STRUCTURAL EQUATION MODEL AND EFFECT OF BRAIN BREAKS VIDEO EXERCISE ON TRANSTHEORETICAL CONSTRUCTS AND PHYSICAL ACTIVITY AMONG PEOPLE WITH TYPE 2 DIABETES MELLITUS

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LIST OF ABBREVIATIONS, ACRONYMS AND SYMBOLS

AF	Aktiviti Fizikal
ANOVA	Analysis of Variance
BMI	Body mass index
CDC	Centers for Disease Control
CFA	Confirmatory factor analysis
CFI	Comparative fit index
CHD	Coronary heart disease
Chisq/df	Chi-square/degrees of freedom
CI	Confidence interval
CKD	Chronic kidney disease
CR	Composite reliability
CVI	Content validity index
CVD	Cardiovascular disease
df	Degree of freedom
DB	Decisional balance
DM	Diabetes mellitus
EFA	Exploratory factor analysis
ESE	Exercise self-efficacy
GCH	Global Community Health
HbA1c	Haemoglobin A1c
HREC	Human Research Ethics Committee
IFT	Impaired fasting glycaemia
IGT	Impaired glucose tolerance

IKB	Indeks Kesesuaian Bandingan
IPAQ	International physical activity questionnaire
ITL	Indeks Tucker Lewis
JEPeM	Jawatankuasa Etika Penyelidikan Manusia
kg	kilogram
KI	Kurtosis index
KMO	Kaiser-Meiyer-Olkin
KMJ2	Kencing Manis Jenis 2
KRK	Klinik Rawatan Keluarga
MANOVA	Multivariate analysis of variance
MT	Model Transteorikal
NCDs	Non-communicable diseases
NHMS	National Health and Morbidity Survey
NIDDK	National Institute of Diabetes and Digestive and Kidney Diseases
OECD	Organization for Economic Cooperation and Development
PA	Physical activity
PALMS	Physical activity leisure motivation scale
PMSAP	Piawai Min Sisa Akar Persegi
POC	Processes of change
PRMAP	Penghampiran Ralat dari Min Akar Persegi
RCT	Randomised controlled trial
RM	Repeated measures
RMR	Root Mean Square Residual
RMSEA	Root Mean Square Error of Approximation
SAFMR	Skala Aktiviti Fizikal dan Motivasi Rekreasi

SSAFA	Soal Selidik Aktiviti Fizikal Antarabangsa
SEM	Structural Equation Modelling
SI	Skew index
SOC	Stages of change
SRM	Standard Root Mean Square Residual
T2DM	Type-2 diabetes mellitus
TLI	Tucker Lewis Index
TTM	Trantheoretical Model
USM	Universiti Sains Malaysia
WHO	World Health Organization

MODEL PERSAMAAN STRUKTUR DAN KESAN VIDEO SENAMAN *BRAIN BREAKS* TERHADAP PEMBINAAN TRANSTEORI DAN AKTIVITI FIZIKAL DALAM KALANGAN PENGHIDAP KENCING MANIS JENIS 2

ABSTRAK

Aktiviti fizikal (AF) telah menjadi tonggak dalam membina dan mengekalkan gaya hidup sihat sejak beberapa abad yang lalu. Peratus penghidap kencing manis jenis 2 (KMJ2) yang tidak aktif secara fizikal adalah tinggi. Terdapat banyak instrumen berdasarkan teori telah dibina untuk mengkaji mekanisma psikologi manusia terhadap AF. Model Transteori (MT) adalah model yang kohesif dan dibina untuk mempelajari perubahan tingkah laku seseorang ketika mereka merasa bersedia untuk berubah. MT yang terdiri daripada Skala Tahap Perubahan (STP), Skala Proses Perubahan (SPP), Skala Keseimbangan Keputusan (SKK), dan Skala Senama Keberkesanan Diri (SSKD) biasanya digunakan untuk menilai kesediaan seseorang dalam menerapkan tabiat baru yang lebih sihat dan memberikan cadangan, atau proese perubahan dalam usaha untuk membantu mereka. Motivasi adalah salah satu komponen penting dalam proses psikologi individu dalam menentukan penglibatan mereka dalam aktiviti fizikal. Terdapat dua objektif utama dalam kajian ini. Pertama adalah untuk menentukan hubungan antara konstruk psikologi MT, motif melakukan FA dan jumlah FA dalam kalangan penghidap KMJ2 di Hospital Universiti Sains Malaysia (USM), Kelantan. Manakal objektif kedua adalah untuk mengenalpasti kesan intervensi video senaman *Brain Breaks* dalam kalangan penghidap KMJ2 di Hospital USM. Kajian ini telah dilakukan dalam dua fasa, iaitu fasa pertama merupakan kajian keratan rentas dan fasa kedua merupakan percubaan rawak terkawal. Persampelan bertujuan telah dilakukan

