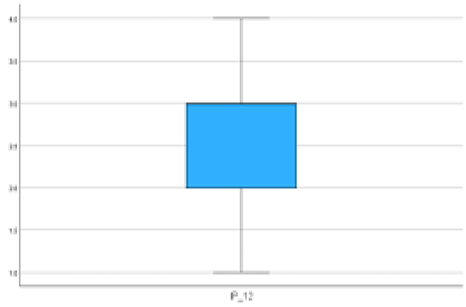
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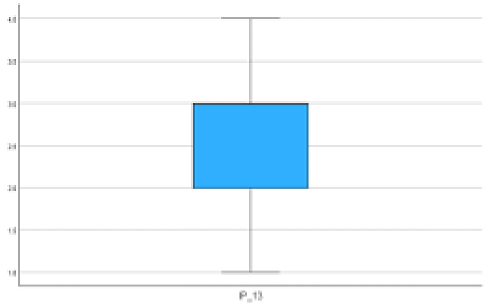
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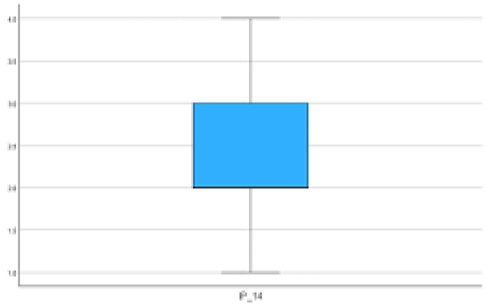
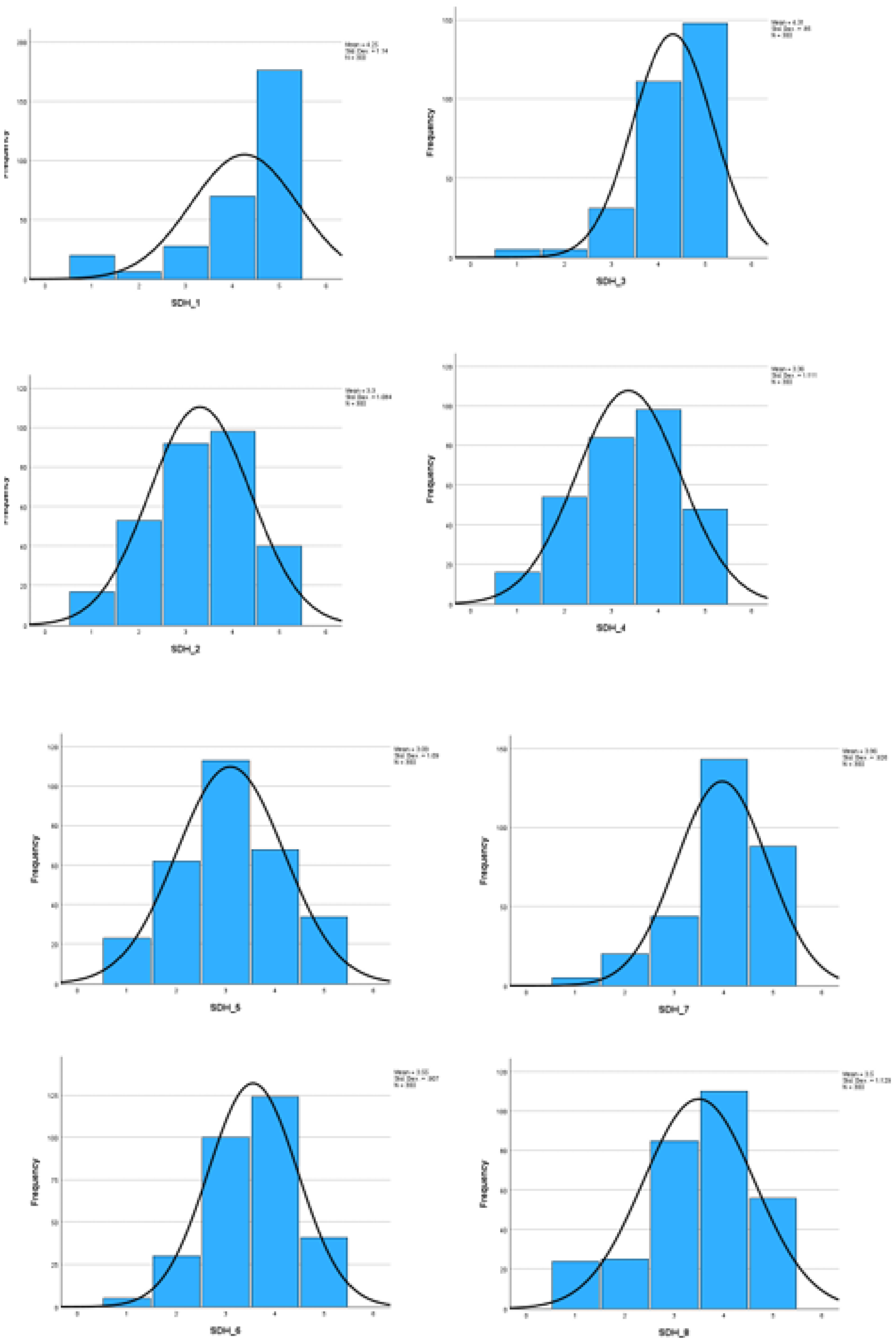
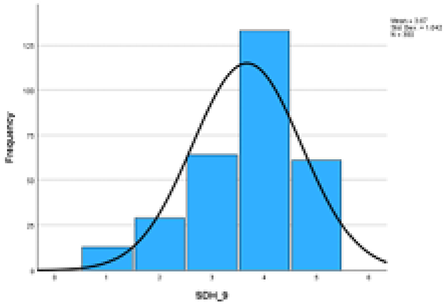
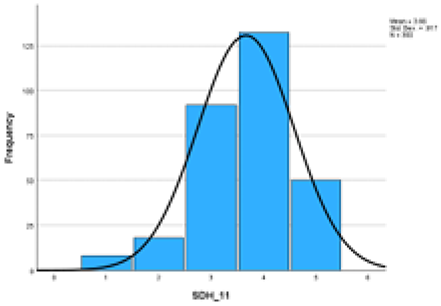
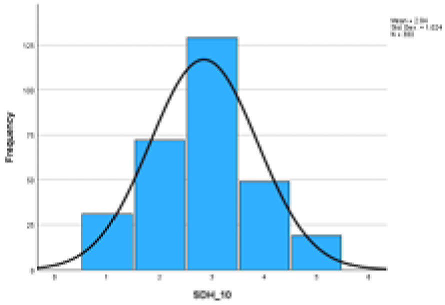

