EFFECTS OF HEALTH EDUCATION ON PHYSICAL ACTIVITY PROMOTION BASED ON PRECEDE-PROCEED MODEL AMONG ADOLESCENTS IN YUNNAN, CHINA

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The sharpening of a sword grants it keenness, just as the harsh winter unveils the fragrance of plum blossoms. My three-year doctoral journey has been one of transformation—from aspiring to academia to dedicating myself to rigorous research. It was a path paved with perseverance, sweat, and moments of triumph and struggle. This journey has shaped me, teaching me resilience in failure, joy in success, and the courage to make life-changing decisions.

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As I reflect on the past, my heart swells with gratitude; as I look ahead, I am filled with confidence. Completing this dissertation is not an end but a new beginning—one that I embrace with determination, appreciation, and a commitment to lifelong learning.

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LIST OF ABBREVIATIONS

ASAFA	Assess Social Support for Physical Activity scale
ASAFA-C	Assess Social Support for Physical Activity scale - Chinese
ANOVA	Analysis of Variance
BMI	Body mass index
CFA	Confirmatory factor analysis
CFI	Comparative fit index
Chisq/df	Chi-square/degrees of freedom
CI	Confidence interval
CR	Composite reliability
CVI	Content validity index
df	Degree of freedom
EBBS-CN	Exercise Benefits/Barriers Scale- Chinese
EBB	Exercise Benefits/Barriers
EBF	Exercise Benefits
EBR	Exercise Barriers
IFT	Impaired fasting glycaemia
ITL	Indeks Tucker Lewis
JEPeM	Jawatankuasa Etika Penyelidikan Manusia (Human Research Ethics Committee)
kg	kilogram
MANOVA	Multivariate analysis of variance
PRECEDE	Predisposing, Reinforcing, and Enabling Constructs in Educational Diagnosis and Evaluation
PROCEED	Policy, Regulatory, and Organizational Constructs in Educational and Environmental Development
PA	Physical activity
PAQ-CN	Physical Activity Questionnaire- Chinese
PASS	Physical Activity Social Support
PF	Physical Fitness
PASES-C	Physical Activity Self-Efficacy Scale-Chinese
PASE	Physical activity self-efficacy
PU	Pull-ups
PFLWS	Physical Fitness Level Weighted Score

Q-SPACE	Questionnaire-School Physical Activity Environment
Q-SPACE-C	Questionnaire-School Physical Activity Environment- Chinese
RCT	Randomised controlled trial
RM	Repeated measures
RMR	Root Mean Square Residual
RMSEA	Root Mean Square Error of Approximation
SPACE	School Physical Activity Environment
SEM	Structural Equation Modelling
SFB	Sitting Forward Bend
SLJ	Standing Long Jump
SU	Sit-ups
TLI	Tucker Lewis Index
VC	Vital Capacity
WHO	World Health Organization

LIST OF APPENDICES

KESAN PENDIDIKAN KESIHATAN TERHADAP PROMOSI AKTIVITI FIZIKAL BERDASARKAN MODEL PRECEDE-PROCEED DI KALANGAN REMAJA DI YUNNAN,CHINA

ABSTRAK

Aktiviti fizikal yang kerap adalah penting untuk pertumbuhan remaja, manakala kekurangannya boleh menjejaskan perkembangan mereka. Model PRECEDE-PROCEED ialah rangka kerja promosi kesihatan yang digunakan secara meluas yang memfokuskan kepada faktor psikologi dan sosial. Model ini terdiri daripada dua fasa: PRECEDE (diagnosis) dan PROCEED (pelaksanaan dan penilaian), dengan jumlah sembilan langkah. Dalam fasa PRECEDE, melalui lima langkah diagnostik (diagnosis sosial, diagnosis epidemiologi, diagnosis tingkah laku dan persekitaran, diagnosis pendidikan dan organisasi, serta diagnosis pengurusan dan dasar), analisis menyeluruh tentang faktor yang mempengaruhi tingkah laku kesihatan dijalankan, meringkaskan faktor mudah terdedah (sikap dan kepercayaan), faktor pengukuhan (sokongan sosial), dan faktor pemboleh (sumber dan dasar). Dalam fasa PROCEED, program intervensi yang disasarkan direka bentuk, dilaksanakan dan dinilai. Kajian ini mengikuti sembilan langkah model PRECEDE-PROCEED dan dijalankan dalam tiga fasa: dua kajian keratan rentas diikuti dengan percubaan terkawal rawak. Peserta dipilih menggunakan pensampelan kelompok. Pada peringkat pertama, kebolehpercayaan dan kesahan beberapa soal selidik berkaitan aktiviti fizikal (ASAFA-C, Q-SPACE-C, EBBS-CN, PASES-C, dan PAQ-CN) telah diuji menggunakan analisis faktor pengesahan dan kebolehpercayaan ketekalan dalaman. Sebanyak 625 soal selidik telah dikumpul, dengan 586 jawapan yang sah (49.8% lelaki, 50.2% perempuan). Analisis data dilakukan menggunakan Mplus 8.0 dan SPSS 29.0, mengesahkan bahawa semua

