STRUCTURAL RELATIONSHIP OF TRANSTHEORETICAL MODEL OF BEHAVIOUR CHANGES, AND AMOUNT OF PHYSICAL ACTIVITY AMONG UNDERGRADUATE STUDENTS IN HEALTH CAMPUS, UNIVERSITI SAINS MALAYSIA

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UNIVERSITI SAINS MALAYSIA

2018

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by

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Thesis submitted in fulfilment of the requirements

for the degree of

Master of Science (Medical Statistics)

AUGUST 2018

ACKNOWLEDGEMENT

I would first like to express my sincere gratitude to my research supervisor, Dr. Kueh Yee Cheng @ Erica for her valuable guidance, encouragement, continuous support throughout my research study. Without her assistance and dedicated involvement throughout the process, this study would have never been accomplished. Thank you for always be there whenever I need help or had questions, and willingly to guide me in the right direction.

I would also like to show my highest gratitude to my co-supervisor, Dr. Garry Kuan Pei Ern. His teaching style and enthusiasm towards the topic was impressive and gave me an extra boost whenever I step out from the office. His positive mindset which is born in nature indirectly influenced and motivate me throughout the completion process. Thank you for being patiently guiding me and sharing the valuable experience as well as sharing knowledge with me. Besides that, I would like to take this opportunity to show my appreciation to Dr. Wan Nor Arifin, who always give suggestions and opinions to improve my research study. Without his passionate participation and input, the study could not have been successfully conducted.

My sincerest appreciation extends to all participants, co-curriculum officers, teachers, coaches and all person who directly and indirectly involved in this study. I am grateful to have your co-operation during data collection and assistance in whatever way to complete my study. Finally, I must express my very profound gratitude to my parents and my siblings for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of completing this study. This accomplishment would not have been possible without all of you.

LIST OF PRESENTATIONS AND RECOGNITION AWARD

The present research has recently been presented at the 5th International Seminar on Sports and Exercise Psychology (ISSEP) 2018 and recognition was given to one of the topics. The list of presentations and award are listed in the following:

Oral presentation:

1. Liu, K. T., Kuan, G., Kueh, Y. C., Arifin, W. N., Kim, Y. H. (2018). *Confirmatory Factor Analysis of Decisional Balance and Processes of Change Scale among Undergraduate Students in Health Campus, Universiti Sains Malaysia (USM)*. Paper presented at the 5th International Seminar on Sport and Exercise Psychology, Kuching, Malaysia.

Conference long abstracts:

1. Liu, K. T., Kuan, G., Kueh, Y. C., Arifin, W. N., Kim, Y. H. (2018). *Confirmatory Factor Analysis of Decisional Balance among Undergraduate Students in Health Campus, Universiti Sains Malaysia (USM)*. Paper presented at the 5th International Seminar on Sport and Exercise Psychology, Kuching, Malaysia.
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Award:

1. Certificate of Distinguished Scholars Oral Presentation Award, the 2nd Prize (Silver Medal) at the 5th International Seminar on Sport and Exercise Psychology, Kuching, Malaysia.

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LIST OF ABBREVIATIONS TERMS

CFA	-	Confirmatory Factor Analysis
CFI	-	Comparative Fit Index
DB	-	Decisional Balance
df	-	Degree of freedom
KI	-	Kurtosis Index
LTPA	-	Leisure-Time Physical Activity
MI	-	Modification Index
MoE	-	Ministry of Education, Malaysia
MoH	-	Ministry of Health, Malaysia
PA	-	Physical Activity
PC	-	Processes of Change
RMR	-	Root Mean Square Residual
RMSEA	-	Root Mean Square Error of Approximation
SC	-	Stages of Change
SE	-	Self-efficacy
SI	-	Skew Index
SEE	-	Self-efficacy scale
SEM	-	Structural equation modelling
SRMR	-	Standardised Root Mean Square Residual
TLI	-	Tucker Lewis Index
TTM	-	Transtheoretical model
USM	-	Universiti Sains Malaysia
WHO	-	World Health Organisation