untuk pengambilan peserta kajian. Seramai 331 penghidap KMJ2 telah menyertai kajian fasa pertama dan 70 daripada mereka juga menyertai kajian fasa kedua. MT, Skala Aktiviti Fizikal dan Motivasi Rekreasi (SAFMR) dan Soal Selidik Aktiviti Fizikal Antarabangsa (SSAFA) telah digunakan untuk mengukur perubahan tingkah laku dan motivasi terhadap AF, dan mengukur jumlah AF. Peserta fasa satu telah melengkapkan satu set soalselidik, yang terdiri daripada data demografi, MT (skala tahap perubahan, skala proses perubahan, skala keseimbangan keputusan, skala senaman keberkesanan diri), SAFMR, dan SSAFA. Selepas tahap SPP, SKK, SSKD, SAFMR, dan SSAFA telah dikenalpasti, fasa dua telah dijalankan bagi menilai tahap keberkesanan video intervensi ke atas pembolehubah-pembolehubah tersebut. Peserta fasa dua telah dibahagikan secara rawak ke dalam kumpulan intervensi dan kawalan bagi menjalani empat bulan tempoh intervensi. Video *Brain Breaks* memaparkan senaman untuk pesakit KMJ2 selama 10 minit yang hanya diberikan kepada kumpulan intervensi. Kedua-dua kumpulan telah melengkapkan set soal selidik yang sama pada setiap bulan sehingga bulan keempat dalam tempoh intervensi. Data yang dikumpul telah dianalisis dengan SPSS 26 untuk statistik deskriptif, graf, dan Analisis Varians Pengukuran Berulang dan Analisis Varians Pelbagai Pengukuran Berulang, dan Mplus 8 untuk analisis pengesahan faktor dan pemodelan persamaan struktur. Pada fasa 1, sebahagian besar peserta adalah lelaki (52%) dan Melayu (89.4%) dengan min umur 62.6 (sisihan piawai 0.56). Model struktur akhir menepati data dan juga menghasilkan indeks model sesuai yang baik [Indeks Bandingan Kesesuaian = 0.953, Indeks Tucker Lewis = 0.925, Baki Punca Kuasa Piawai Min = 0.031, Penghampiran Punca Kuasa Ralat Min (PPKRM) (90% Selang Keyakinan) = 0.059 (0.040, 0.078), nilai-*p* PPKRM = 0.209]. Ia juga menghasilkan hubungan yang bererti antara MT, motif FA, dan jumlah FA dengan 16 hipotesis khusus bagi permodelan persamaan struktur (11 hipotesis dari

model asal dan lima penambahan hipotesis alternatif) yang disokong oleh model akhir. Faktor kecenderungan kepada keseimbangan keputusan, jangkaan orang lain, dan keadaan psikologi adalah konstruk yang mempengaruhi FA secara langsung. Manakala, konstruk yang lain mempunyai hubungan tidak langsung yang bererti dengan FA. Seperti pada fasa 1, peserta fasa 2 juga kebanyakkannya terdiri dari bangsa Melayu (90%) dan lelaki (55.7%), dengan median umur 56 tahun (julat antara kuartil = 10). Kumpulan intervensi menunjukkan markah yang lebih tinggi yang bererti berbanding dengan kumpulan kawalan dalam sembilan konstruk psikologi (kognitif, tingkah laku, kelebihan, kekurangan, penampilan, jangkaan orang lain, keadaan fizikal, penguasaan dan skala senaman keberkesanan diri dengan nilai $p < 0.001$, < 0.001, < 0.001, 0.008, 0.014, < 0.001, 0.023, 0.021 dan < 0.001, masing-masing). Kumpulan intervensi juga menghasilkan markah yang lebih tinggi yang bererti berbanding kumpulan kawalan dalam jumlah FA (nilai $p = 0.001$). Kesimpulannya, pemikiran positif sangat penting dalam menentukan perubahan tingkah laku kearah gaya hidup yang aktif dalam kalangan penghidap KMJ2, kerana ia mempengaruhi proses perubahan, keseimbangan keputusan, senaman keberkesanan diri dan motivasi FA dengan prestasi FA. Video *Brain Breaks* adalah berguna secara empirik terhadap penghidap KMJ2 kerana ia mengubah tingkah laku dan motivasi untuk lebih cenderung ke arah FA.

STRUCTURAL EQUATION MODEL AND EFFECT OF BRAIN BREAKS VIDEO EXERCISE ON TRANSTHEORETICAL CONSTRUCTS AND PHYSICAL ACTIVITY AMONG PEOPLE WITH TYPE 2 DIABETES MELLITUS

ABSTRACT

Physical activity (PA) has become a cornerstone in developing and maintaining a healthy lifestyle over the past century. A high percentage of people with type 2 diabetes mellitus (T2DM) are physically inactive. Many theoretical instruments have been developed to study the psychological mechanism behind people's attitudes towards PA. The transtheoretical model (TTM) is a cohesive model and was developed to encourage changes in a person's behaviour when they felt ready to change. TTM that consists of Stages of change (SOC), Processes of change (POC), Decisional balance (DB), and Self-efficacy (SE) were commonly applied to assess a person's preparedness to adopt a new, healthier habit and offers suggestions, or change processes, to help them. Motivation is one of the essential components in the psychological process of individuals in deciding their participation in physical activities. There were two main objectives of this study. First, to determine the relationship between TTM psychological constructs, motives for PA and amount of PA among people with T2DM at Hospital Universiti Sains Malaysia (USM), Kelantan. While second objective, to identify the effect of Brain Breaks video intervention on the measured variables among people with T2DM at Hospital USM. The study was carried out in two phases, which were phase 1, a cross-sectional study and phase 2, a randomised controlled trial. Purposive sampling was used to recruit participants. In phase 1, 331 people with T2DM were recruited, and 70 people from phase 1 were involved in phase 2. The TTM,

physical activity and leisure motivation scale (PALMS), and international physical activity questionnaire (IPAQ) were used to measure the behaviour changes and motivation for and the amount of PA. Participants in phase 1 completed a set of questionnaires, consists of the demographics data, TTM [processes of change (POC) scales, decisional balance (DB) scales, exercise self-efficacy (ESE) scales], PALMS, and IPAQ. After the level of participants' POC, DB, ESE, PA motivation, and PA amount were determined, Phase 2 was performed to discover the effectiveness of video intervention on the measured variables. Participants in phase 2 were randomised into intervention and control groups who underwent four months of intervention. A10-minutes Brain Breaks video featuring exercises were given only to the intervention group. Both groups completed the same set of questionnaires monthly until the fourth month of the intervention period. The collected data were analysed with SPSS 26 for descriptive statistics, graphs, and repeated measures analysis of variance and repeated measures multivariate analysis of variance and Mplus 8 for confirmatory factor analysis and structural equation modelling. In phase 1, most participants were males (52%) and Malays (89.4%) with a mean age of 62.6 years (SD 0.56). The final structural model fits the data well as it produced good model fit indices [comparative fit index (CFI) = 0.953, Tucker Lewis index (TLI) = 0.925, standardised root mean square residual (SRMR) = 0.031, root mean square error of approximation (RMSEA) (90% CI) = 0.059 (0.040, 0.078), RMSEA p-value = 0.209]. It also produced a significant inter-relationship between the TTM, PA motives and amount of PA, with 16 SEM specific hypotheses (11 hypotheses from the initial model and five additional alternative hypotheses) were supported by the final model. Pros of DB, other's expectation, and psychological condition were constructs that directly affected PA, while the other constructs had a significant indirect relationship with PA. As in phase 1, participants in