model mempunyai kesesuaian yang baik dalam julat yang boleh diterima. Keputusan ini mengesahkan soal selidik sebagai alat yang boleh dipercayai untuk menilai aktiviti fizikal remaja di Wilayah Yunnan. Dalam Kajian 2, persampelan rawak menghasilkan 1,250 soal selidik yang lengkap, dengan 920 jawapan yang sah (51.2% lelaki, 48.8% perempuan). SPSS 29.0 digunakan untuk menganalisis faktor yang mempengaruhi aktiviti fizikal remaja, termasuk sokongan sosial, efikasi kendiri, faedah/halangan senaman, persekitaran sekolah, kecergasan fizikal, dan tahap aktiviti. Keputusan menunjukkan tahap aktiviti fizikal tidak mencukupi, kecergasan fizikal mereka berada pada tahap lulus, dan faktor lain berada pada tahap sederhana dalam kalangan remaja (pelajar sekolah menengah) di Wilayah Yunnan, China. SEM mengesahkan hubungan yang signifikan antara faktor-faktor ini, dengan indeks muat model yang baik (RMSEA (90% CI) = 0.029 [0.026, 0.033], CFI = 0.981, TLI = 0.979, SRMR = 0.031). Dalam Kajian 3, program pendidikan kesihatan selama 12 minggu telah dibangunkan, menggabungkan kuliah dengan aktiviti fizikal. Intervensi itu termasuk sesi pembelajaran interaktif selama 45 minit dan aktiviti fizikal selama 45 minit, dengan ibu bapa mengambil bahagian dalam dua sesi. Seramai 156 pelajar sekolah menengah mengambil bahagian, dengan kumpulan intervensi (n = 79) dan kumpulan kawalan (n = 77). Peserta melengkapkan soal selidik dan ujian kecergasan fizikal pada empat mata: sebelum intervensi, semasa minggu ke-4 dan ke-8, dan selepas program. Analisis data menggunakan SPSS 29.0 dan ANOVA Campuran menunjukkan bahawa kumpulan intervensi mempunyai skor yang lebih tinggi secara signifikan dalam sokongan sosial, efikasi kendiri, faedah senaman, kecergasan fizikal, dan tahap aktiviti fizikal. Mereka juga mempunyai markah yang lebih rendah dalam halangan senaman dan had persekitaran sekolah berbanding kumpulan kawalan. Kajian itu menyimpulkan bahawa alat ukuran yang disahkan secara berkesan menilai aktiviti fizikal remaja, dan

program pendidikan kesihatan berasaskan PRECEDE-PROCEED berjaya meningkatkan faktor utama yang mempengaruhi penyertaan aktiviti fizikal dalam kalangan pelajar sekolah menengah di China. Walaupun kajian ini memberikan pandangan yang berharga, adalah penting untuk ambil perhatian bahawa sampel adalah terhad secara geografi, yang mungkin menjejaskan kebolehgeneralisasian keputusan.

EFFECTS OF HEALTH EDUCATION ON PHYSICAL ACTIVITY PROMOTION BASED ON PRECEDE-PROCEED MODEL AMONG ADOLESCENTS IN YUNNAN, CHINA

ABSTRACT

Regular physical activity is crucial for adolescent growth, while a lack of it can harm development. The PRECEDE-PROCEED model is a widely used health promotion framework that focuses on psychological and social factors. The model consists of two phases: PRECEDE (assessment) and PROCEED (implementation and evaluation), with a total of nine steps. In the PRECEDE phase, through five assessment steps, a comprehensive analysis of factors affecting health behavior is conducted, summarizing susceptible factors (attitudes and beliefs), reinforcing factors (social support), and enabling factors (resources and policies). In the PROCEED phase, targeted intervention programs are designed, implemented, and evaluated. This study followed the nine steps of the PRECEDE-PROCEED model and was conducted in three phases: two cross-sectional studies followed by a randomized controlled trial. In Phase 1, the researchers used cluster random sampling to select the participants. The reliability and validity of several physical activity-related questionnaires (ASAFA-C, Q-SPACE-C, EBBS-CN, PASES-C, and PAQ-CN) were tested using confirmatory factor analysis and internal consistency reliability. A total of 625 questionnaires were collected, with 586 valid responses (49.8% male, 50.2% female). Data analysis was done using Mplus 8.0 and SPSS 29.0, confirming that all models had good fit within acceptable ranges. These results validated the questionnaires as reliable tools for assessing adolescent physical activity in Yunnan Province. In Phase 2, cluster random sampling resulted in 1,250 completed questionnaires, with 920 valid responses (51.2%

male, 48.8% female). SPSS 29.0 was used to analyse factors influencing adolescent physical activity, including social support, self-efficacy, exercise benefits/barriers, school environment, physical fitness, and activity levels. The results showed that physical activity level was insufficient, their physical fitness was at a passing level, and the other factors were at a moderate level among adolescents (high school students) in Yunnan Province, China. SEM confirmed significant relationships between these factors, with good model fit indices (RMSEA (90% CI) = 0.029 [0.026, 0.033], CFI = 0.981, TLI = 0.979, SRMR = 0.031). In Phase 3, a 12-week health education program was developed, combining lectures with physical activity. The intervention included 45-minute interactive learning sessions and 45-minute physical activities, with parents participating in two sessions. A total of 156 high school students participated, with the intervention group (n=79) and control group (n=77). Participants completed questionnaires and physical fitness tests at four points: before the intervention, during the 4^{th} and 8^{th} weeks, and after the program. Data analysis using SPSS 29.0 and Mixed ANOVA showed that the intervention group had significantly higher scores in social support, self-efficacy, exercise benefits, physical fitness, and physical activity levels. They also had lower scores in exercise barriers and school environment limitations compared to the control group. The study concluded that the validated measurement tools effectively assess adolescent physical activity, and the PRECEDE-PROCEED-based health education program successfully improved key factors influencing physical activity participation among high school students in China. Although this study provides valuable insights, it is important to note that the sample was geographically limited, which may affect the generalizability of the results.