ABSTRAK

Pengenalan: Aktiviti fizikal adalah penting dalam menentukan kesihatan fisiologi dan psikologi, dan mencegah beberapa jenis penyakit yang lazim. Walaupun menyedari tentang kebaikan melibatkan aktiviti fizikal secara teratur, namun kebanyakan pelajar universiti tidak aktif secara fizikal. Salah satu teori telah diwujudkan untuk memahami mekanisme psikologi yang melibatkan tingkat laku aktiviti fizikal pelajar. Model "Transtheoretical" (TTM) merupakan model bersepadu yang bertujuan untuk memahami perubahan tingkah laku individu dengan mengalami satu siri kesediaan untuk melakukan perubahan. **Objektif:** Kajian ini bertujuan untuk menentukan kesahihan Model TTM dengan menggunakan "Confirmatory Factor Analysis" (CFA) dan mengkaji hubungan struktur Model TTM dengan jumlah aktiviti fizikal dalam kalangan pelajar di Universiti Sains Malaysia (USM). **Kaedah:** Kajian rentas keratan telah dijalankan terhadap pelajar yang mengambil bahagian dalam program kokurikulum. Sebanyak 562 pelajar telah mengambil bahagian dalam kajian ini. Dengan menggunakan persampelan secara "purposive", pelajar dimaklumkan bahawa penyertaan mereka adalah secara sukarela, maka, mereka yang berminat menyiapkan soal selidik dan mengembalikannya kepada penyelidik. Pembinaan TTM terdiri daripada proses perubahan (PC), keseimbangan (DB), keberkesanan diri (SE) dan peringkat perubahan (SOC) telah digunakan secara meluas untuk mempromosikan aktiviti fizikal. Data dianalisis dengan menggunakan SPSS 24 untuk statistik dan grafik deskriptif. Mplus versi-8 digunakan untuk menganalisis CFA dan juga "Structural Equation Modelling" (SEM) untuk statistik inferensi. **Keputusan:** Majoriti pelajar yang menyertai kajian ini adalah Melayu (73.3%), wanita (79.0%), dengan purata sebanyak 2.62 kali senaman setiap minggu dan purata 43.14 minit dalam setiap sessi. Dalam

menguji model pengukuran PC, model terakhir, iaitu 30 item sesuai dengan data berdasarkan beberapa indeks (CFI = 0.921, SRMR = 0.066, RMSEA (90% CI) = 0.047 (0.043, 0.051), RMSEA *p*-value = 0.888). Untuk skala DB, 10 item model pengukuran yang terakhir menunjukkan indeks yang sangat baik (CFI = 0.960, TLI = 0.943, SRMR = 0.055, RMSEA (90% CI) = 0.061 (0.047, 0.074), RMSEA *p*-value = 0.096. Manakala bagi skala SE, model 12 item pengukuran terakhir menunjukkan indeks yang sangat baik (CFI = 0.924, SRMR = 0.064, RMSEA (90% CI) = 0.067 (0.057, 0.078), RMSEA *p*-value = 0.004). Model struktur yang terakhir sesuai dengan data berdasarkan beberapa indeks (CFI = 0.951, SRMR = 0.034, RMSEA (90% CI) = 0.056 (0.038, 0.074), RMSEA *p*-value = 0.284). Ini menunjukkan hubungan antara pembinaan TTM adalah signifikan dan disokong oleh sembilan hipotesis dalam model ini. Walau bagaimanapun, antara semua perbincangan yang diperiksa, hanya PC akan menjejaskan aktiviti fizikal. Sementara itu, SC, "pros" dan SE mempunyai hubungan tidak langsung yang signifikan dengan aktiviti fizikal. **Kesimpulan:** Hasil dapatan kajian ini mencadangkan bahawa tahap perubahan dalam individu akan mempengaruhi tahap keberkesanan diri, keupayaan untuk membuat keputusan positif dan negatif dan melaksanakan mengikut tingkah laku mereka. Kajian ini mengesahkan bahawa dengan membuat keputusan yang betul dan mengambil tindakan sewajarnya, jumlah aktiviti fizikal akan ditingkatkan.

Kata-kunci: Keseimbangan keputusan, proses perubahan, aktiviti fizikal, "Confirmatory Factor Analysis", "Structural Equation Modelling", keberkesanan diri, model transtheoretical