phase 2 were also predominantly Malays (90%) and males (55.7%), with a median age was 56 years (IQR = 10). The intervention group showed significantly higher score than the control group in nine psychological constructs [cognitive, behavioural, pros, cons, appearance, others' expectation, physical condition, mastery, and ESE with *p*-values < 0.001, < 0.001, < 0.001, 0.008, 0.014, < 0.001, 0.023, 0.021, and < 0.001, respectively]. The intervention group also scored significantly higher in the amount of PA than the control group (*p*-value = 0.001). In conclusion, a positive mind-set is crucial in deciding a behavioural change towards an active lifestyle in people with T2DM, because it influences POC, DB, ESE and PA motivations with PA performance. Brain Breaks videos empirically beneficial for people with T2DM because they changed people's behaviour and motivations to make them inclined towards more PA.

CHAPTER 1

INTRODUCTION

1.1 Background

Physical activity (PA) has become a cornerstone of developing and maintaining a healthy lifestyle over the past century. It is admitted since fifth century BC by a physician, Hippocrates who stated, “all parts of the body, if used in moderation and exercised in labours to which each is accustomed, become thereby healthy and well developed and age slowly; but if they are unused and left idle, they become liable to disease, defective in growth and age quickly” (Kokkinos & Myers, 2010) (Kokkinos & Myers, 2010, p.1637). In the early 1970s and 1980s, the discovering of the population’s PA levels has begun and continued up until today (Ainsworth & Macera, 2012). Besides, physical inactivity was also recognised as one of the vital risk factors of coronary heart disease (Fletcher et al., 1996). Since then, the apprehensiveness over physical inactivity has emerged as one of the health major issues. Thus, doctors and researchers initiated many studies and research that related to the PA and disease reduction (Plotnikoff et al., 2010; Pinto et al., 2013; Beekman et al., 2014; K. Shah et al., 2016).

World Health Organization (2020a) defined non-communicable diseases (NCDs) as “chronic diseases, tend to be of long duration and are the result of a combination of genetic, physiological, environmental and behaviours factors”. Cardiovascular diseases, cancers, chronic respiratory diseases, and diabetes are the example types of non-communicable diseases by which, CVD is the highest death cause of non-communicable diseases with 17.7 million per year. These four diseases with

other non-communicable diseases causing 15 million deaths in the world population age between 30 to 69 years old every year. As for diabetes, it is predicted that diabetes incidence and prevalence will reach 366 to 438 million (7.8% of the world's adult population) by 2030, while hypertension will rise to 60% from the total of 1.56 billion people in 2025 (Wild et al., 2004; Lago et al., 2007; Chin et al., 2013). Moreover, WHO presented tobacco use, physically inactive, harmful use of alcohol, and unhealthy diets are also the major risks of deaths from non-communicable diseases.

Diabetes is defined by World Health Organization (2020b) as "a chronic disease that occurs either when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces". There are three types of diabetes listed by WHO, type 1 diabetes mellitus, type 2 diabetes mellitus, which the majority of diabetic patients resulted from excess body weight and physical inactivity, and gestational diabetes that occur during pregnancy where the blood glucose level is above normal but below diagnostic of diabetes value. This condition is also known as impaired glucose tolerance (IGT) and impaired fasting glycaemia (IFG) where the blood glucose level is between normal and diabetic. Fasting blood glucose (FBS) is one of the diagnostic tests to determine diabetes. A value of 5.6 mmol/L is counted as normal FBS, 5.6 mmol/L to 6.9 mmol/L is IGT, and IFG value, while a person with FBS of 7 mmol/L and above are diagnosed with diabetes.

For decades, other than diet and medication, PA has been considered as a foundation of diabetic management (Sigal et al., 2004). It is crucial to develop and maintain patient's motivation towards PA as it could be one of the managements and therapy of the disease. Stated by the American Diabetes Association (2004), "The possible benefits of physical activity for the patient with type 2 diabetes mellitus

(T2DM) are substantial, and recent studies strengthen the importance of long-term physical activity programs for the treatment and prevention of this common metabolic abnormality and its complications", showed that not only regular medications, but PA could also play a major role in improving T2DM patients' condition. Therefore, it is believed that T2DM incidence could lessen up to 60% by a proper routine of PA together with healthy food and well BMI control (Canadian Diabetes Association, 2018). According to Marcus et al. (1992), "researchers and clinicians are faced with two main challenges: first, how to get people to initiate exercise behaviour and, second, how to help active people maintain their exercise behavior". Both issues are related to their psychological perspective and motivational towards PA.

Psychologically, the Transtheoretical Model (TTM) is the model suggested that behaviour change, such as quitting tobacco, should be viewed more as a continuum than a binary: the shift from risky to healthy behaviour (Chouinard & Robichaud-Ekstrand, 2007). Other than smoking, it also been used for overweight and diet problem (Mastellos et al., 2014), and physically inactive behavior (Kirk et al., 2010). Initially developed since the 1970s and 1980s by Prochaska, DiClemente, and colleagues, the Transtheoretical Model (TTM), also known as the Stage of Change (SOC) Model was finally matured in the 1990s (Glanz et al., 2008). Since its inception, the TTM has served as a coherent framework for understanding readiness to begin physical activity and was developed through a comparative analysis of change systems used in psychotherapy (Sonstroem, 1988). As a result of four narrative reviews, it has been determined that the TTM is an effective tool for understanding physical activity behaviour (Marcus & Simkin, 1994; Prochaska & Marcus, 1994; Buxton et al., 1996; Reed, 1999). TTM represents the dynamic idea of wellbeing conduct change including exercise and perceives that people regularly should make a few endeavours at conduct

change before they achieve their goal (Y. Kim, 2007). TTM consists of four core constructs. There are: (1) the six stages of exercise behaviour change (i.e., pre-contemplation, contemplation, preparation, action, maintenance and relapse (Middelkamp, 2017), the psychological constructs which consists of (2) processes of change (overt and covert activities that individuals utilize to modify their behavior; Y. Kim, 2007), (3) decisional balance (involves the perceived "pros" (advantages) and "cons" (disadvantages) of continuing a current behavior or adopting a new behavior; Plotnikoff et al., 2001), and (4) exercise self-efficacy (how well one can execute courses of action required to deal with prospective situations; Bandura, 1977).