CHAPTER 1

INTRODUCTION

1.1 Background

Physical activity (PA) is clearly defined in a related report released by the World Health Organization (WHO) in 2010 as any bodily movement produced by skeletal muscles that requires energy expenditure (World Health Organization, 2010). For adolescents, the scope of physical activity is vast, encompassing organised and unorganised forms of activity. Organized activities include physical education classes offered by schools and structured exercise programs organised by schools or communities. Unorganized activities, on the other hand, include playing with peers, spontaneously running or playing ball games, choosing to walk or cycle as a mode of transportation to and from school, and engaging in various recreational activities during leisure time (Hu, 2022).

The health benefits of physical activity for children and adolescents have been well documented (Etnier et al., 2009; Janssen et al., 2010; Kuan et al., 2019; Timmons et al., 2012). Physical activity during childhood and adolescence plays a vital role in health outcomes in adulthood, such as increasing bone mineral density and indirectly preventing overweight (Loprinzi et al., 2012). Existing evidence shows that people's health behaviours in adulthood are derived from the environment in which they live since childhood, and behavioural habits formed in childhood tend to be maintained in adulthood (Jones et al., 2013; Telama, 2009). At the same time, physical activity plays a vital role in the growth of adolescents, and its impact covers multiple levels of physiology, psychology, and cognition. Many studies have fully confirmed this. Regarding physiology, regular physical activity can improve cardiopulmonary function and enhance endurance and metabolic levels, while strength training can

promote muscle and bone development and increase bone density (Corder et al., 2008; Strong et al., 2005). In terms of psychology, exercise helps relieve learning and life pressure, reduce anxiety and depression, and enhance self-confidence and psychological resilience, which is closely related to the secretion of endorphins, dopamine, and other neurotransmitters during exercise (Biddle et al., 2019; Dinas et al., 2011; Dishman et al., 2009). Regarding cognition, physical activity can promote the secretion of neurotransmitters, improve attention, memory, and learning ability, and enable adolescents to perform better in academic development (Donnelly et al., 2011; Hillman et al., 2008).

In 2018, China issued the "Guidelines for Physical Activity for Chinese Children and Adolescents", which recommends that school-age children and adolescents (6-17 years old) should participate in moderate to high-intensity physical activity (MVPA) for no less than 60 minutes a day, including strenuous exercise at least 3 days a week (Zhang et al., 2017). However, a survey showed that as many as 84.3% of adolescents in China still need to meet this standard (Guthold et al., 2020). With the rapid development of science and technology, electronic devices such as smartphones and tablets are becoming increasingly popular and are deeply loved by adolescents. According to data from the China Internet Network Information Centre (CNNIC) (China Internet Network Information Center, 2024), the number of young Internet users is vast, and the Internet has become an essential part of their daily lives. This has led to a significant increase in the sedentary time of adolescents, who are immersed in electronic games and short videos for a long time, and a substantial decrease in the time and frequency of physical activities.

Meanwhile, Chinese adolescents, especially high school students, face significant academic pressure (Sun et al., 2012; Zhu et al., 2017); the high expectations of schools

and parents regarding academic performance place a heavy burden on students. As a result, they have to devote a substantial amount of time to studying. In this context, their extracurricular time is significantly reduced, further limiting opportunities for physical activity (Zhu et al., 2021). Insufficient physical activity among adolescents potentially threatens their physical and mental health development (World Health Organization, 2020). Lack of physical activity will lead to an increase in adolescent obesity rates, a decline in physical fitness, and an increased risk of chronic diseases such as cardiovascular disease and diabetes, which will hurt the physical and mental health of adolescents (Tremblay et al., 2011). Therefore, it is necessary to promote participation in physical activity among adolescents. At present, traditional ways of promoting physical activity have problems such as single content, boring form, and lack of pertinence, which makes it difficult to fully meet the actual needs of adolescents (Chen et al., 2020). Therefore, a more scientific and systematic theoretical framework is needed to design and implement effective intervention strategies to improve the intervention effect fundamentally.

The PRECEDE-PROCEED (Predisposing,.Reinforcing, and Enabling Constructs in Educational Diagnosis and Evaluation- Policy, Regulatory, and Organizational Constructs in Educational and Environmental Development) model was developed by Lawrence W. Green, a famous American health educator, as a practical, theoretical framework for evaluating, planning, implementing and promoting health programs (Gielen et al., 2008; Green et al., 2005). The model has become one of health education's most commonly used models (Crosby et al., 2011; Gielen et al., 2008). It is a guiding framework for health promotion strategies for different populations and has the advantage of integrating theoretical frameworks, interventions, and evaluations (Kim et al., 2022). The model comprehensively identifies the key factors affecting

adolescent physical activity through multi-dimensional diagnoses, such as sociology, epidemiology, behaviour, and environment (Green et al., 2005), and designs more targeted intervention strategies for predisposing factors, enabling factors, and reinforcing factors. During implementation, the model emphasises dynamic evaluation of processes, impacts, and results to ensure interventions' scientific nature and sustainability. From the feasibility perspective, the PRECEDE-PROCEED model has been widely used in health promotion projects worldwide and has accumulated rich empirical experience (Kim et al., 2022). As the central place for adolescent activities, schools can provide sufficient venues, teachers, and organizational support. At the same time, parents' attention to adolescent health has created a good social environment for implementing the model. In addition, the model has a clear, logical structure and rigorous steps, which are easy for health educators to understand and operate, thereby effectively promoting the implementation of intervention projects to promote adolescent physical activity (Gielen et al., 2008).