ABSTRACT

Introduction: Physical activity is an important determinant of the physiological and psychological health, protecting against several common diseases. Despite knowing the benefit of engaging in physical activity (PA) regularly, the majority of the university students were not physically active. A theoretically based tool was developed to understand the psychological mechanism involving students' PA behaviour. The Transtheoretical Model (TTM) is an integrated model which aimed to understand individual's behavioural changes by experiencing a series of readiness for change. **Objectives:** The study aimed to determine the validity of TTM constructs using a confirmatory approach and examine structural relationship of the TTM and the amount of PA among undergraduate's students in Universiti Sains Malaysia (USM). **Method:** A cross-sectional study was carried out to test the students who took part in the co-curricular programme. A total of 562 students participated in this study. By using purposive sampling, students were informed that their participation is entirely voluntarily, those who interested completed the self-administered questionnaires. The TTM constructs consists of processes of change (PC), decisional balance (DB), self-efficacy (SE) and stages of change (SOC) have been used widely to promote PA. The data was analyzed using SPSS 24 for descriptive statistics and graphs. Mplus version-8 was used for confirmatory factor analysis as well as Structural Equation Modelling (SEM) analysis for inferential statistics. **Results:** The majority of the students were Malay (73.3%), female (79.0%) with the mean of 2.62 times exercise per week and mean of 43.14 minutes exercise per session. In testing the measurement model of PC, the 30 items final model fits the data well based on several fit indices (CFI=0.921, SRMR= 0.066, RMSEA (90%CI) = 0.047 (0.043, 0.051), RMSEA *p*-value =0.888). For the DB scale, the 10 items of final measurement model displayed excellent fit indices

(CFI=0.960, TLI=0.943, SRMR=0.055, RMSEA (90%CI) = 0.061 (0.047, 0.074), RMSEA *p*-value = 0.096). For the SE scale, the 12 items of final measurement model showed excellent fit indices (CFI = 0.924, SRMR= 0.064, RMSEA (90% CI) = 0.067 (0.057, 0.078), RMSEA *p*-value= 0.004). The final structural model fit the data well based on several fit indices (CFI=0.951, SRMR= 0.034, RMSEA (90%CI) = 0.056 (0.038, 0.074), RMSEA *p*-value= 0.284). It also showed significant inter-relationship among the TTM constructs and nine hypotheses were supported from the model. However, among all the constructs examined, only PC would affect PA. Meanwhile, the SOC, pros and SE had significant indirect relationship with PA. **Conclusion:** The findings suggested that SOC in an individual would affect the SE level, the ability to make a positive and negative decision and perform according to their behaviour. This study confirmed that by making the correct decision and taking action accordingly, the amount of PA would be increased.

Keywords: Decisional balance, processes of change, physical activity, confirmatory factor analysis, structural equation modelling (SEM), self-efficacy, transtheoretical model (TTM)

CHAPTER 1: INTRODUCTION

1.1 Background

Physical activity (PA) is an important determinant of physiological and psychological health, protecting against several common diseases (World Health Organisation, 2005). It is a common knowledge that regular PA can help to prevent many diseases and health conditions such as ischemic heart disease, hypertension, breast and colon cancer as well as obesity, and diabetes (Molanorouzi *et al.*, 2015) and improves the overall quality of life. Regular engage in PA including moderate level of exercise is associated with lower death rates among adults (U.S. Department of Health and Human Services, 2010).

World Health Organization (WHO) has encouraged leaders from all over the world to develop effective strategies and programs such as predicting behaviour maintenance that promote healthy lifestyle through diet and PA. However, the program is yet to develop due to limited access of resources (Oman and King, 1998). Despite numerous health benefits, 40% of American adults do not meet the minimum requirement under the guidelines for PA (U.S. Department of Health and Human Services, 2010).

People with higher self-efficacy in exercise more likely to be regularly physically active and maintain PA over a long term. Regular PA can help improve mood and increase self-esteem, thus it is likely to reduce depression and anxiety which is also useful in managing stress. In this regard, self-efficacy has been referred to as an important factor influencing PA (Lee *et al.*, 2007; Resnick *et al.*, 2008; Resnick *et al.*, 2007). Furthermore, a positive affective response in exercise could contributes to the adherence to exercise. A person with positive attitude in PA could influences exercises behaviour because it helps to enhance and maintain motivation in participation of PA (Kwan and Bryan, 2010). The statement is supported by Annesi (2005b), a positive

affective response to exercise would positively reinforce behaviour meanwhile a negative affective response would affect the exercise behaviour.

The possible factors causing low engagement and adherence to PA are biopsychosocial factors (e.g., motivational status, low social support, limited access to PA facilities, depression, anxiety (Ekkekakis and Lind, 2006), lack of time, and lack of safe environments in which to be active (U.S. Department of Health and Human Services, 2010). Although exercise self-efficacy is important to PA and affective symptoms influence exercise self-efficacy (Clum *et al.*, 2014), yet only little empirical work was done to examine the adherence of PA with self- efficacy (Farris *et al.*, 2016).