IP_14

Appendix M Histogram plot for EFA assumption checking of Malaysian sample




Frequency
SDH_9


Frequency
SDH_11


Frequency
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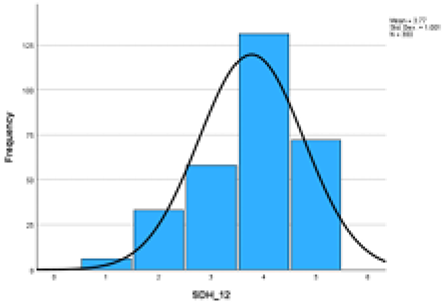
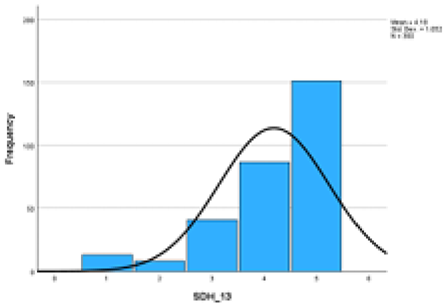
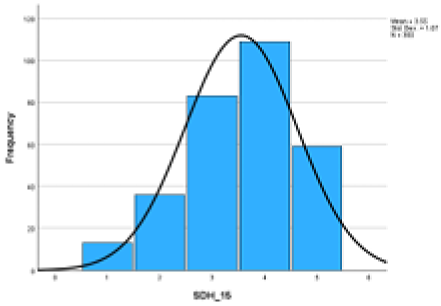
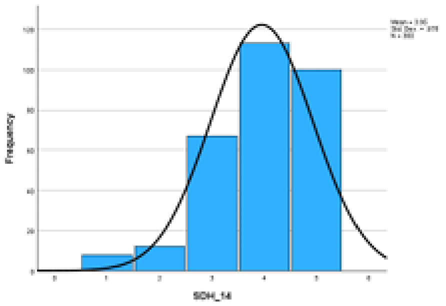
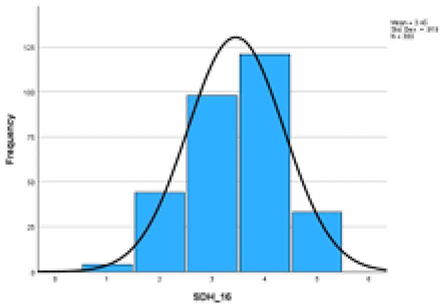
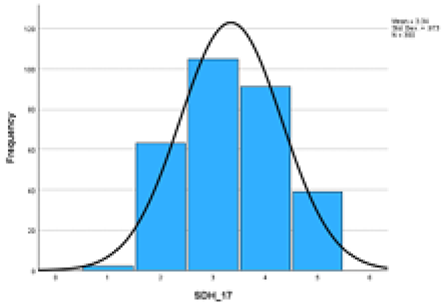