In this context, this study explored the impact of health education based on the PRECEDE-PROCEED model on the promotion of physical activity among Chinese adolescents, aiming to improve adolescents' ability to participate in physical activity, enhance their relevant knowledge, and improve their physical health through systematic guidance and intervention. The study's results would provide empirical support for the formulation of scientific and practical strategies to promote physical activity among adolescents and contribute necessary evidence to improving the level of physical activity among Chinese adolescents and promoting their physical and mental health development.

1.2 Problem statement

Globally, many children and adolescents were relatively inactive, and most did not even meet the recommended amount of physical activity (Ferreira de Moraes et al., 2013). The trend of insufficient physical activity is rapidly increasing in most societies around the world (Hallal et al., 2012; Müller et al., 2013). A study based on 1.6 million school-age adolescents explored adolescents' physical activity in 146 countries and regions and assessed the global, regional, and national trends in insufficient physical activity. The results showed that most adolescents do not meet the physical activity guidelines, risking their current and future health (Guthold et al., 2020). In China, as in other parts of the world, insufficient physical activity is considered a key factor affecting human health (Guthold et al., 2010; Shangyi Guan, 2013). There is now sufficient evidence to show that insufficient physical activity is an essential cause of poor health among adolescents (Lu et al., 2017). Therefore, it is very necessary to pay attention to their health behaviours during adolescence and cultivate an active and healthy lifestyle for adolescents. Promoting physical activity is an integral part of health intervention measures.

Promoting adolescent physical activity has become a key public health concern (World Health Organization, 2020). However, most current approaches still heavily rely on traditional methods. Regular physical education classes follow standardized curricula, focusing on everyday sports activities (You et al., 2021). The main drawback of these conventional methods is their lack of individualization. Adolescents exhibit significant differences in cognition, physical fitness, interests, and sports skills. Yet, traditional approaches fail to account for these factors, leading to a lack of enthusiasm for physical activity among some students (Zhu et al., 2021).

The interaction of many complex factors affects adolescents' physical activity levels. Individual cognitive factors are crucial. Adolescents' interest and mental level in sports determine their willingness to participate in physical activities. If adolescents clearly understand the benefits of sports and are interested in a particular sport, they will participate more actively in related physical activities (Hallal et al., 2012); the individual's physical fitness level will also affect their participation in physical activities. Studies have found that a higher level of physical fitness in adolescence often encourages individuals to maintain active physical activity habits in adulthood (Mohlala, 2019). The family environment plays a vital role in this. Parents' attitudes and participation directly affect adolescents' cognition and behaviour towards physical activity. Parents who actively participate in sports and encourage their children to exercise are more likely to have children who develop good exercise habits (Niermann et al., 2015). Friends' support is also an essential factor affecting adolescent physical activity. Adolescents are in a stage of eagerness to socialize, and the social interaction and sports atmosphere between peers has a significant impact on their participation in sports. When peers around them are actively involved in physical activities, adolescents are more likely to be infected and take the initiative to participate in them (Biddle et al., 2011). The school atmosphere should not be ignored either. Reasonable sports curriculum settings and prosperous activity organization can give adolescents more opportunities and motivation to participate in sports. For example, increasing the diversity of sports courses, introducing novel projects, and holding various sports competitions can all help create a positive sports atmosphere (Rezende et al., 2015).

Although many studies have focused on factors related to adolescent physical activity, few studies have comprehensively explored the combined effects of individual cognition, physical fitness level, family environment, peer influence, school

atmosphere, and adolescent physical activity. Previous studies have often focused on analysing a single factor or a few factors and have failed to fully consider the complex interactions between these factors (Hearst et al., 2012; Lu et al., 2017), resulting in a lack of in-depth understanding of adolescent physical activity behaviour. This limitation in understanding adolescent physical activity behaviour is also reflected in actual intervention measures.

In recent years, traditional intervention measures to promote physical activity, such as simply increasing physical education classes and holding sports games, have improved adolescents' participation in physical activity to a certain extent. Still, there are significant limitations (Salmon et al., 2007). Health education based on the PRECEDE-PROCEED model, widely applied and proven effective in health promotion (Gielen et al., 2008; Green et al., 2005; Kim et al., 2022), remains underexplored in adolescent physical activity interventions in China. This model overcomes the limitations of traditional approaches, aiming to provide a comprehensive and targeted solution for enhancing adolescent physical activity levels and achieving long-term improvements.

Therefore, this study is based on the overall theoretical framework of the PRECEDE-PROCEED model, which follows the nine steps outlined in the model. First, the study analyzed the scores of adolescents (high school students) regarding physical activity social support, physical activity self-efficacy, exercise benefits and barriers, school physical activity environment, physical fitness, and PA level. To summarize the predisposing, enabling, and reinforcing factors affecting physical activity (PA) based on the literature analysis and analysis results. Then, we constructed

a structural equation model to examine the relationships among the variables. Finally, a targeted health education intervention program was designed and implemented.