To increase participation of physical activity among university students, Transtheoretical Model (TTM) was widely used to portrays behavioural change as a process that involves the progression through a series of stages (Prochaska and DiClemente, 1983). Concerted efforts for initiation and maintenance in PA have been carried out using behavioural and cognitive strategies to concentrate on exercise adherence with its interaction with psychological variables (Kim, 2007). TTM is used to study exercise behaviour and often applied an in-depth understanding of the specific behaviour and its change over time (Buckworth *et al.*, 2013; Bull, 2001).

There are five constructs in TTM, which are stages of change, decisional balance, self-efficacy, processes of change, and temptation that are integrated to produce behaviour change (Prochaska and Velicer, 1997). The core construct in TTM is stages of change which contain five main stages in adopting a healthy behaviour (Dishman *et al.*, 2010). The five stages with ordinal levels are pre-contemplation, contemplation, preparation, action and maintenance. In the second construct of TTM, decisional balance consists of two main scales, pros and cons. It is important for changing behaviour (Janis and Mann,

1977) and influencing persons in an early stage (pre-contemplation to preparation) to action stage (Velicer *et al.*, 1998). Self-efficacy involves the degree of confidence a person does not engage in a problem behaviour in the tempting situations (Middelkamp *et al.*, 2017). An individual with perceived self-efficacy is more likely to initiate and maintain the behaviour and engage in PA regularly. The ten processes of change consist of cognitive and behavioural processes.

University students are the most suitable population to be recruited for study because they can easily access to well-equipped exercise facilities in university. Their willingness or readiness towards participating in PA depend on one's behaviour and ability to make a change. However, a report was done by U.S. Department of Health and Human Services (2008) and World Health Organisation (2010) stated that students reported relatively low levels of PA internationally despite knowing health-benefits of regular exercise. College students perceived themselves at a greater disadvantage in exercise opportunity comparing with a nonstudent adult regardless of having free time, flexible schedules, and access to free or low-cost exercise facilities (Calfas *et al.*, 1994). Therefore, it is necessary to conduct a study among university students as they view cons more than pro in maintaining regular exercise.

1.2 Problem Statements

It is well known that regular PA in young adults offers numerous health benefits. The issue concerning health is related to changes in PA level due to societal trends that are leading to less activity (Hallal *et al.*, 2012). Despite the broad dissemination of health information about the benefits of regular participation in PA, physical inactivity is a common occurrence in industrialised countries (Martinez *et al.*, 2013).

According to WHO (2013), physical inactivity is the fourth leading risk factor for global mortality and cause 6% of deaths in worldwide. Despite the established physical and mental health benefits of regular PA, a large proportion of the population in the United States (Haskell *et al.*, 2007), Europe (Commission, 2010) and Malaysia (Poh *et al.*, 2010) do not participate in adequate PA to gain these health benefits, either being not sufficiently active or maintaining a sedentary lifestyle (Molanorouzi *et al.*, 2015).

A report from National Centre for Health Statistics in 2009 reported there are only 35% of adults engaged in regular PA and 30% were found to be inactive. The report was done after considering their leisure activity time in PA. Meanwhile, 55% of adults were reported that they never engaged in any periods of vigorous leisure-time PA that lasting more than ten minutes per week, and only 28% engaged in vigorous activity more than three times per week (National Center for Health Statistics, 2009). Besides that, research found out that most individuals willing to initiate in an exercise program, however, half of the participants drop out within the first six months (Sallis and Hovell, 1990).

In Malaysia, reports based on International Physical Activity Questionnaire guideline found out 30.5% men and 41% women were classified as inactive in PA (*Non-communicable diseases, vol II*, 2011). The results also supported by a study from Poh *et al.* (2010) which reported most of the Malaysian students had low (35%) and moderate (62%) PA levels.

Lack of awareness and understanding on importance of regular PA are the factors contributing to individual not engage in PA. Collaborative efforts have been focused on the behavioural and cognitive strategies that being proven useful for promoting and maintaining PA based on the TTM (Kim, 2008 ; Simonavice and Wiggins, 2008). A

study based on PA guideline which conducted in the United States (US) reported nearly half of American has insufficient PA participation in 2014 (American College Health Association, 2014).