Frequency
SDH_12

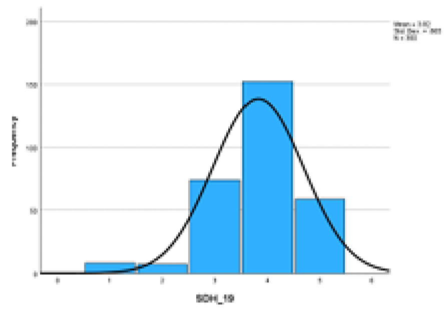

Frequency
SDH_13

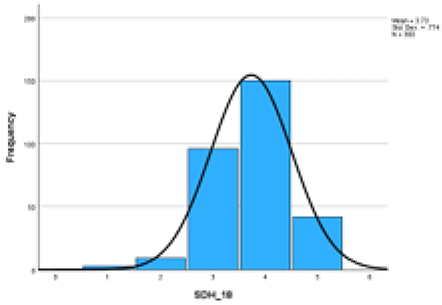

Frequency
SDH_15

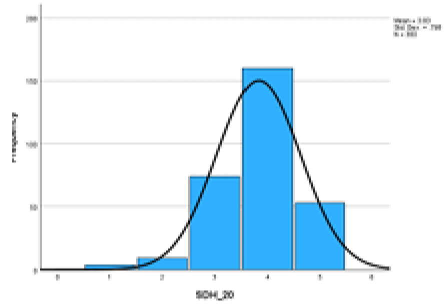

Frequency
SDH_14

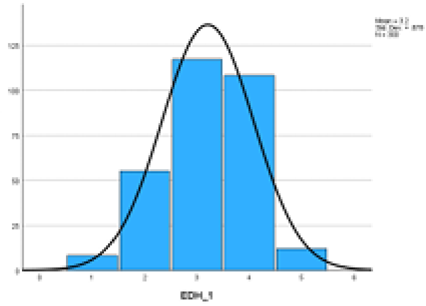

Frequency
SDH_16

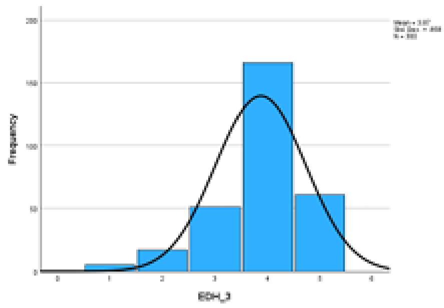

Frequency
SDH_17

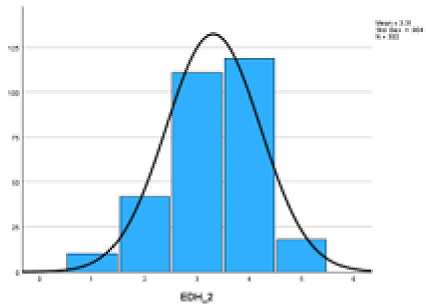

SDH_19

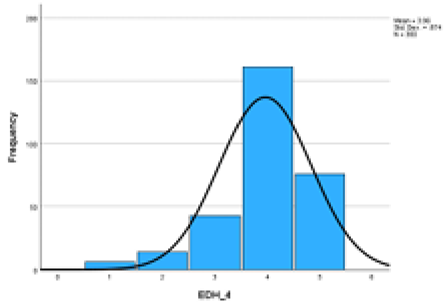

Frequency
SDH_18

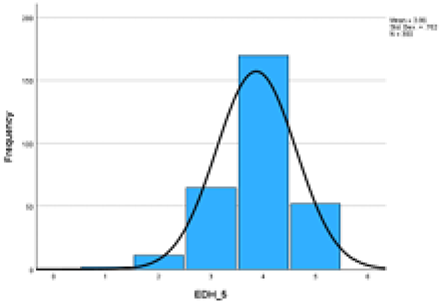

SDH_20

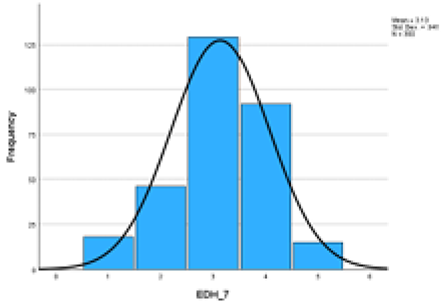

EDH_1

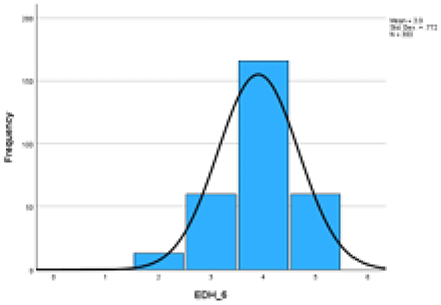

Frequency
EDH_3

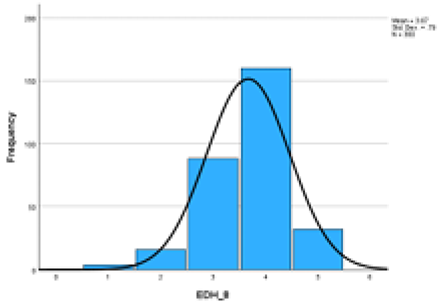

EDH_2

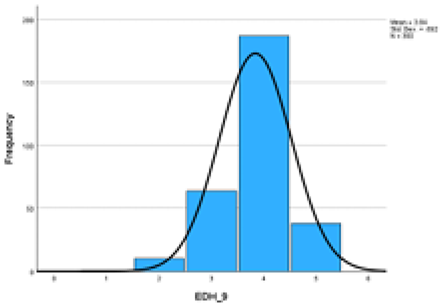

Frequency
EDH_4

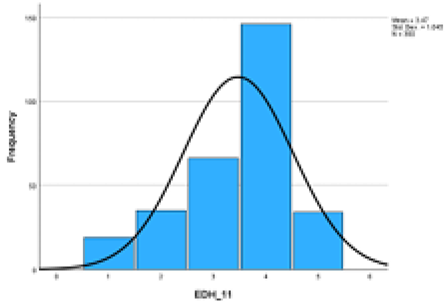

Frequency
EDH_5

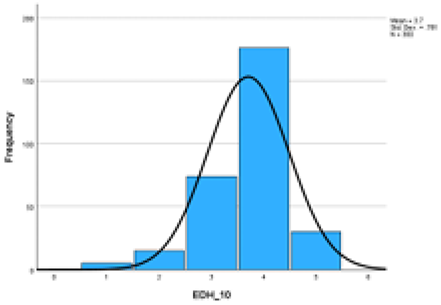

Frequency
EDH_7

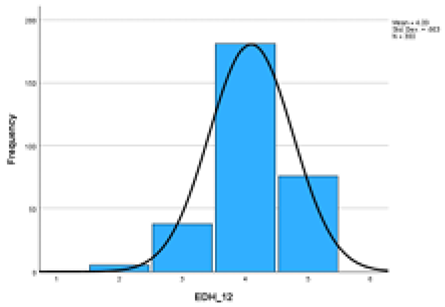

Frequency
EDH_6


Frequency
EDH_8


Frequency
EDH_9


Frequency
EDH_11


Frequency
EDH_10


Frequency
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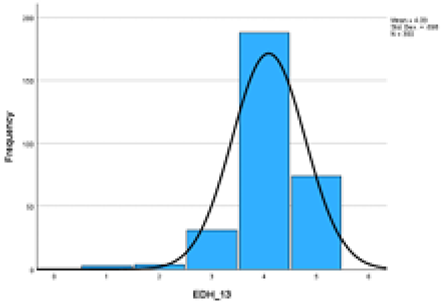
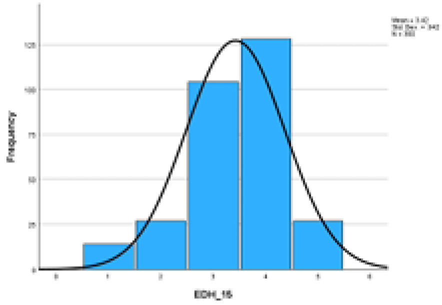

Frequency
EDH_13


Frequency
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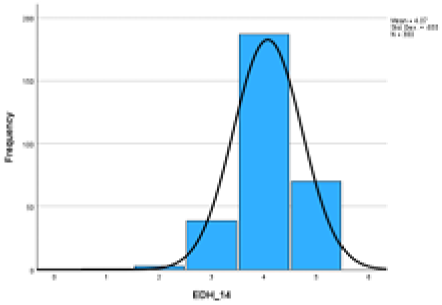
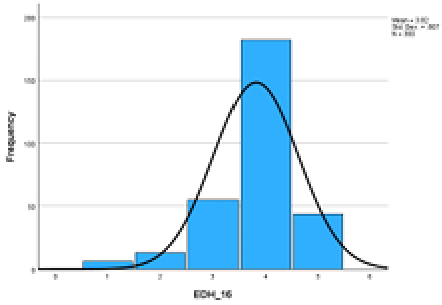
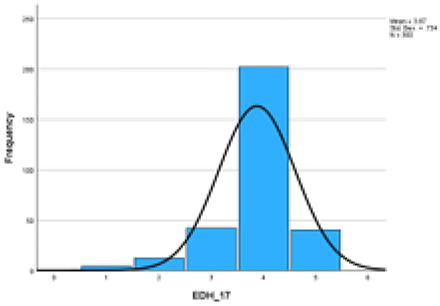
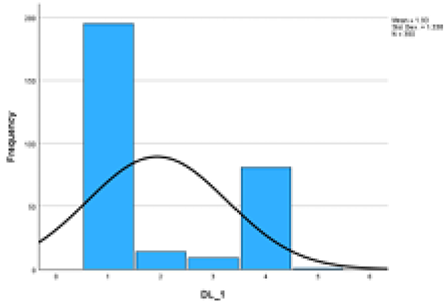
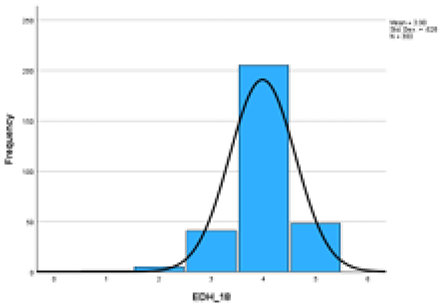
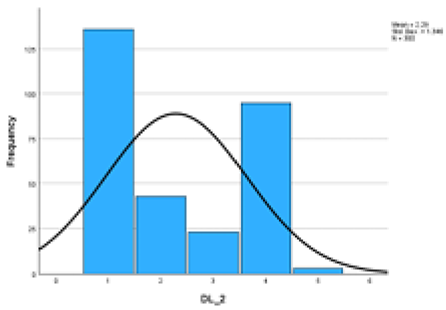