1.3 Rationale and Significance of the Study

1.3.1 Rationale of the Study

This study employs the PRECEDE-PROCEED model (Green et al., 2005), an internationally recognized framework for developing and evaluating systematic health promotion programs (Crosby et al., 2011; Green et al., 2005; Kim et al., 2022), as its theoretical foundation. The model constructs a multidimensional analytical framework encompassing predisposing factors (individual-level factors, such as knowledge and attitudes), enabling factors (environmental factors, including resources and skills), and reinforcing factors (macro-level factors, including social support and policies). Through assessments in the PRECEDE phase, factors influencing health behaviors are systematically identified. In the PROCEED phase, targeted interventions are implemented, with comprehensive evaluations of the process, effects, and outcomes. This study applied the model's systematic methodology to conduct an empirical survey of insufficient physical activity among adolescents in Yunnan Province, China, providing scientific theoretical support for the design and evaluation of intervention strategies.

Insufficient physical activity among adolescents has become a global public health concern. According to data from the World Health Organization, 81% of adolescents worldwide fail to meet the recommended daily level of physical activity (World Health Organization, 2010). Studies in China have likewise revealed increasing prevalence of sedentary behavior and excessive screen time among adolescents (Chinese Health Education Center & Chinese Center for Disease Control

and Prevention, 2017; Zhang et al., 2020; Department of Physical, Health and Arts Education, Ministry of Education of the People's Republic of China, 2022). In response, the WHO Guidelines on Physical Activity, Sedentary Behaviour and Sleep explicitly recommend that adolescents engage in at least 60 minutes of moderate-to-vigorous physical activity per day (World Health Organization, 2020). In China, the *Healthy China 2030* blueprint and relevant local policy documents in Yunnan Province have identified "strengthening school health education" and "improving adolescent physical fitness" as key development objectives (Central Committee of the Communist Party of China & State Council of the People's Republic of China., 2016;Yunnan Provincial People's Government.,2017;Yunnan Provincial Committee of the Communist Party of China.,2020), providing both policy support and practical guidance for the implementation of this study.

1.3.2 Significance of the Study

The significance of this study is to address a critical public health issue: insufficient physical activity levels among adolescents. Regular physical activity is essential for maintaining physical and mental health, but many adolescents fail to meet recommended activity levels. The findings of this study may have important implications in several ways: First, confirmatory factor analysis (CFA) conducted to validate the Chinese versions of the Assess Social Support for Physical Activity scale (ASAFA), Questionnaire-School Physical Activity Environment (Q-SPACE), Exercise Benefits/Barriers Scale (EBBS), Physical Activity Questionnaire (PAQ), and Physical Activity Self-efficacy Scale (PASES) scales, thereby enriching the research tools for promoting physical activity among Chinese adolescents.

Secondly, this study aims to improve adolescents' physical and mental health by promoting physical exercise and provides a basis for designing effective

intervention measures. The research helps policymakers understand the key conditions for promoting physical exercise among adolescents and supports the development of policies that encourage physical exercise in schools. Based on the PRECEDE-PROCEED model and considering the actual situation in China, the study uses structural equation models to construct a model of factors influencing physical exercise among Chinese adolescents. It analyses the relationships and interactions between these factors and exercise levels, ultimately forming a health education program suitable for promoting physical exercise among Chinese adolescents.

In addition, this study would help develop educational programs suitable for implementation in schools to help students understand the benefits of physical activity and how to overcome barriers to exercise. By systematically improving the physical activity level of adolescents in multiple dimensions, exercise can become an indispensable part of their lives. This study is also likely to have a broad and far-reaching impact on the long-term health of adolescents. As adolescents develop physical exercise habits and the effects of exercise gradually emerge, in the future, they will be able to significantly reduce their risk of chronic diseases such as obesity, diabetes, and heart disease in adulthood, laying a solid foundation for building a healthier and more vibrant society. In summary, this study explored the impact of health education based on the PRECEDE-PROCEED model on promoting physical activity among adolescents, aiming to fully understand the factors affecting physical activity and develop effective intervention measures to increase physical activity levels and ultimately promote the physical and mental health of adolescents.

1.4 Research question

Phase 1

1. Is the Chinese version questionnaire of ASAFA-C, Q-SPACE-C, PASES-C, PAQ-CN, EBBS-CN valid and reliable among adolescents with high school students in Kunming, Yunnan, China, based on confirmatory factor analysis?

Phase 2

2. What are the scores of physical activity social support, physical activity self-efficacy, exercise benefits and barriers, school physical activity environment, physical fitness, and PA level among adolescents, Yunnan, China?

3. Are there any significant path relationships between physical activity social support, physical activity self-efficacy, exercise benefits and barriers, school physical activity environment, physical fitness, and PA level among adolescents in Yunnan, China?

Phase 3

4. Is there any time effect of the PRECEDE-PROCEED model health education program intervention on physical activity social support, physical activity self-efficacy, exercise benefits and barriers, school physical activity environment, physical fitness, and PA level among adolescents in Yunnan, China?

5. Is there any group effect of the PRECEDE-PROCEED model health education program intervention on physical activity social support, physical activity self-efficacy, exercise benefits and barriers, school physical activity environment, physical fitness, and PA level among adolescents in Yunnan, China?

6. Is there any interaction effect (group*time) of the PRECEDE-PROCEED model health education program intervention on physical activity social support, physical activity self-efficacy, exercise benefits and barriers, school physical activity environment, physical fitness, and PA level among adolescents in Yunnan, China?

1.5 Research objective

General objective:

This study had three main objectives. First, to translate the Chinese versions of the ASAFA and Q-SPACE scales and verify the reliability and validity of the Chinese versions of ASAFA-C, Q-SPACE-C, PASES-C, PAQ-CN, and EBBS-CN. The second objective was to construct Structural Equation Modelling (SEM) to determine the interrelationships among social support for physical activity, physical activity self-efficacy, exercise benefits/barriers, school physical activity environment, physical fitness, and physical fitness level. The third objective was to develop a PRECEDE-PROCEED model health education intervention plan and implement the intervention to determine its impact on the measured variables among adolescents in Yunnan, China.