1.3 Significance of the Study

Regular PA is important for maintaining a healthy body, enhancing psychological well-being, and preventing several diseases. Exercise on a regular basis helps in preventing various diseases and condition such as cancer, cardiovascular disease, hypertension, non-insulin-dependent diabetes mellitus, and anxiety. Regular participate in PA program could act as an alternative therapy for relieving symptoms as hot flashes, night sweats, depression, irritability, headache, and sleep disturbances (Li *et al.*, 1999). It is easy for an individual to attempt start exercise, however, it is hard for them to maintain exercise on regular basis.

People who regularly active in exercise tend to have a positive attitude towards exercise. They feel confident about PA and view exercise more positively, thus more likely to participate in PA (Lee *et al.*, 2006). Once motivation level increases, they are prone to exercise after engaging in healthy behaviour. According to the report by Prochaska and Velicer (1997), a positive decisional balance is associated with more advanced motivational readiness for exercise.

Moreover, this study is aimed to examine the effect of relationships between TTM and amount of PA among students who are studying in university. Through understanding these pathways, it can help to create awareness and encourage university students to involve in PA.

Throughout the research, four core constructs of TTM including SE, PC, DB, and SOC are assessed on the amount of PA to identify participant's motivational readiness to exercise and their behaviour and path relationship between each scale.

In conclusion, this study can be used by Ministry of Health (MoH) and Ministry of Education (MoE), Malaysia for implementing effective solution and strategies to encourage as well as educate university students to practice the healthy lifestyle. Overall, this study would provide beneficial information in reducing morbidity and mortality rate in our nation and encourage the behaviour change of the individual. Furthermore, the result of study would increase public understanding on student's way of initiating and maintaining regular exercise.

1.4 Benefits of Study

One of the great advantages of classifying individuals into these stages is the possibility of developing tailored interventions to promote PA that are may be more effective (Nakamura *et al.*, 2013). Because of lacking awareness on PA, there is a need for development of theory-based tools to reduce sedentary behaviours among the population (Han *et al.*, 2015). Based on numerous previous studies, TTM indicate the effectiveness in changing various health-related behaviours, and it also might provide a useful and theoretical framework to address a prolonged sedentary behaviour among college students (Prochaska and Velicer, 1997). This statement is supported by Han *et al.* (2015) that the TTM questionnaires for sedentary behaviours are acceptable to use for reducing sedentary times among college and university students and could be used to support a theory-based framework in future intervention studies.

1.5 Operational Definition

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, 2011). In this context, SEM is used to see the structural relationship between SOC, PC, DB, SE and amount of PA.
Processes of Change (PC)	-	PC is the covert (cognitive) and overt (behavioural) activities and strategies that people utilize to modify their behaviour (Prochaska and DiClemente, 1983). In this study, the tens processes are grouped into two higher- order factors representing cognitive (i.e., consciousness raising, dramatic relief, self-reevaluation, environmental re-evaluation, and self-liberation) and behavioural (i.e., social liberation, counter-conditioning, stimulus control, reinforcement management, and helping relationships) processes.
Stages of Change (SOC)	-	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 and Courneya, 1998). In this study, the SOC referred to pre-contemplation, contemplation, preparation, action, and maintenance.
Decisional Balance (DB)	-	DB contains two main scales of pros and cons that are important in influencing persons in an early stage (Pre-contemplation – preparation) to the action stage (Velicer *et al.*, 1998). The current study focused on pros and cons. Pros is the perceived of positive aspect that can influence individuals' exercise behaviour. Cons is the perceived of negative aspect that can influence individuals' exercise behaviour.
Self-Efficacy (SE)	-	SE is a person's belief in own capabilities to overcome personal, environmental and social barriers to exercise (Middelkamp *et al.*, 2017). The current study used internal feeling, competing demands, and situational as study factor.
TTM of behaviour change	-	TTM of behaviour change is used to systematically describe and understand a wide range of health behaviours and changes (Middelkamp *et al.*, 2017). In the study, TTM of behaviour referred to PC, DB, SE, and SOC.
Amount of PA	-	Exercise status of a participant. The general recommendation for exercise by the American College of Sports Medicine is moderate intensity; exercise is engaged in at least 30min per day at least 5 days a week to accumulate a total of 150–300min per week, or vigorous intensity of at least 20min per day for 3–5 days per week to a total of 75–100min/week (Pescatello, 2013). This study focuses on exercise status of the student which measure weekly leisure-time activity.