PA intervention has been widely implemented to improve T2DM patients' PA level as well as their health conditions (Andrews et al., 2011; Umpierre et al., 2011; Avery et al., 2012). Recently, one promising intervention brought forward by HopSports (2014), is a video-exercise known as the Brain breaks® Physical Activity Solutions or brain breaks for short. It is a web-based structured PA break that stimulates individual's health and learning as well as being specifically designed for the individual or group setting to motivate them to enhance their mental skills and also provide the opportunity not only to be physically active during breaks but also learn new motor skills, language, art, music and different cultures (Chin et al., 2013). In the Global Community Health (GCH) Foundation website, educators from all across the world contribute by uploading exercise videos that suit their respective customs and cultures. These videos are then shared online and are accessible to anyone that would like to implement these short exercises. Of particular note, Malaysian educators have even uploaded their exercise video, using 'silat' as a medium for exercise. By contributing these videos, educators from all over the world with access to an internet connection can implement PA and simple exercises to promote cognitive development and health.

This movement is also endorsed by the United Nations as a means of health promotion. Other implementations of brain breaks are simple transitional physical and mental exercises designed to equip the teacher with tools to manage the physiology and attention of the class as well as to keep children in the most receptive state for learning (Weslake & Christian, 2015). Thus, in this study, the researcher proposed to use Brain breaks as the intervention because it is motivational, easy, fun and promoting exercise and physically active using a new innovative, yet fun environment for the participants.

1.2 Problem Statement

The WHO reported that physical inactivity placed in fourth in global mortality risk factors with 6% of death around the world are caused by it. The researcher aware that the knowledge of health benefits from PA is widely known all around the globe. Yet, despite the widespread health benefits knowledge from performing regular PA, the prevalence of physical inactivity in industrialised countries is still high (Martinez et al., 2013). In addition, Western regions such as the United States (Haskell et al., 2007), Europe (Eurobarometer, 2014), and Malaysia (Poh et al., 2010) also reported with a high population of performing inadequate PA to get health benefits. They tend to maintain their sedentary lifestyle or preferring to insufficiently active in their daily life (Molanorouzi et al., 2015).

This issue has led to an increase in the incidence and prevalence of non-communicable diseases in Malaysia, especially the main focus for the present study, T2DM. The National Health and Morbidity Survey (NHMS) in Malaysia showed that the prevalence of diabetes mellitus in 1996 (6.9%), 2006 (11.6%), 2011 (15.2%) and 2015 (17.5%) reported upward growth for the past two decades (Tee & Yap, 2017). The results of the National Health and Morbidity Survey (NHMS) of 2015 showed that

17.5% of >18-year-olds (3.5 million people in total) had diabetes in Malaysia. The World Health Organization, in their latest report, showed that 73% of total deaths in Malaysia are caused by non-communicable diseases, of which 36% are from cardiovascular diseases and 3% are diabetic patients. In addition, NHMS 2015 listed diabetes mellitus as number one cardiovascular diseases risk factor other than hypertension and hypercholesterolaemia. From these reports, it is clear that diabetes is a fatal threat to our nation and should be addressed rapidly. Handling the prevalence of diabetes mellitus could be a major step to indirectly control the prevalence of cardiovascular diseases and mortality rate.

Exercise, or PA, is one of the most important ways to reverse the debilitation of our health (CDC, 2015) and should be implemented as one of the main preventive methods specifically for non-communicable diseases. Other than using the prescribed medicine, PA could also be adopted as part of treatment plans (Pinto et al., 2013; Shah et al., 2016). Based on Malaysia's Diabetic Care Performance Report 2016, the prevalence of insufficient PA as a diabetes risk factor showed only a 2.9% decrease during the 2006–2015 period. Although it was reported to decrease, the prevalence of insufficient PA in Malaysia is the highest among the Organization for Economic Cooperation and Development (OECD) countries at 52.3%, whereas New Zealand placed second with 39.8%. This classification included diabetic patients who displayed inadequate self-care practices (regarding diet, medications, and PA) (Tan & Magarey, 2008). Moreover, Ibrahim et al. (2014) reported that 60.8% of their pre-diabetic patients were physically inactive and performed PA at a mean of <600 MET-minutes/week.

The researcher believes that the application and exposure of these constructs to Malaysian people with T2DM could produce a positive effect on their control of blood

sugar levels. As with the Brain Breaks video that will be adopted as an intervention instrument in the present study, there is a lack of exposure to this kind of material among not only people with T2DM but also the whole Malaysian population. With the application of both the TTM and Brain Breaks video for the present study, the researcher hopes TTM and Brain Breaks video could be materials that help to decrease the prevalence of T2DM in Malaysia in the future.

Thus, for the present study, the researcher decided to apply the combination of TTM exercise behaviour and PA intervention among Malaysians with T2DM. Brain breaks video is the instrument for the PA intervention to be given to the participants. Participants' base level of POC, DB, ESE, PA motives and PA amount could help in determining the effectiveness of PA intervention (Brain breaks video) to improve those measured variables. Positive effect is expected by the researcher which could help people with T2DM community to be more physically active and obtain health benefits from it.