Frequency
EDH_14


Frequency
EDH_16


Frequency
EDH_17


Frequency
DL_1


Frequency
EDH_18


Frequency
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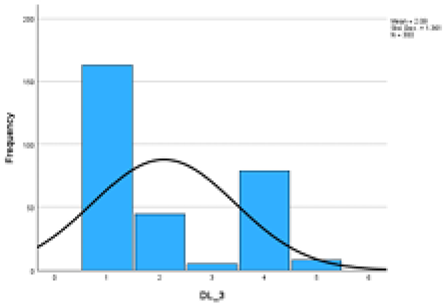
Frequency
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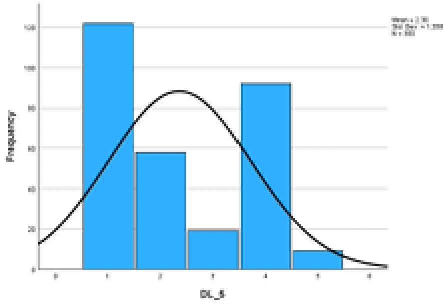
Frequency
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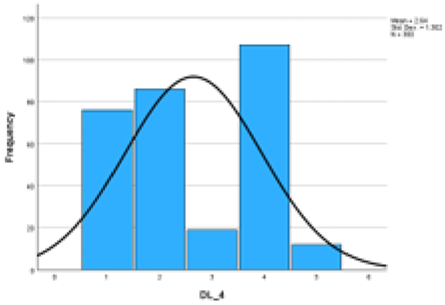
Frequency
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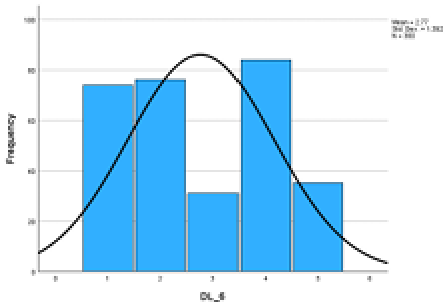
Frequency
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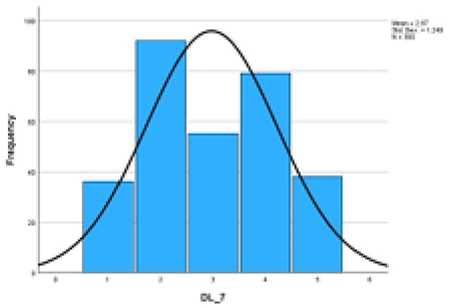
Frequency
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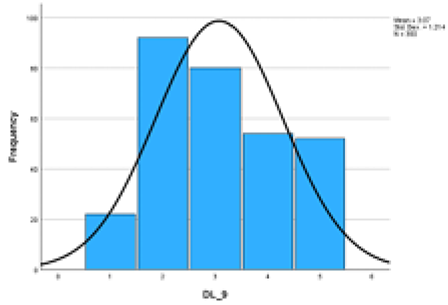
Frequency
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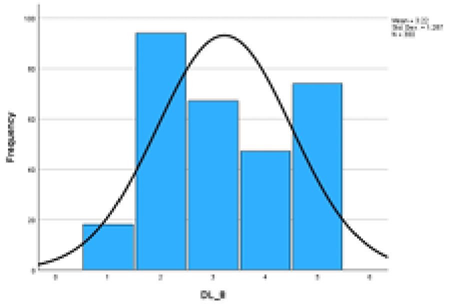
Frequency
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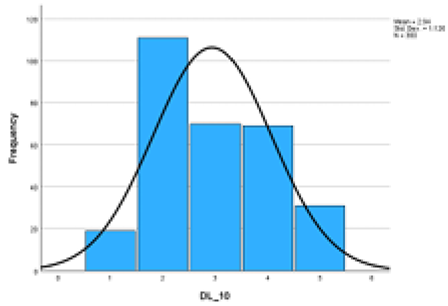
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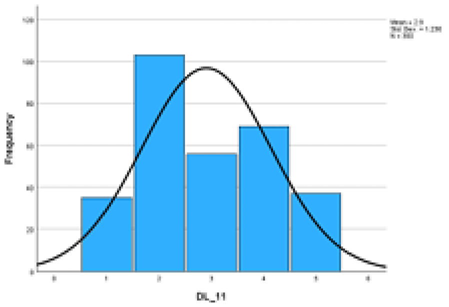
Frequency
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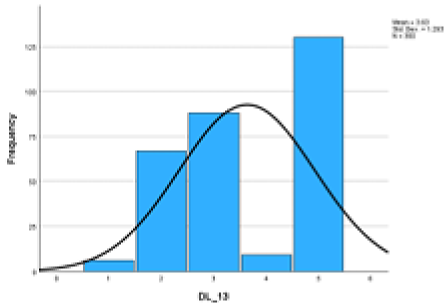
Frequency
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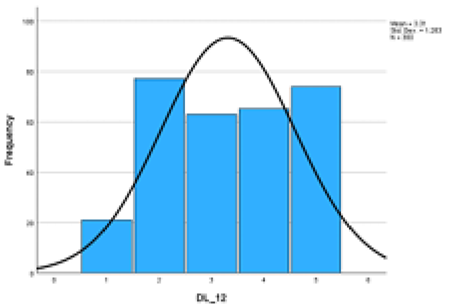
Frequency
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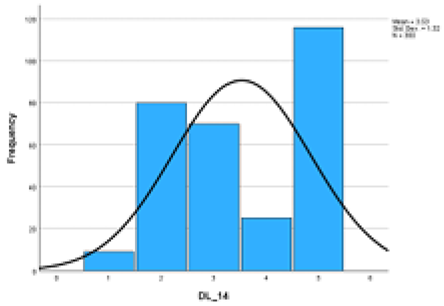
Frequency
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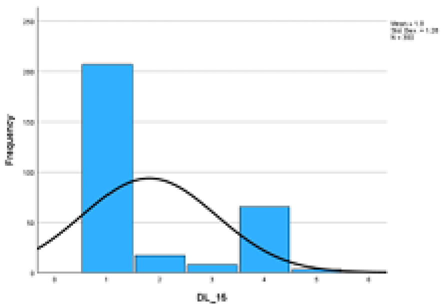
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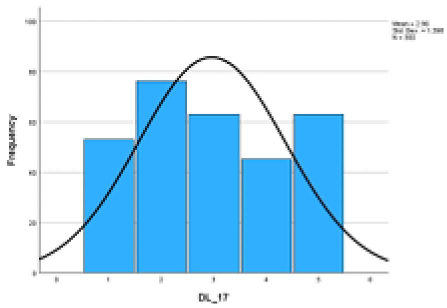
Frequency
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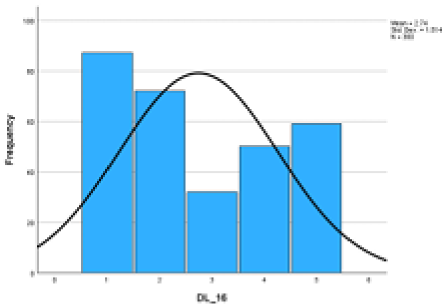
Frequency
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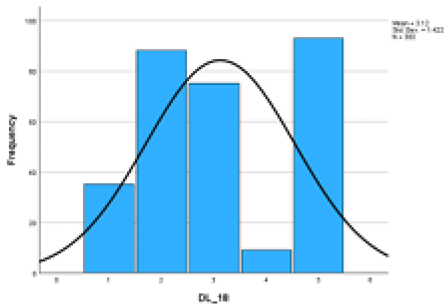
Frequency
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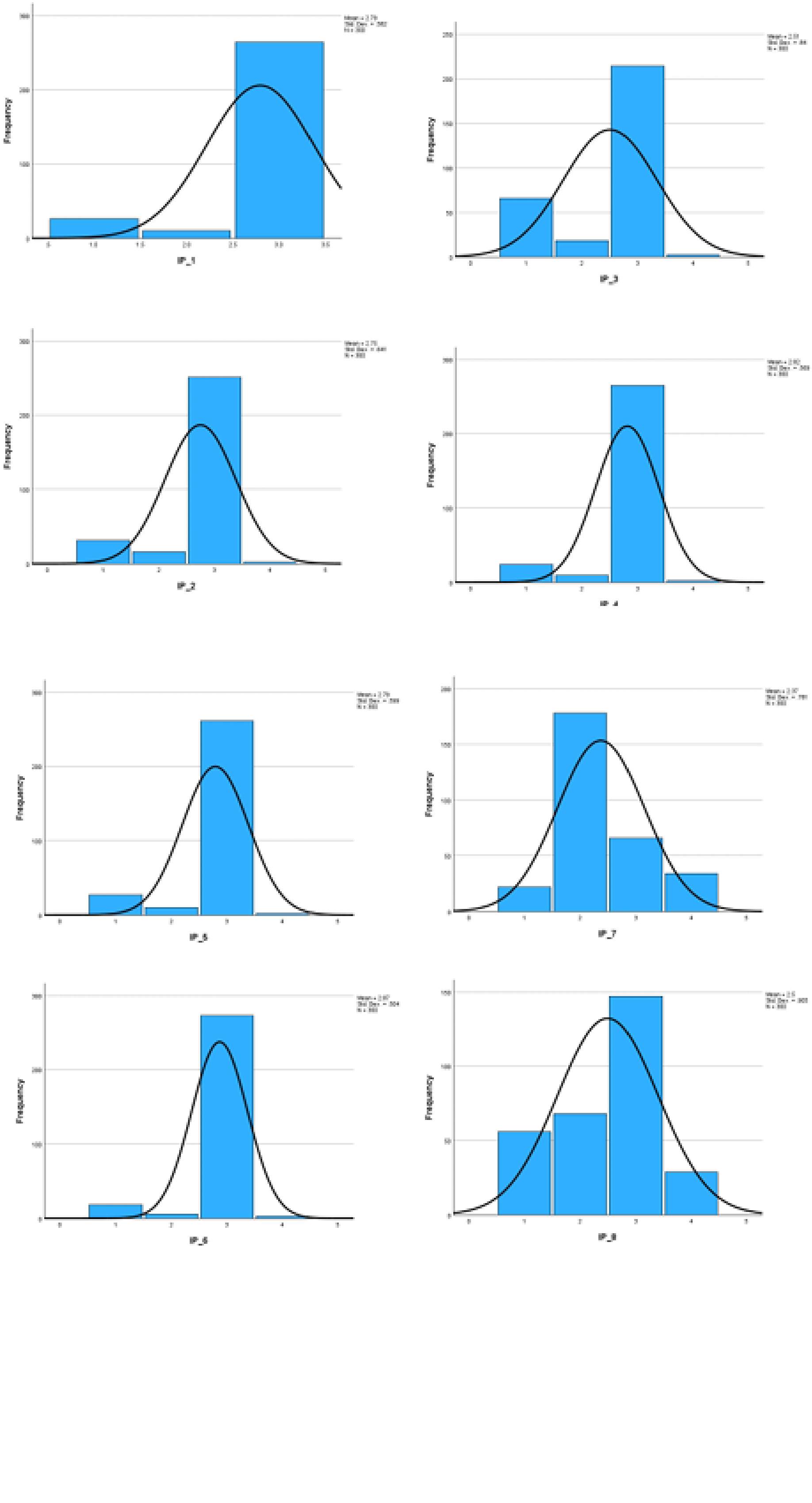
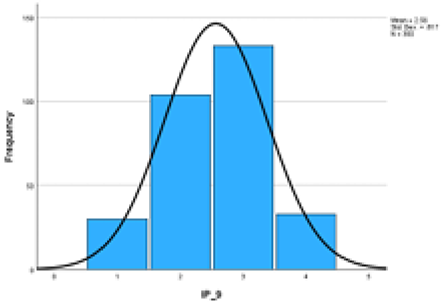