1.6 Chapter Summary

This chapter presents the overview of the thesis. Begin with the background of the study, followed by problem statements and signification of the study. The benefits of study and operation definition were elucidated in this chapter.

CHAPTER 2: RESEARCH QUESTIONS, OBJECTIVES, HYPOTHESIS

2.1 Research question

1. Are the factor structures of three scales in TTM (PC scales, DB scales, and SE scales) valid and reliable among undergraduate students in Health Campus, USM by using the Confirmatory Factor Analysis (CFA)?
2. Are there any significant path relationships between PC, DB, and SE on SOC and the amount of PA among undergraduate students in Health Campus, USM by using the Structural Equation Modelling (SEM)?

2.2 Research objectives

General objective

To determine the structural relationship between components of TTM of behaviour changes [SOC, PC, DB, and SE] with the amount of PA among undergraduate students in Health Campus, USM by using the SEM.

Specific objectives

1. To determine the validity and reliability of three scales in TTM (PC scales, DB scales, and SE scales) among undergraduate students in Health Campus, USM by using the CFA.
2. To examine the path relationships between PC, DB, and SE on SOC and the amount of PA among undergraduate students in Health Campus, USM by using the SEM.

2.3 Research hypothesis

1. The three scales from TTM (PC scales, DB scales, and SE scales) are valid and reliable among undergraduate students in Health Campus, USM by using the CFA.
2. There are significant path relationships between PC, DB, and SE on SOC and the amount of PA among undergraduate students in Health Campus, USM by using the SEM.

CHAPTER 3: LITERATURE REVIEW

3.1 Introduction of the chapter

This chapter presents a review of the literature to develop a comprehensive picture of what is presently known about the topic under investigation. The literature review is a summary and critical analysis of research and non-research literature, which are relevant to the subject being studied. The purpose of the literature review is to enable the readers to understand the knowledge that has been documented by scholar and researchers. It also recognised gaps or inconsistency between existing knowledge, thus helping to inspire research ideas (Cronin *et al.*, 2008).

The resulting literature review was organised into ninth sections covering topics supporting or disagreeing with the study's hypotheses (see previous chapter section 2.2). The first section (3.2) focuses on search terms and databases, the second (3.3) on the TTM of behavioural change and third (3.4) on Processes of Change (PC). The fourth (3.5) on Decisional Balance (DB) and (3.6) on Self-Efficacy (SE). The sixth (3.7) focused on stages of change (SOC), (3.8) Godin's leisure-time exercise questionnaire, and (3.9) on past literature review. The last section (3.10) details on the study's conceptual framework focus on the TTM of behavioural changes.

3.2 Search terms and databases

An exhaustive search of electronic databases was undertaken to include ScienceDirect, Google Scholar, ProQuest, Sage Journal and for relevant journals, theses, books, and articles. Key search terms used individually or in combination included Transtheoretical Model, Transtheoretical Model of behavioural change, exercise self-efficacy, decisional

balance scales, PA, Godin's leisure-time exercise, processes of change scale, stages of change, and psychometric properties.

3.3 TTM of behavioural change

TTM is a contemporary psychological framework that attempts to explain the intentional health behaviour adoption and maintenance as a process that occurs over time as a function of behavioural history and motivation (Prochaska and DiClemente, 1983). To develop interventions to promote PA, several studies have used the TTM or Stages of Behavioural Change (SBC) Model (Gorczynski *et al.*, 2010; Si *et al.*, 2011; Tuah *et al.*, 2011). This model describes a series of five different changes when people want to change their new behaviour. TTM of behaviour change is frequently used to systematically describe and understand a wide range of health behaviours and changes therein, such as smoking cessation, safer sex, quitting cocaine, or the adoption and maintenance of exercise (Prochaska and DiClemente, 1983; Prochaska and Marcus, 1994). Recent studies by Marcus and Forsyth (2009) showed that stages of motivational readiness, a central construct of TTM was used for that emphasising both motivation for change and actual behaviour.

The TTM of behavioural change consists of five stages of readiness for change, ten PC, pros and cons of changing, and eighteen SE items. This model suggests that individuals who are intended to change new behaviour would experience a series of change. The SOC includes pre-contemplation (not planning to make any changes or intend to remain at current stage), contemplation (considering making a change), preparation (begin exercise, but not regularly), action (actively engaging in exercise but within six months), and maintenance (exercising regularly for at least six months) (Lee *et al.*, 2006).