Specific objective：

Phase 1

1. To translate the ASAFA and Q-SPACE into Chinese versions, and support ASAFA, Q-SPACE literature search, content validity, and pre-testing.

2. To validate the translated Chinese version questionnaire ASAFA-C, Q-SPACE-C, PASES-C, PAQ-CN, EBBS-CN as valid and reliable among adolescents in high school students in Kunming, Yunnan, using Confirmatory Factor Analysis (CFA).

Phase 2

3. To analyse the scores of physical activity social support, physical activity self-efficacy, exercise benefits/barriers, school physical activity environment, physical fitness, and PA level among adolescents in Yunnan Province.

4. To develop a Structural Equation Modelling (significant path relationship) of physical activity social support, physical activity self-efficacy, exercise benefits/ barriers, school physical activity environment, physical fitness, and PA level among adolescents in Yunnan, China.

Phase 3

5. To determine the group effect of the PRECEDE-PROCEED model health education program intervention on physical activity social support, physical activity self-efficacy, exercise benefits/barriers, school physical activity environment, physical fitness, and PA level among adolescents in Yunnan, China.

6. To examine the group effects (between groups) of the PRECEDE-PROCEED model health education program intervention on physical activity social support, physical activity self-efficacy, exercise benefits/barriers, school physical activity environment, physical fitness, and PA level among adolescents in Yunnan, China.

7. To examine the interaction effects (within and between groups) of the PRECEDE-PROCEED model health education program intervention on physical activity social support, physical activity self-efficacy, exercise benefits/barriers, school physical activity environment, physical fitness, and PA level among adolescents in Yunnan, China.

1.6 Research hypothesis

Phase 1

1. The translated Chinese version questionnaire ASAFA-C, Q-SPACE, PASES-C-C, PAQ-CN, and EBBS-CN are valid among adolescents with high school students in Kunming, Yunnan, based on confirmatory factor analysis.

Phase 2

2. There are significant path relationships between physical activity social support, physical activity self-efficacy, exercise benefits and barriers, school physical activity environment, physical fitness, and PA level among adolescents in Kunming, Yunnan, China.

3. There are significant indirect relationships between physical activity social support, physical activity self-efficacy, exercise benefits and barriers, school physical activity environment, physical fitness, and PA level among adolescents in Kunming, Yunnan, China.

Phase 3

4. There is a significant time effect on the PRECEDE-PROCEED model health education program intervention on physical activity social support, physical activity self-efficacy, exercise benefits and barriers, school physical activity environment, physical fitness, and PA level among adolescents in Yunnan, China.

5. There is a significant group effect on the PRECEDE-PROCEED model health education program intervention on physical activity social support, physical activity self-efficacy, exercise benefits and barriers, school physical activity environment, physical fitness, and PA level among adolescents in Yunnan, China.

6. There is a significant interaction effect (group*time) on the PRECEDE-PROCEED model health education program intervention on physical activity social support, physical activity self-efficacy, exercise benefits and barriers, school physical activity environment, physical fitness, and PA level among adolescents in Yunnan, China.

1.7 Operational definition

1.7.1 PRECEDE phase (evaluation phase)

The researchers evaluated the current status of physical activity and health problems based on the PRECEDE stage of the PRECEDE-PROCEED model among adolescents in Yunnan Province, China. This evaluation is conducted through a series of steps, including sociological assessment, epidemiological assessment, behavioural and environmental assessment, educational assessment, organisational assessment, and management policy assessment.

1.7.1(a) Sociological assessment

Sociological assessment uses qualitative or quantitative research to understand all sociological characteristics that may affect the target population (Gielen et al., 2008; Green et al., 2005). This study effectively elucidates sociological assessment by analysing key social factors such as family or peer support. Family support may encompass parental encouragement for physical activity and providing resources for exercise. In contrast, peer support manifests through interactions with friends. This study used the *A Social Support for Physical Activity Scale for Adolescents* (ASAFA-C) for assessment.

1.7.1(b) Epidemiological assessment

Epidemiological assessment is based on existing health problem incidence data to assess the most pressing and vulnerable issues affecting quality of life (Gielen et al., 2008; Green et al., 2005). The epidemiological assessment of this study involved analysing the overall physical activity level and physical fitness level of adolescents. We assessed adolescents' overall physical activity levels using the PAQ-CN (*Physical Activity Questionnaire for Adolescents*). The evaluation followed the National Student

Physical Health Standard (2014 revision) (Ministry of Education., 2014), which includes test indicators such as BMI, vital capacity, 50-meter sprint, standing long jump, sit-ups, 1000-meter run (for boys) / 800-meter run (for girls), pull-ups (for boys) / sit-ups (for girls), and other physical fitness tests.

1.7.1(c) Behavioural environment assessment

Behavioural environment assessment is an assessment of the target population's physical activity, behavioural cognition, and environmental factors that may lead to health problems (Gielen et al., 2008; Green et al., 2005). The behavioural environment assessment in this study mainly refers to the behavioural patterns and environments that are particularly related to adolescents' cognition of physical activity, including exercise self-efficacy, exercise benefits and barriers, and the school physical activity environment. The *Physical Activity Self-efficacy Scale* (PASES-C), the *Exercise Benefits/Barriers Scale-Chinese* (EBBS-CN), and the *School Physical Activity Environment Questionnaire* (Q-SPACE-C) were used for assessment.