Frequency
IP_1
IP_3
IP_2
IP_4
IP_5
IP_7
IP_6
IP_8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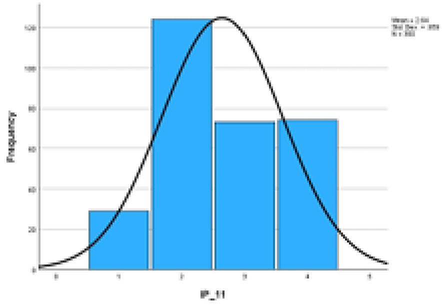
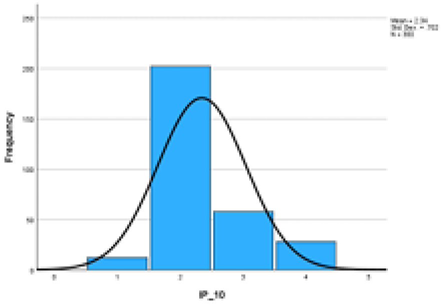
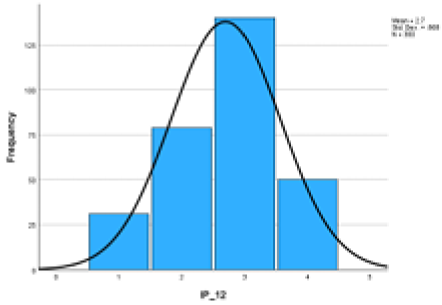
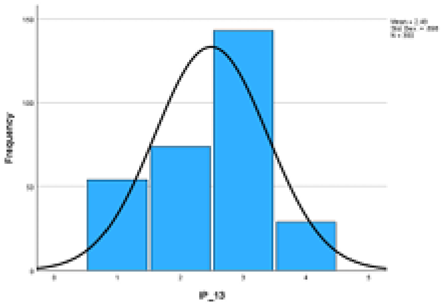
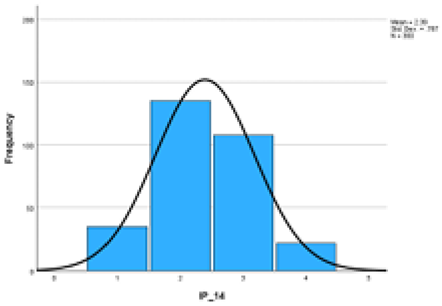
IP_9


Frequency
IP_11


Frequency
IP_10


Frequency
IP_12


Frequency
IP_13


Frequency
IP_14

Appendix N Univariate normality of skewness and kurtosis tests, Malaysian sample

SDHQ Model

UNIVARIATE SKEW AND KURTOSIS TESTS OF FIT

Variable	Sample Value	Mean	Standard Deviation	P-Value
TWO-SIDED UNIVARIATE SKEW TESTS OF FIT				
SDH1	-2.038	0.012	0.121	0.0000
SDH2	-0.234	-0.003	0.118	0.0400
SDH3	-1.475	-0.008	0.114	0.0000
SDH4	-0.380	0.000	0.111	0.0000
SDH5	-0.173	0.004	0.114	0.1200
SDH6	-0.361	0.010	0.114	0.0000
SDH7	-0.886	-0.001	0.123	0.0000
SDH8	-0.409	0.003	0.111	0.0000
SDH9	-0.772	0.005	0.111	0.0000
SDH10	0.076	0.004	0.114	0.5300
SDH11	-0.644	-0.005	0.107	0.0000
SDH12	-0.578	0.017	0.115	0.0000
SDH13	-1.351	0.012	0.116	0.0000
SDH14	-0.751	-0.006	0.117	0.0000
SDH15	-0.717	0.009	0.123	0.0000
SDH16	-0.323	-0.005	0.112	0.0200
SDH17	-0.184	-0.005	0.116	0.1000
SDH18	-0.713	-0.005	0.111	0.0000
SDH19	-0.804	0.018	0.123	0.0000
SDH20	-0.620	0.005	0.116	0.0000
TWO-SIDED UNIVARIATE KURTOSIS TESTS OF FIT				
SDH1	3.637	-0.029	0.230	0.0000
SDH2	-0.571	-0.044	0.209	0.0000
SDH3	2.534	-0.045	0.215	0.0000
SDH4	-0.635	-0.009	0.247	0.0000
SDH5	-0.527	-0.019	0.231	0.0100
SDH6	-0.416	-0.037	0.202	0.0200
SDH7	0.877	-0.035	0.229	0.0000
SDH8	-0.435	-0.027	0.227	0.0100
SDH9	0.393	-0.035	0.231	0.0800
SDH10	-0.559	-0.049	0.225	0.0000
SDH11	0.347	-0.030	0.254	0.1500
SDH12	-0.317	-0.024	0.217	0.1400
SDH13	1.403	-0.029	0.208	0.0000
SDH14	0.466	-0.010	0.237	0.0600
SDH15	0.022	-0.024	0.248	0.7300
SDH16	-0.463	-0.005	0.246	0.0200
SDH17	-0.737	-0.019	0.227	0.0000
SDH18	0.713	-0.054	0.213	0.0000
SDH19	0.604	0.002	0.235	0.0100
SDH20	0.415	-0.022	0.214	0.0700