1.3 Rationale and Significance

For many years, PA and exercise have been empirically accepted by clinicians and researchers as able to improve the health status of adults with any kind of disease. With the application of the TTM to adults with diseases, researchers can understand their stages of exercise behaviour changes as well as the relationship between their exercise behaviours. The TTM is comprised of four questionnaires that have specific questions for each psychological construct: SOC, POC, DB and ESE. All the questionnaires were translated into Malay and validated accordingly. However, for the ESE construct questionnaire, there was an obvious discrepancy between single-factor and three-factor versions of ESE-M (Sabo et al., 2019).

Thus, the researcher decided to validate the ESE-M again with a different population so the researcher could assess the best version (either single factor or three factor) to be adapted for people with T2DM. The newly validated ESE-M could be adapted for future study of people with T2DM with the right version (single factor or three factors) for the purpose of analysis. By knowing the current level of those constructs, the researcher could establish another hypothesis for future RCT studies with a larger Malaysian population. With the right information on which psychological constructs may influence the amount of PA, researchers and doctors could put more focus on those psychological factors relevant among people with T2DM in order to improve their PA amount. Hence, the present study also intends to build significant and indirect relationships between TTM psychological constructs and PA motives with amount of PA. A Brain Breaks video was the intervention material used for the researcher to assess whether it may enhance the participants' psychological factors and amount of PA. Supposing that the Brain Breaks video produces a positive impact on the participants' psychological factors and amount of PA, it should be introduced and exposed widely to the Malaysian population. The researcher is convinced that the given intervention could help improve and/or maintain Malaysians' stages of change in exercise behaviours.

By improving and/or maintaining their stage of motivation, this could indirectly help them to initiate or sustain any kind of PA, whether indoors or outdoors. People with T2DM who are continuously motivated to do regular exercise could sustain a long period of exercise, which could improve their health status with good blood sugar control. For people with or without T2DM, detecting the stages of exercise behaviour changes in healthy and younger people is also crucial. It could be used as a preventive method for any non-communicable diseases. The usage of the TTM as one of the

prevention methods and treatment plans (other than prescribed medicine) will be beneficial for our national health status, especially insofar as it helps to reduce the percentage of adults with the aforementioned non-communicable diseases.

1.4 Operational Definition

1. Confirmatory Factor Analysis (CFA)
    - CFA is a type of structural equation modelling that manages specially the measurement models, which is, the relationships between observed variables or indicators (items, test scores, social perception appraisals) and latent variables or factors (Brown & Moore, 2012). It gives a more miserly comprehension of the covariation among a number of indicators on the grounds that the quantity of factors is not exactly the quantity of measured variables.
2. Structural Equation Modelling (SEM)
    - SEM is a combination of factor analysis and multiple regression analysis that used to analyse the structural relationship between measured variables and latent constructs (Kline, 2015). SEM is adopted to see the structural relationship between SOC, POC, DB, ESE, amount of PA, and motives of PA.
3. Stages of Change
    - SOC represents ordered categories following a continuum of motivational readiness to change PA and focus the notion that PA takes place gradually through different stages (Nigg & Courneya, 1998). In the present study, SOC presented by pre-contemplation, contemplation, preparation, action, maintenance, and relapse.

4. Processes of Change (POC)
    - POC is the covert (cognitive) and over (behavioural) activities and strategies that people utilize to modify their behaviour (Prochaska & DiClemente, 1983). Two main second-order factors consist of the ten first-order factors, the cognitive (consciousness raising, dramatic relief, self-reevaluation, environmental re-evaluation, and self-liberation), and the behavioural (social liberation, counter-conditioning, stimulus control, reinforcement management, and helping relationships) processes.
5. Decisional Balance (DB)
    - DB contains two main scales of pros and cons that are important in influencing persons in an early stage (Pre-contemplation to preparation) to the action stages (Velicer et al., 1998). In this study, the researcher focused on the pros and cons.
    - Pros are perceived as positive aspects that can influence an individual's exercise behaviour.
    - Cons is perceived as a negative aspect that can influence an individual's exercise behaviour.
6. Exercise self-efficacy (ESE)
    - Exercise self-efficacy is a person's belief in their potential of doing and achieving the given goals and targets that could give them higher benefits by vanquishing all the obstacles that came on their way (Middelkamp et al., 2017). The present study used the single factor of ESE developed by Bandura (1997).
7. TTM of behaviour change

- TTM of behaviour change is used systematically to describe and understand a wide range of health behaviours and changes (Middelkamp et al., 2017). For the present study, TTM of behaviour change was presented by SOC, POC, DB, and ESE.

8. Amount of PA

- PA level and exercise status of the participants. As the present study adopted the International Physical Activity Questionnaire (IPAQ), the IPAQ group divided the PA scoring into categorical and continuous score systems (IPAQ, 2018; Putri et al., 2019). For categorical score, there are low category, moderate category, and high category. Whereby for continuous score, it was suggested to be expressed as MET-min per week: MET level x MET level x Minutes of activity x Events per week. Details of IPAQ scoring protocol will be discussed in Chapter 3, section 3.6.6. In this study, the study variable of amount of PA refer to the continuous score based on IPAQ.

9. Motives of PA

- Motivation plays a major role not only in promoting involvement in PA but also in maintaining this involvement (Aaltonen et al., 2012). For the present study, eight factors (competition, appearance, others' expectation, affiliation, physical condition, psychological condition, mastery, and enjoyment) from PALMS were used to indicate the motives of participants in participating PA.

10. Type 2 Diabetes Mellitus

    - One of diabetes mellitus type where the body's cells unable to react with the insulin properly (insulin resistance). It may reach to a level where our body secret insufficient amount of insulin to reduce the blood sugar level (Kerner & Brückel, 2014).

1.5 Objective, Research Questions, Research Hypothesis

Objectives, research questions, research hypotheses were divided into Phase 1 and Phase 2 based on the sequences of the study.

1.5.1 Research Questions

Phase 1

1. What are the stages of changes and level of PA among people with T2DM in Hospital USM, Kelantan?
2. What are the mean levels of processes of change, decision balance for exercise, exercise self-efficacy, and motives of PA among people with T2DM in Hospital USM, Kelantan?
3. Is the translated Malay version questionnaire of the Exercise self-efficacy Scale valid and reliable among people with T2DM in Hospital USM, Kelantan based on confirmatory factor analysis?
4. Are there any significant path relationships between processes of change, decision balance, exercise self-efficacy, stage of exercise behaviour, motives to PA, and the amount of PA among people with T2DM in Hospital USM, Kelantan?