1.7.1(d) Educational organization assessment

The educational and organizational assessment involves identifying predisposing, reinforcing, and enabling factors through literature analysis after selecting relevant behavioural and environmental intervention factors to initiate and sustain the change process (Gielen et al., 2008; Green et al., 2005). These factors collectively influence the likelihood of behavioural and environmental changes occurring.

Predisposing factors are antecedents of behavior, providing reasons or motivation for the behaviour (Green et al., 2005). They include personal knowledge, attitudes, beliefs, personal preferences, existing skills, and self-efficacy beliefs. Reinforcing factors are subsequent to the behaviour, providing continuing rewards or incentives for the persistence or repetition of the behaviour (Green et al., 2005). Examples include

social support, peer influence, significant others, and vicarious reinforcement. Enabling factors are prerequisites for behaviour or environmental change, facilitating the realization of motivation or environmental policy (Green et al., 2005). Enabling factors can directly or indirectly influence behaviour through environmental factors. They include programs, services, and resources required to achieve behavioural and environmental outcomes.

1.7.1(e) Administrative and policy assessment

Administrative and policy assessment policies, regulations, and organisational management capabilities and resources that affect the implementation of intervention measures (Gielen et al., 2008; Green et al., 2005). The study will review relevant policies on physical activity at the national, provincial, municipal, and school levels through literature research to provide policy support for implementing intervention measures for youth physical activity.

1.7.2 PROCEED phase (experimental intervention)

The second stage is the PROCEED stage, which uses policies, regulations and organisational means to implement education and environmental interventions, including four steps: implementation, process evaluation, impact evaluation and outcome evaluation (Gielen et al., 2008; Green et al., 2005). Based on the assessment results of the PRECEDE phase, we developed a health education program and implementation plan to promote physical activity among adolescents using the PRECEDE-PROCEED model. We used a randomised controlled trial (RCT) method to evaluate the changes in research variables (physical activity social support, physical activity self-efficacy, exercise benefits and barriers, school physical activity environment, physical fitness, and PA level) before and after the intervention of the PRECEDE-PROCEED model health education program.

1.7.2(a) Implementation

Based on the evaluation results of the PRECEDE stage, formulate a health education intervention plan and determine in detail the implementation steps, timetable, and person in charge of the intervention plan (Gielen et al., 2008; Green et al., 2005); conduct training mobilization and train the personnel participating in the intervention plan to improve their execution ability and enthusiasm; carry out health education activities according to the plan to ensure that all activities are completed on time, with quality, and in quantity.

1.7.2(b) Process evaluation

In implementing the intervention plan, process evaluation is essential to ensure that the plan proceeds as intended (Gielen et al., 2008; Green et al., 2005). We monitored the implementation progress through observation, recording, and interviews, providing real-time oversight of intervention activities. We collected feedback to understand participants' opinions and evaluate the effectiveness of the intervention activities while identifying any existing issues. Based on the evaluation results, we promptly adjusted the intervention measures to enhance the implementation's effectiveness.

1.7.2(c) Impact evaluation

After a period of implementing the intervention plan, conduct an impact assessment to understand the short-term effects of the intervention measures (Gielen et al., 2008; Green et al., 2005). We assessed behaviour changes by evaluating the target population's health behaviour changes through questionnaires and fitness tests. We evaluated changes in health knowledge and attitudes by assessing shifts in the target population's health knowledge and attitudes through questionnaires. Additionally, we summarised the impact effects by evaluating the short-term effects

on the target population's health behaviours, health knowledge, and attitudes through questionnaires and fitness tests.

1.7.2(d) Outcome evaluation

After completing the intervention plan, a results evaluation should be conducted to understand the long-term effects of the interventions (Gielen et al., 2008; Green et al., 2005). We assessed adolescents' physical activity levels and related variables through questionnaires and fitness tests, evaluating the changes in these variables. We then compiled a summary report to evaluate the overall effectiveness of the intervention plan.

1.7.3 Physical activity social support (PASS)

PASS, which stands for "Physical Activity Social Support", was used in this study, and we used the ASAFA scale for measurement. It assesses the level of social support adolescents receive in physical activity. The ASAFA scale is a specially designed measurement tool that quantifies the support adolescents receive from various social relationships, such as parental and friend support (Farias et al., 2014). Through the ASAFA scale, we can gain a comprehensive understanding of the support system for adolescents in physical activity, providing data support and guidance for promoting adolescent physical activity.

1.7.4 Physical activity self-efficacy (PASE)

The PASE, which stands for "Physical Activity Self-Efficacy", reflects adolescents' confidence and cognitive abilities in initiating and maintaining physical activities. This study used the PASES-C scale to measure and assess adolescents' self-confidence levels when facing various situations and challenges, helping researchers

understand their psychological motivation and beliefs in physical activity (Chen et al., 2019).

1.7.5 Exercise benefits and barriers (EBBS)

EBB, which refers to “Exercise Benefits and Barriers”, is used to assess adolescents' perception of the potential benefits and possible barriers to physical exercise. This concept reflects how adolescents view the positive impact of exercise on their health and quality of life when considering participating in exercise, as well as the barriers that may be encountered in the actual participation process. This study adopted the EBBS-CN scale to measure this area more comprehensively (Guo, 2016). This scale is designed to quantify adolescents’ perceptions of the benefits and barriers of exercise in order to gain a deeper understanding of their exercise attitudes and behaviours.