EDHQ Model

UNIVARIATE SKEW AND KURTOSIS TESTS OF FIT

Variable	Sample Value	Mean	Standard Deviation	P-Value
TWO-SIDED UNIVARIATE SKEW TESTS OF FIT				
EDH1	-0.003	0.003	0.122	0.8900
EDH2	0.016	0.010	0.119	0.9600
EDH3	-0.450	0.012	0.118	0.0000
EDH4	-0.699	0.015	0.119	0.0000
EDH5	-0.501	0.007	0.110	0.0000
EDH6	-0.558	0.012	0.109	0.0000
EDH7	-0.075	0.011	0.116	0.4600
EDH8	-0.588	0.011	0.114	0.0000
EDH9	-0.748	-0.005	0.116	0.0000
EDH10	-0.438	0.014	0.113	0.0000
EDH11	-0.302	0.009	0.115	0.0200
EDH12	-0.928	0.006	0.118	0.0000
EDH13	-0.894	0.000	0.115	0.0000
EDH14	-0.588	0.006	0.123	0.0000
EDH15	-0.309	0.018	0.113	0.0000
EDH16	-0.650	0.018	0.103	0.0000
EDH17	-0.910	0.012	0.112	0.0000
EDH18	-0.884	-0.004	0.111	0.0000

TWO-SIDED UNIVARIATE KURTOSIS TESTS OF FIT

EDH1	-0.733	-0.014	0.255	0.0000
EDH2	-0.980	-0.009	0.278	0.0000
EDH3	-0.717	-0.053	0.222	0.0000
EDH4	-0.090	-0.054	0.206	0.9300
EDH5	-0.205	-0.044	0.234	0.4800
EDH6	-0.220	-0.017	0.243	0.4100
EDH7	-0.611	-0.026	0.248	0.0000
EDH8	-0.190	-0.025	0.226	0.4000
EDH9	0.043	-0.052	0.212	0.6300
EDH10	-0.518	-0.014	0.242	0.0000
EDH11	-0.781	-0.045	0.231	0.0000
EDH12	0.592	-0.018	0.232	0.0200
EDH13	0.320	-0.031	0.208	0.1300
EDH14	-0.321	-0.009	0.242	0.1400
EDH15	-0.856	-0.042	0.241	0.0000
EDH16	-0.395	-0.042	0.215	0.0700
EDH17	0.538	-0.019	0.217	0.0100
EDH18	0.715	-0.027	0.204	0.0000

DLQ Model

UNIVARIATE SKEW AND KURTOSIS TESTS OF FIT

Variable	Sample Value	Mean	Standard Deviation	P-Value
TWO-SIDED UNIVARIATE SKEW TESTS OF FIT				
DL1	1.282	0.001	0.124	0.0000
DL2	0.763	0.020	0.117	0.0000
DL3	0.771	0.007	0.120	0.0000
DL4	0.166	-0.010	0.119	0.0900
DL5	0.437	0.001	0.104	0.0000
DL6	0.209	-0.011	0.121	0.0400
DL7	-0.278	-0.018	0.120	0.0300
DL8	-0.273	0.000	0.107	0.0200
DL9	-0.389	0.008	0.117	0.0000
DL10	-0.116	0.008	0.110	0.2800
DL11	-0.258	-0.004	0.114	0.0300
DL12	-0.555	-0.005	0.121	0.0000
DL13	-0.595	0.000	0.113	0.0000
DL14	-0.555	0.007	0.113	0.0000
DL15	0.691	0.010	0.113	0.0000
DL16	-0.303	-0.007	0.114	0.0100
DL17	-0.104	0.009	0.112	0.3100
DL18	-0.018	0.004	0.116	0.8500
TWO-SIDED UNIVARIATE KURTOSIS TESTS OF FIT				
DL1	0.262	-0.008	0.243	0.2900
DL2	-0.881	-0.021	0.247	0.0000
DL3	-0.806	-0.017	0.229	0.0000
DL4	-1.197	-0.020	0.238	0.0000
DL5	-1.134	-0.045	0.235	0.0000
DL6	-1.266	-0.016	0.246	0.0000
DL7	-1.204	-0.026	0.246	0.0000
DL8	-1.234	-0.051	0.230	0.0000
DL9	-1.178	-0.028	0.236	0.0000
DL10	-1.180	-0.028	0.228	0.0000
DL11	-1.269	-0.032	0.237	0.0000
DL12	-1.097	0.007	0.252	0.0000
DL13	-0.958	-0.057	0.262	0.0000
DL14	-1.044	-0.034	0.234	0.0000
DL15	-1.025	-0.070	0.217	0.0000
DL16	-1.328	-0.044	0.227	0.0000
DL17	-1.240	-0.014	0.243	0.0000
DL18	-1.102	-0.029	0.229	0.0000

IPQ Model

UNIVARIATE SKEW AND KURTOSIS TESTS OF FIT

Variable	Sample Value	Mean	Standard Deviation	P-Value
TWO-SIDED UNIVARIATE SKEW TESTS OF FIT				
IP1	0.497	0.003	0.123	0.0000
IP2	0.568	0.013	0.115	0.0000
IP3	0.483	-0.013	0.121	0.0000
IP4	0.574	-0.001	0.121	0.0000
IP5	0.527	-0.004	0.117	0.0000
IP6	0.598	0.006	0.126	0.0000
IP7	-0.358	0.015	0.112	0.0000
IP8	-0.209	0.026	0.109	0.0400
IP9	0.139	0.010	0.110	0.2400
IP10	0.026	0.022	0.120	0.9700
IP11	0.175	0.020	0.115	0.2200
IP12	-0.254	0.015	0.125	0.0300
IP13	-0.414	0.005	0.117	0.0100
IP14	-0.223	0.003	0.107	0.0600

TWO-SIDED UNIVARIATE KURTOSIS TESTS OF FIT

IP1	-1.468	-0.034	0.223	0.0000
IP2	-1.300	-0.045	0.237	0.0000
IP3	-1.223	-0.026	0.244	0.0000
IP4	-1.319	-0.019	0.240	0.0000
IP5	-1.358	-0.042	0.241	0.0000
IP6	-1.274	-0.023	0.232	0.0000
IP7	-0.942	-0.047	0.233	0.0000
IP8	-0.960	-0.029	0.238	0.0000
IP9	-0.634	-0.049	0.225	0.0000
IP10	-0.889	-0.029	0.233	0.0000
IP11	-1.117	-0.039	0.215	0.0000
IP12	-0.743	-0.029	0.235	0.0000
IP13	-1.005	-0.047	0.221	0.0000
IP14	-0.686	-0.022	0.224	0.0000