5. Are there any indirect relationships between processes of change, decision balance, exercise self-efficacy, stage of exercise behaviour, motives to PA, and the amount of PA among people with T2DM in Hospital USM, Kelantan?

Phase 2

6. Is there any time effect of Brain breaks video exercise intervention on processes of change, decision balance, exercise self-efficacy, motives of PA, and the amount of PA among people with T2DM in Hospital USM, Kelantan?
7. Is there any group effect of Brain breaks video exercise intervention on processes of change, decision balance, exercise self-efficacy, motives of PA, and the amount of PA among people with T2DM in Hospital USM, Kelantan?
8. Is there any interaction effect (group*time) of Brain breaks video exercise intervention on processes of change, decision balance, exercise self-efficacy, motives of PA, and the amount of PA among people with T2DM in Hospital USM, Kelantan?

1.5.2 Research Hypotheses

Phase 1

1. The translated Malay version questionnaire of the Exercise self-efficacy Scale is valid among people with T2DM in Hospital USM, Kelantan based on confirmatory factor analysis.
2. There are significant path relationships between processes of change, decision balance, exercise self-efficacy, stage of exercise behaviour, motives of PA, and the amount of PA among people with T2DM in Hospital USM, Kelantan.
3. There are indirect relationships between processes of change, decision balance, exercise self-efficacy, stage of exercise behaviour, motives to PA, and the amount of PA among people with T2DM in Hospital USM, Kelantan.

Phase 2

4. There is an improvement in time effect on the processes of change, decision balance, exercise self-efficacy, motives of PA, and the amount of PA among people with T2DM in Hospital USM, Kelantan after given the Brain breaks video intervention.
5. There is an improvement in group effect on the processes of change, decision balance, exercise self-efficacy, motives of PA, and the amount of PA among people with T2DM in Hospital USM, Kelantan after given the Brain breaks video intervention.
6. There is an improvement in interaction effect (group*time) on the processes of change, decision balance, exercise self-efficacy, motives of PA, and the amount of PA among people with T2DM in Hospital USM, Kelantan after given the Brain breaks video intervention.

1.5.3 General Objective

There were two main objectives of this study. First, to determine the relationship between TTM psychological constructs, motives for PA and amount of PA among people with T2DM at Hospital Universiti Sains Malaysia (USM), Kelantan. While second objective, to identify the effect of the Brain Breaks video intervention on the measured variables among people with T2DM at Hospital USM.

1.5.4 Specific Objectives

Phase 1

1. To determine the stages of changes and level of PA among people with T2DM in Hospital USM, Kelantan.

2. To determine the mean levels of TTM psychological constructs and motives of PA among people with T2DM in Hospital USM, Kelantan.
3. To validate the translated Malay version questionnaire Exercise self-efficacy Scale among people with T2DM in Hospital USM, Kelantan using Confirmatory Factor Analysis (CFA).
4. To develop a structural equation model (significant path relationships) of processes of change, decision balance, exercise self-efficacy, stage of exercise behaviour, motives to PA, and the amount of PA among people with T2DM in Hospital USM, Kelantan.
5. To identify indirect relationships between processes of change, decision balance, exercise self-efficacy, stage of exercise behaviour, motives to PA, and the amount of PA among people with T2DM in Hospital USM, Kelantan.

Phase 2

6. To examine the time effects (within groups) of Brain breaks video exercise processes of change, decision balance, exercise self-efficacy, motives of PA, and the amount of PA among people with T2DM in Hospital USM, Kelantan.
7. To examine the group effects (between groups) of Brain breaks video exercise on the processes of change, decision balance, exercise self-efficacy, motives of PA, and the amount of PA among people with T2DM in Hospital USM, Kelantan.
8. To examine the interaction effects (within-between groups) of Brain breaks video exercise on the processes of change, decision balance, exercise self-efficacy, motives of PA, and the amount of PA among people with T2DM in Hospital USM, Kelantan.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

To understand more ideas regarding the research, the researcher did a thorough literature review on published and unpublished previous studies, which related to the research topic. All the information from the review, summarised by the researcher in this chapter to give the readers an understanding about the present study. There will be subchapters that covered comprehensively all the related variables and concepts of the present study.

All previous studies articles were obtained from the online databases which supply the authentic journals that published all the related articles. Online databases such as PubMed, PsycInfo, ResearchGate, Scopus, and Google Scholar were the main databases for the researcher to collect all the related previous studies. Physical activity, health status, non-communicable diseases, hypertension, diabetes, type 2 diabetes mellitus, prevalence, transtheoretical model, stages of change, processes of change, decisional balance, exercise self-efficacy, motives, motivations, brain breaks video, intervention, RCT, CFA, SEM, repeated measures, ANOVA, and MANOVA, were the keywords used by the researcher during the literature search. “AND” or “OR” were used as Boolean operators for combining the keywords while doing the literature search. Table 2.1 shows the summary of how the literature search strategy was carried out.

Table 2.1: Summary of Literature search strategy

	Search Engine			
	Google scholar	**PubMed**	**ResearchGate**	**PsycInfo**
Using phrase (examples)				
-Relationship between TTM with PA	32100	78	252	303
-Motivation of PA	3550000	17407	5012	10390
-Prevalence of diabetes	3230000	194525	27167	10801
-Effects of brain breaks video on PA level	1020	1	146	26
-Effects of PA on T2DM	105000	1044	307	367
Using Boolean operators and keywords (examples)				
"Transtheoretical model" AND "physical activity"	20600	54	186	402
"Transtheoretical model" AND "physical activity" AND "type 2 diabetes mellitus"	11800	8061	102	331
"Motivation" AND "physical activity"	474000	154200	2050	575
"stages of change" OR "processes of change" OR "decisional balance" OR "exercise self-efficacy" AND "physical activity"	17800	5602	816	358

2.2 Physical activity and Health Status

World Health Organisation (2020c) defined PA as "any bodily movement produced by skeletal muscles that require energy expenditure". Walking, cycling or any participation in sports are the examples of the moderate intensity PA that can be done regularly and beneficial for health (World Health Organization, 2020c). It also can be defined any works done by the body muscles lead to movement of the body which need more energy than resting (National Heart, Lung and Blood Institute, 2020). Other examples, dancing, yoga, and gardening also included as the example of physical activities.