1.7.6 School physical activity environment (SPAE)

SPAE stands for “School Physical Activity Environment” and covers the resources and facilities that schools provide to promote students’ participation in physical activities. This includes the physical education curriculum, the organization of physical activities, the availability of sports equipment, the accessibility of sports facilities, the importance of physical activities in schools, and the attitudes of teachers and students towards physical activities. This study used the Q-SPACE scale to measure and evaluate the environmental conditions and support systems related to physical activities within schools (Martin et al., 2011). The scale is designed to quantify the different dimensions of the school physical activity environment (physical environment and social environment), thereby helping researchers to gain a deeper understanding of its role in promoting students' participation in physical activities.

1.7.7 Physical fitness (PF)

PF, which stands for “Physical fitness”, reflects the physical health level of adolescents. According to the National Student Physical Fitness Standard (revised in 2014) issued by the Ministry of Education of China (Ministry of Education, 2014), physical fitness level is divided into three aspects: body composition, body function, and physical quality. The comprehensive evaluation of the physical health of high school students is based on the Physical Fitness Standard formulated by the Ministry of Education in 2014. In Kunming, Yunnan Province, the physical fitness level assessment of high school students includes the measurement of BMI, vital capacity, 50-meter sprint, standing long jump, sit-ups, 800-meter run for girls/1000-meter run for boys, pull-ups for boys/sit-ups for girls. In this study, the PF comprehensive score is calculated by the weighted sum of the scores of various indicators (BMI, VC, 50 meters, SLJ, SFB, 800/1000 meters, PU/SU).

1.7.8 Physical activity level (PA)

PA, which stands for “physical activity level”, reflects the frequency and intensity of an individual’s participation in physical exercise. This indicator demonstrates the extent to which an individual engages in various physical activities in daily life, including sports, exercise, and everyday tasks. In this study, we utilised the PAQ-CN scale to assess the level of physical activity among adolescents (high school students), as it is designed to quantify participants’ physical activity levels systematically.

1.7.9 Confirmatory factor analysis (CFA)

CFA is a structural equation that deals with measurement models: the relationships between observed variables or indicators (items, test scores, social cognitive assessments) and latent variables or factors (Brown et al., 2012). It gives a

narrower understanding of covariation between multiple indicators since the number of factors differs from the number of measured variables.

1.7.10 Structural equation modelling (SEM)

SEM combines factor and multiple regression analyses to analyze the structural relationships between measured variables and latent constructs (Kline, 2023). SEM was used to examine the structural relationships between physical activity social support, physical activity self-efficacy, exercise benefits and barriers, school physical activity environment, physical fitness, and PA level.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

To understand the research topic comprehensively, the researcher conducted an extensive review of existing literature, encompassing both published and unpublished studies in the relevant field. The findings from this meticulous review have been synthesised and presented in this chapter to provide readers with invaluable insights into the current research. Subchapters will comprehensively address all pertinent variables and concepts.

The previous research articles were obtained from well-known online databases, including authoritative journals such as Google Scholar, PubMed, Sport Discus (EBSCO), Web of Science, Scopus, and CNKI. Researchers utilized these databases to collect relevant studies comprehensively. The literature search process involved the use of keywords related to various aspects, including the definition of adolescents and physical activity, the PRECEDE-PROCEED model, health promotion programs for adolescent physical activity, fitness levels, exercise-related social support and self-efficacy, barriers, and benefits of exercise participation. Factors in designing and evaluating school sports environments were also considered. Additionally taken into account were factors influencing program implementation (predisposing factors), factors supporting program effectiveness (enabling factors), reinforcing factors for promoting healthy behaviour intervention measures in health education programs, randomized controlled trials (RCTs), confirmatory factor analysis (CFA); structural equation modelling (SEM); Mixed-design Analysis of Variance (ANOVA) and Mixed-design multivariate analysis of variance (MANOVA). In the literature search process, Boolean operators “AND” or “OR” were combined with keywords.

2.2 Definitions of relevant concepts

2.2.1 Adolescents

The age group of "adolescents" varies from organization to organization, region to region, and from research literature to research literature. The World Health Organization (WHO) defines children and adolescents as 5-17 years old and adolescents as 11-17 years old (World Health Organization, 2020). The Australian Department of Health defines the adolescent group as 13-17 (Okely et al., 2019). The UK Chief Medical Officer Recommendation - Physical Activity Guidelines defines children and adolescents as 5-18 years old, with adolescents aged 11-18 (Moore, 2019). German National Physical Activity Recommendations and Physical Activity Promotion divides the age group of children and adolescents into 5-18 years old, among which 12-18 years old are adolescents (Rütten et al., 2016). The Physical Activity Guidelines for Americans (Second Edition) formulated by the US Department of Health and Human Services defines the age range of 3-5 years as preschool children, the age range of 6-17 years as children and adolescents, and the age range of 11-17 years as adolescents (Piercy et al., 2018). Guo defined adolescents in the age range of 11-22 years in their doctoral thesis (Guo, 2016), while Hu defined adolescents in the age range of 11-18 years in their doctoral dissertation (Hu, 2022). This study refers to the definition of adolescents by scholars at home and abroad. It combines with the object of this study to define the age range of adolescents as 15-18 years old, which is mainly Chinese students in the stage of high school education.

2.2.2 Physical activity

Physical activity (PA) is widely defined as any form of body movement that requires energy expenditure and involves skeletal muscle contractions (World Health Organization, 2010). This definition encompasses a range of activities from daily basic