Appendix O Multivariate normality using Mardia's multivariate normality tests, Malaysian sample

SDHQ Model

```
TECHNICAL 13 OUTPUT


     SKEW AND KURTOSIS TESTS OF MODEL FIT

     TWO-SIDED MULTIVARIATE SKEW TEST OF FIT

          Sample Value                                   101.594
          Mean                                            21.425
          Standard Deviation                               0.826
          P-Value                                         0.0000

     TWO-SIDED MULTIVARIATE KURTOSIS TEST OF FIT

          Sample Value                                   630.732
          Mean                                           438.336
          Standard Deviation                               2.720
          P-Value                                         0.0000
```

EDHQ Model

```
TECHNICAL 13 OUTPUT


     SKEW AND KURTOSIS TESTS OF MODEL FIT

     TWO-SIDED MULTIVARIATE SKEW TEST OF FIT

          Sample Value                                    47.266
          Mean                                            15.809
          Standard Deviation                               0.733
          P-Value                                         0.0000

     TWO-SIDED MULTIVARIATE KURTOSIS TEST OF FIT

          Sample Value                                   478.864
          Mean                                           358.643
          Standard Deviation                               2.625
          P-Value                                         0.0000
```

DLQ Model

```
TECHNICAL 13 OUTPUT

     SKEW AND KURTOSIS TESTS OF MODEL FIT

     TWO-SIDED MULTIVARIATE SKEW TEST OF FIT

          Sample Value                                         31.035
          Mean                                                 15.770
          Standard Deviation                                    0.748
          P-Value                                              0.0000

     TWO-SIDED MULTIVARIATE KURTOSIS TEST OF FIT

          Sample Value                                        397.536
          Mean                                                358.457
          Standard Deviation                                    2.502
          P-Value                                              0.0000
```

IPQ Model

```
TECHNICAL 13 OUTPUT

     SKEW AND KURTOSIS TESTS OF MODEL FIT

     TWO-SIDED MULTIVARIATE SKEW TEST OF FIT

          Sample Value                                         27.775
          Mean                                                  7.779
          Standard Deviation                                    0.530
          P-Value                                              0.0000

     TWO-SIDED MULTIVARIATE KURTOSIS TEST OF FIT

          Sample Value                                        299.212
          Mean                                                223.039
          Standard Deviation                                    1.869
          P-Value                                              0.0000
```

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LIST OF PUBLICATIONS RELATED THIS PHD WORK

1. **Sabo, A.**, Kuan, G., Abdullah, S., Kuay, H. S., Goni, M. D., & Kueh, Y. C. (2024). Psychometric properties of the social determinants of health questionnaire (SDH-Q): development and validation. *BMC Public Health, 24*(1), 2507.
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4. **Sabo, A.**, Kuan, G., Abdullah, S., San Kuay, H., & Kueh, Y. C. (2024). Assessment of psychometric properties of the perceived demands of life questionnaire (DL-Q): development and validation. (*Accepted, BMC psychology*).

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BMC Public Health

RESEARCH Open Access

Psychometric properties of the social determinants of health questionnaire (SDH-Q): development and validation

Abdulwali Sabo[1,2], Garry Kuan[3], Sarimah Abdullah[1], Hue San Kuay[4], Mohammed Dauda Goni[5,6] and Yee Cheng Kueh[1*]

Abstract

Background The influence of social determinants of health (SDH) on sustainable development goals (SDG) has gained attention in recent years. However, there is a scarcity in the availability of valid and reliable instruments to assess the multiple aspects of SDH. Hence, this study was conducted to develop a brief self-reported measure for assessing SDH.

Method A cross-sectional survey was conducted among university undergraduate students in Nigeria. The study consisted of 300 participants in the EFA (males 55.7%, females 44.3%) and 430 participants in the CFA (males 54.0%, females 46.0%). Participants were selected using a convenience sampling approach to assess their perceptions regarding SDH. Content Validity Index (CVI), Face Validity Index (FVI), Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), Composite Reliability (CR), Average Variance Extracted (AVE), Cronbach's alpha, and Intraclass Correlation Coefficient (ICC) were computed to determine the psychometric properties of the newly developed SDH scale.

Results In the EFA, two factors were extracted (structural determinants of SDH and intermediary determinants of SDH), with all 20 items retained. The total variance explained by the EFA model was 61.8%, and the factor correlation was 0.178. The Cronbach's alpha values of the two factors were 0.917 and 0.939. In the CFA, the initial model did not fit the data well based on fit indices. After several re-specification of the model, the final re-specified measurement model demonstrated adequate fit factor structure of the SDH scale with two factors and 20 items (CFI = 0.943, TLI = 0.930, SRMR = 0.056, RMSEA = 0.053, RMSEA p-value = 0.220). The CR was 0.797 for structural determinants of SDH and 0.794 for intermediary determinants of SDH. The ICC was 0.938 for structural determinants of SDH and 0.941 for intermediary determinants of SDH.

Conclusion The findings indicate that the SDH scale has adequate psychometric properties and can be used to assess the perceived level of SDH. We recommended that this tool be tested in other populations with diverse age groups and other demographic characteristics.

Keywords Social determinants of health, Questionnaire, Validity, Reliability, Construct

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BMC Psychology

RESEARCH

Open Access

Psychometric properties of the newly developed self-report environmental determinants of health questionnaire (EDH-Q): development and validation

Abdulwali Sabo[1,2], Garry Kuan[3], Abdullah Sarimah[1], Hue San Kuay[4] and Yee Cheng Kueh[1*]

Abstract

Background The environmental determinants of health (EDH) have a significant impact on people's physical, mental, and social wellbeing. Everyone needs access to environmental resources of all types, including food, materials, and energy, to survive. Currently, no valid and reliable instrument exists for evaluating individuals' perceived levels of EDH. Hence, the purpose of this study was to develop and validate the environmental determinants of health questionnaire (EDH-Q) among undergraduate students in Nigeria.

Method We conducted a cross-sectional survey among undergraduate students in Nigeria to assess the psychometric properties of the newly developed Environmental Determinants of Health Questionnaire (EDH-Q). Respondents were selected using a convenience sampling approach to evaluate their perceptions of environmental determinants of health. The Content Validity Index (CVI) and Face Validity Index (FVI) were calculated to ascertain the scale's content validity and response process validity, respectively. Additionally, exploratory factor analysis (EFA), confirmatory factor analysis (CFA), composite reliability (CR), average variance extracted (AVE), Cronbach's alpha, and intraclass correlation coefficient (ICC) were computed to assess the scale's construct validity.

Results The study involved 300 respondents in the EFA (males 55.7%, females 44.3%) and 430 respondents in the CFA (males 54.0%, females 46.0%). In the EFA, two constructs were identified (the natural environment and the built environment). The EFA model was able to explain 63.57% of the total cumulative variance, and the factor correlation was 0.671. The whole scale Cronbach's alpha value was 0.947, while the two constructs' Cronbach's alpha values were 0.918 (natural environment) and 0.935 (built environment). In the CFA, six pairs of error covariances were included between items within the same construct to improve the fit indices of the initial proposed measurement model. The final re-specified measurement model showed that the EDH-Q, which has two constructs and 18 items, has adequate construct validity (CFI = 0.948, TLI = 0.938, SRMR = 0.046, RMSEA = 0.052, and RMSEA p-value = 0.344). The CRs were 0.845 (natural environment) and 0.854 (built environment). The ICCs were 0.976 (natural environment) and 0.970 (built environment).