For many years, PA and exercise had been empirically accepted by clinicians and researchers able to improve the health status of patients with any kind of diseases. For example, a study conducted by Taylor et al. (2004), found that coronary heart disease patients who were given exercise training (intervention group) showed decreasing in percentage of total and cardiac mortality rates, 20% and 26% respectively compared to the regular medical care control group (Slovinec D'Angelo, Pelletier, Reid, & Huta, 2014). Other than treating the existing diseases, PA could be adopted as a prevention method. Lynch, Neilson, and Friedenreich (2010) conducted a review on 73 epidemiological studies of PA and breast cancer risk summarised that most physically active group of women have lesser breast cancer risk by 25% compared to the least active women group.

In Malaysia, although sports development showing improvements, yet the acceptance of PA among Malaysians is vice versa. Report by National Health and Morbidity Survey 2015 showed that PA rates among Malaysians over the past 30 years are fiercely decreased (Bakar et al., 2015). Moreover, with more than 60% of Malaysian adults being sedentary, made Malaysia been pointed out as one of the most physically inactive countries around the globe (Cai Lian et al., 2016). As for diabetes patients in Malaysia, a survey reported that 54% of this population were physically inactive (Tan & Magarey, 2008; Hussein et al., 2015). In addition, Malaysia's 2016 report card for children and adolescents presented results where overall PA was assigned a grade of D (Sharif et al., 2016). All the information are indicators on how physically inactive Malaysians are. This becomes one of the most major factors of increasing the percentage of non-communicable diseases in Malaysia. In accordance with this issue, the present study could contribute as one of the ways to improve the number of non-communicable patients in our nation.

2.3 Non communicable disease

It has become a worldwide dilemma where non-communicable diseases are spreading almost all over the world, and social-economic groups, as well as a threat to all women and men including the children (Beaglehole & Bonita, 2011). There are ten facts about non-communicable diseases presented by WHO (World Health Organization, 2020a): 1) non-communicable diseases, primarily cardiovascular diseases, cancers, chronic respiratory diseases and diabetes, are responsible for 63% of all deaths worldwide (36 million out of 57 million global deaths), 2) 80% of non-communicable diseases deaths occur in low- and middle-income countries, 3) more than 9 million of all deaths attributed to non-communicable diseases occur before the age of 60, 4) around the world, non-communicable diseases affect women and men almost equally, 5) non-communicable diseases are preventable through effective interventions 6) non-communicable diseases force many people into, or entrench them in poverty due to catastrophic expenditures for treatment, 7) 1.5 billion adults, 20 and older, were overweight in 2008, 8) nearly 43 million children under 5 years old were overweight in 2010, 9) tobacco use kills nearly 6 million people a year, and 10) if the major risk factors for non-communicable diseases were eliminated, at around three-quarter of heart disease, stroke and T2DM would be prevented.

Narrow down our focus to the Malaysian population, based on National Health and Morbidity Survey 2015, 73% of the total deaths in Malaysia were due to non-communicable diseases, and half of those were caused by cardiovascular diseases. Moreover, it could be assumed that the prevalence of non-communicable diseases risk factors continued to rise and was a worrying trend for the country. In addition, statistical analysis done by Global Disease Burden (2017) showed that annual mortality rate per

100,000 people (357.5), annual years of healthy life lost per 100,000 people (15425), change in annual years of healthy life loss was (since 1990) (11.1%), and percentage of years of healthy life lost attributed to risk factors (44.5%) were due to non-communicable diseases in Malaysia.

2.4 Physical activity and Non-communicable diseases

Other than risk factors such as tobacco use and unhealthy diet, WHO ascertained that physical inactivity is one of the major risks causes of non-communicable diseases. Supported by I.-M. Lee et al. (2012) who did a study aiming to quantify the impact of physical inactivity on major non-communicable diseases, stated that "Strong evidence shows that physical inactivity increases the risk of many adverse health conditions, including the world's major non-communicable diseases of coronary heart disease (CHD), T2DM, and breast and colon cancers, and shortens life expectancy". Based on the results obtained from the study, they concluded that by terminating physical inactivity could improve 6% to 10% of major non-communicable diseases such as coronary heart diseases, type-2 diabetes mellitus, and breast and colon cancer, as well as rising the life expectancy.

The situation is similar in our country where physical inactivity plays major role in the up and down of the percentage of non-communicable diseases. In 2003, among the countries of Southeast Asia, Malaysia placed on highest rank for Prevalence of insufficient PA as one of the major non-communicable diseases risk factors, other than Prevalence of insufficient fruit and vegetable consumption and Prevalence of current daily smokers (Dans et al., 2011). Furthermore, recent report displayed that there was fiercely increased of the relationship between physically inactivity with obesity and non-communicable diseases rates in Malaysia over the past 20 years (Cai Lian et al.,

2016). However, we also presented with our younger generation are the most physically active among the different age groups. This supported by a study done by Wong, Parikh, Poh, Deurenberg, and Group (2016) who described the PA of primary school children according to sociodemographic characteristics and activity domains. In that study, youngers' age was found to be one of the high overall activity scores groups. With that, this youth generation's motivation towards PA is crucially to be maintained as part of our early prevention plan to reduce the percentage of non-communicable diseases in Malaysia as well as improving the stage of motivation among elder group.