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Development and validation of the Individual Potentials Questionnaire (IP-Q)

Abdulwali Sabo[1,2], Garry Kuan[3], Sarimah Abdullah[1], Hue San Kuay[4] & Yee Cheng Kueh[1]✉

Individual potential has recently been acknowledged by the holistic health model as being essential to successfully addressing life's demands, both now and in the future. The study employed a cross-sectional survey among Nigerian university undergraduate students, using a convenience sampling method, to assess their subjective individual potential. The study investigated the psychometric properties of the newly developed Individual Potentials Questionnaire (IP-Q). The study involved a total of 730 participants (EFA = 300 and CFA = 430). The I-CVIs and S-CVIs fall within the range of 0.83 to 1, and the I-FVIs and S-FVIs are 1. Two factors (biologically given potential and personally acquired potential) emerged in the EFA analysis, with all 14 items retained due to satisfactory factor loadings (above 0.50) and KMO = 0.905 (*p*-value < 0.001). The final CFA model fit indices were: CFI = 0.984, TLI = 0.980, SRMR = 0.034, RMSEA = 0.041, and RMSEA *p*-value = 0.880. Furthermore, the ICCs for the test–retest are 0.976 (biologically given potential) and 0.953 (personally acquired potential). The results show that the newly developed IP-Q has adequate construct validity and able to assess subjective individual potential.

Keywords Demands, Life, Holistic, Health, Reliability, Construct

Most individuals strive to maintain control over their lives and future trajectory while maintaining close relationships with family and friends within their social circles. However, these relationships naturally evolve as people age[1]. Additionally, newborns are entirely dependent on caregivers, a reliance that intensifies during illness or the frailty of old age. As a result, individuals must continually adapt to age- and culturally specific demands and challenges throughout each stage of life[1]. This adaptability highlights that an individual's ability to meet short-, medium-, and long-term needs serves as a reflection of their overall health status[2]. The concept of "potential" effectively encompasses all prospective abilities required to address life's needs[1,3].

The Meikirch model of holistic health emphasizes the importance of individual potential in effectively meeting life's demands, both in the short and long term[1,3]. This model defines individual potential as comprising two dimensions: biologically given potentials and personally acquired potentials[1]. Biologically given potential refers to the innate biological basis of life, which begins at birth with a finite value determined by genetic factors and the quality of pregnancy and then declines over the course of life, eventually reaching zero at death. The personally acquired potential encompasses the total physiological, mental, and social resources a person accumulates throughout their life, which starts developing in utero and continues to grow as long as the individual actively seeks to foster their personal development and resides in a supportive and health-promoting social environment[1,3].

Similarly, the Health Belief Model (HBM) is widely utilized to explain health-related behaviors by focusing on the perceptions and beliefs that drive decision-making[4,5]. Within the HBM, two key constructs are particularly relevant to individual potential: (1) perceived severity, which reflects an individual's understanding of the seriousness of health issues, which fosters a proactive approach, encourages taking responsibility for well-being, and enhances resilience, and (2) perceived benefits, which reflect the belief in the effectiveness of actions, such as adopting healthy habits, which reinforce positive behaviors and instil confidence in personal growth[4]. Ultimately, the Meikirch model of holistic health and HBM offer valuable frameworks for understanding and fostering individual potential, particularly regarding health behaviors, personal development, and the perceptions that shape decision-making.

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Application No: LY2024P08872

Applicant :

*** Title of work** *(Original language)* : ENVIRONMENTAL DETERMINANTS OF HEALTH QUESTIONNAIRE

Translation *(If the title of work is neither in Bahasa nor English)* :

Transliteration *(If the title of work is neither in Bahasa nor English)* :

Name of the Language *(Language use in the work)* : ENGLISH

*** Section A : Category of Works** (Please tick ONE only)

■ Literary ☐ Musical ☐ Artistic ☐ Film ☐ Sound Recording ☐ Broadcast *('broadcasting service' only)* ☐ Derivative

Date of Creation / Fixation : 01 | 02 | 2024

Section B : Publication

The Work is : ■ Published ☐ Unpublished

If published : 13 | 08 | 2024 **(Date of first publication)** United Kingdom **(Country)**

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Name *(as per NRIC/Passport)* : REFER TO THE ATTACHED LIST OF AUTHORS.

NRIC / Passport No. :

Nationality :

DD | MM | YY **(Date of Death** *(if applicable)* **)**

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CR - 1

Application No: LY2024P08873

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Transliteration *(If the title of work is neither in Bahasa nor English)* :

Name of the Language *(Language use in the work)* : ENGLISH

*** Section A : Category of Works** (Please tick ONE only)

[■] Literary [ ] Musical [ ] Artistic [ ] Film [ ] Sound Recording [ ] Broadcast *('broadcasting service' only)* [ ] Derivative

Date of Creation / Fixation : 01 | 02 | 2024

Section B : Publication

The Work is : [■] Published [ ] Unpublished

If published : 16 | 09 | 2024 (Date of first publication) — United Kingdom (Country)

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CR - 1

Application No: LY2024P08670

Applicant :

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Transliteration *(If the title of work is neither in Bahasa nor English)* :

Name of the Language *(Language use in the work)* : ENGLISH

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Date of Creation / Fixation : 01 | 02 | 2024

Section B : Publication

The Work is : [ ] Published [■] Unpublished

If published : DD | MM | YYYY (Date of first publication) ______ (Country)

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Application No: LY2024P08871

Applicant :

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Translation *(If the title of work is neither in Bahasa nor English)* :

Transliteration *(If the title of work is neither in Bahasa nor English)* :

Name of the Language *(Language use in the work)* : ENGLISH

*** Section A : Category of Works** (Please tick ONE only)

[■] Literary [ ] Musical [ ] Artistic [ ] Film [ ] Sound Recording [ ] Broadcast *('broadcasting service' only)* [ ] Derivative

Date of Creation / Fixation : 01 | 02 | 2024

Section B : Publication

The Work is : [ ] Published [■] Unpublished

If published : DD | MM | YYYY **(Date of first publication)** ____ **(Country)**

*** Section C : Author** (To add additional Authors, please attach separate sheet)

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Nationality : DD | MM | YYYY **(Date of Death** *(if applicable)***)**

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Category of Work	:	**LITERARY**
Date of Notification	:	**20 DECEMBER 2024**
Date of Creation	:	**01 FEBRUARY 2024**
Date of First Published	:	**16 SEPTEMBER 2024**

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Category of Work	:	**LITERARY**
Date of Notification	:	**20 DECEMBER 2024**
Date of Creation	:	**01 FEBRUARY 2024**
Date of First Published	:	**13 AUGUST 2024**

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Category of Work	:	**LITERARY**
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[Subregulation 8(2)]

Notification Number	:	**CRLY2024P08870**
Title of Work	:	**INDIVIDUAL POTENTIALS QUESTIONNAIRE (IPQ)**
Category of Work	:	**LITERARY**
Date of Notification	:	**20 DECEMBER 2024**
Date of Creation	:	**01 FEBRUARY 2024**

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