2.5 Diabetes

Centers for Disease Control and Prevention (CDC) (2020) defined diabetes as "a chronic (long-lasting) health condition that affects how your body turns food into energy". From a different perspective, diabetes defined by National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) (2020) as "a disease that occurs when your blood glucose, also called blood sugar, is too high". However, NIDDK also explained that blood glucose is the main source of energy for our body. Thus, both given definitions are in the same concept where glucose that produced from the digested food did not convert into energy by insulin, leading to the rise of blood glucose level.

Diabetes also a global fatal threat that recorded high morbidity and mortality rate around the world. It is a common situation where a person does not realise that he/she is having diabetes issue. CDC listed numbers of symptoms of diabetes for the community so that early management could be started before it gets worse. Frequent urination, excessive thirst, unexplained weight loss, extreme hunger, sudden vision changes, tingling or numbness in hands or feet, feeling very tired much of the time, very dry skin, sores that are slow to heal, and more infections than usual are the common

symptoms of diabetes that should be detected by our community themselves (CDC, 2020).

The global report by WHO reported that 422 million adults suffer from diabetes which the amount is quadrupled since 1980 (108 million) (World Health Organization, 2020a). WHO added that the drastic rise of the number is due to the rise in T2DM and factors driving it include overweight and obesity. Heart attack, stroke, blindness, kidney failure, and lower limb amputation are the common complications that could be faced by diabetic patients other than death. There are other facts of diabetes reported by WHO which could portray on how diabetes considered as one of the most killer diseases in the world if not detected earlier: a) diabetes is 1 of the leading causes of death in the world, b) there are two major forms of diabetes, Type 1 (lack of insulin production) and Type 2 (body's ineffective use of insulin), c) Gestational diabetes is the third type of diabetes and characterized by hyperglycaemia, or raised blood sugar, d) T2DM is much more common than Type 1 diabetes, e) people with diabetes can live long and healthy lives when their diabetes is detected and well-managed, f) undiagnosed and untreated diabetes may lead to the worse health outcomes, g) majority of diabetes deaths occur in low- and middle-income countries, h) diabetes of all types can lead to complications in many parts of the body, and i) PA on most days and a healthy diet can drastically reduce the risk of developing T2DM.

Wan Nazaimoon et al. (2013) started their study with the objective of to determine the current status and to evaluate the diagnostic usefulness of the HbA1c cut-off point of 48 mmol/mol (6.5%). Participants aged ≥ 18 years were recruited from five zones. From 4341 recruited participants with WHO criteria, results showed that; 1) the prevalence of diabetes mellitus was 22.9%; of that percentage (10.8% was known

diabetes and 12.1% was newly diagnosed diabetes), 2) diabetes was most prevalent amongst Indians (37.9%) and Malays (23.8%), 3) prevalence of new diabetes mellitus was only 5.5% (95% CI 4.9–6.3) when based on the HbA1c diagnostic criteria of 48 mmol/mol (6.5%). Based on the results, Wan Nazaimoon et al. (2013) notified that the prevalence reported were almost a twofold increase from 11.6% reported in 2006. They also concluded that 45 mmol/mol value of HbA1c was a better predictive cut-off point to screen multi-ethnic population for revealing new diabetes incidence.

2.5.1 Prevalence of diabetes mellitus

Based on the recent report of International Diabetes Federation (2021), global diabetes prevalence in 2019 was 463 million and to be expected could reach 578 million in 2030 and 700 million in 2045. From the total of 463 million, 163 million are from Western Pacific region, 88 million are from South-East Asia region, 59 million are from Europe, 55 million are from Middle East and North Africa, 48 million are from North America and Caribbean, 32 million are from South and Central America, and 19 million are from Africa region. IDF also reported that diabetes affects people of all ages, typically showing higher prevalence with increasing age up to 60-69 years. From the report also stated that 1 in 5 people >65 years diagnosed with diabetes. In low- and middle-income countries, four out of every five adults possess undiagnosed diabetes and 87% of deaths were diabetes-related. For Western Pacific Region, one in three of adults at risk of developing T2DM. Top ten countries of diabetes prevalence are China, USA, India, Pakistan, Brazil, Mexico, Germany, Indonesia, Egypt, and Bangladesh where 67% of adults with diabetes live there.

In Malaysian population, more than a decade ago, Mustaffa (2004) statistically showed on the development of diabetes until it became epidemic in Malaysia. Diabetes

prevalence was increased from 0.65% in 1960 to 2-4% in early 1980s (Mustaffa, 2004). In the same paper, was also stated in the mid-1990's the prevalence rises up to 8-12% and the percentage as predicted increased in 1998 with reported 14% of prevalence appeared. As we all know, diabetes potentially causing complications to the patients if it is not well controlled. Based on country-wide survey done by Mustaffa (2004), diabetic patients had been complicated with reported retinopathy (53%), neuropathy (58%), and microalbuminuria (52%.) He then added that Malaysian diabetics were at high potential of suffering from ischaemic heart disease and stroke as complications of macro vascular. The macro vascular complications were due to late diagnosis and poor glycaemic control (mean HbA1c >9%), and also due to the close relation with obesity (43-52% are either overweight or obese, more so in female Malays and Indians), hypertension (10-37%), and hyperlipidaemia (63-76%).

As for Kelantan, the state of the present study target population, prevalence of overall (known and diagnosed) diabetes for aged 18 years old and above was 11.7% in 2006, 19.7% in 2011, and 18.5% in 2015 based on recently reports (Diabetes Care Performance Report 2016) by Malaysian Healthcare Performance Unit, 2016. The report also presented the prevalence of impaired fasting glucose (fasting blood glucose: FBG 5.6 – 6.1 mmol/L) that showed Kelantan's impaired fasting glucose were 4.5 in 2006, 7.6 in 2011, and 6.6 in 2015. Moreover, as one of the crucial risk factors, the report also presented the prevalence of obesity among Kelantan people, which is 12.5 in 2006, 29.5 in 2011, and 28.8 in 2015. With the minimally decrease of prevalence of diabetes, impaired fasting glucose, and obesity in 2015, proper action should be taken to assure the prevalence of those variables will be lower for Kelantan population in the future report.