Movement through these stages often occurs in a cyclic pattern despite in linear pattern because people would have to make several efforts to change or turn their behaviour before meeting their goals and move up (Marcus *et al.*, 1996). Through the SOC, people could use different methods and strategies depending on their goals and motivation to participate in PA (Lee *et al.*, 2006). Romain *et al.* (2018) stated that TTM constructs could use in public health interventions to tailor the processes that can induce movement through the stages in order to sustain improvement in PA.

Although the applicability of the TTM to exercise behaviour seems promising, the current state of literature is inconclusive (Spencer *et al.*, 2006). Dishman *et al.* (2010) concluded that the TTM failed to predict change in regular PA in a multi-ethnic cohort. Fallon *et al.* (2005) and Spencer *et al.* (2006), reported that TTM studies have several important limitations: The lack of diverse and representative participants, lack of longitudinal studies, different definitions of exercise and most importantly some studies rely on self-reports despite objective measurements. Several studies reported that they do not include all TTM constructs due to lack of validity for some constructs. Most of the studies recruited participants from the middle-class group, hence limit the generalisability of the studies. In a systematic review, 33 studies which conducted among members in the fitness clubs and found that only eight agreed TTM constructs could affect their exercise behaviour (Middelkamp and Steenbergen, 2015).

In conclusion, TTM can be a useful framework to examine the exercise behaviour of university students. Throughout different stages of exercise behaviour change, TTM model can enhance university students to be active in PA. This model helps to generate awareness among university students on their exercise behaviour, emphasise the importance of participating in exercise and promote a healthy lifestyle. In addition,

benefits from regular active in PA helps in reducing mortality and morbidity in acute and chronic diseases.

3.4 Processes of change (PC)

PC is the strategies and techniques that used overt (behavioural) and covert (cognitive) processes to modify their experiences and environment to change their behaviour (Prochaska and Velicer, 1997). The PC includes five experiential and five behavioural strategies that people use to move from pre-contemplation to maintenance (Bernard *et al.*, 2014). Cognitive processes is the individual's efforts to gain information (Kim, 2007). The examples of cognitive processes are consciousness raising, dramatic relief, self-re-evaluation, environmental re-evaluation and social liberation. The consciousness raising refers to the effort made by the individual to look for an additional information and aware of the existing problem), while dramatic relief involves the individuals' affective aspects of change in dealing with the problem, example: emotional experiences). Self-re-evaluation involve the combination of cognitive and affective assessment towards one's behaviour, environmental re-evaluation explains how the problem or personal habit affects the social environments, and social liberation occurs when individuals' aware of the alternative behaviour that can lead to healthy lifestyles in society (Bernard *et al.*, 2014).

Meanwhile, behavioural processes refer to individual obtain information from environmental events (Kim, 2007). The examples of behavioural processes are self-liberation, counter-conditioning, stimulus control, reinforcement management and helping relationship. Self-liberation is a person believe that he can change the problem behaviour and commit in new behaviour, counter-conditioning refers to individual find

alternative behaviours to replace the problem behaviour, and stimulus control refers to the substances or other possible caused that trigger the problem behaviour). Reinforcement management involves remind oneself about the consequences for taking steps to maintain the problem behaviour and helping relationships is a combination of supporting, trusting and caring of an individual for his effort to change the problem behaviour (Bernard *et al.*, 2014).

Individual's behaviour may change according to different SOC. Studied by Velicer *et al.* (1998) found out cognitive processes was peak at the earlier SOC which is contemplation, whereas behavioural processes was found peak at the later SOC. Self-changers often used self-re-evaluation during contemplation and action stage and also used self-liberation, helping relationships, plus reinforcement management during action and maintenance stage. However, they seldom focus on pre-contemplation stage (Prochaska and DiClemente, 1983).

In contrary, Dishman *et al.* (2010) reported people use both cognitive and behavioural processes while they plan to initiate or maintain their PA regardless of either earlier or later stages. Normally, people frequently used cognitive processes in the early SOC, whereas behavioural processes in the later SOC (Marcus and Forsyth, 2009).

3.5 Decisional Balance (DB)

An individual need to have good behaviour and attitude to engage in exercise. People tend to change exercise habit by themselves after considering the advantages and disadvantages of exercise. They will evaluate and encounter the consequence before changing their exercise habit. Some will consider the costs compared to the advantages when deciding whether to change or not (Abbaspour *et al.*, 2017). Thus, by weighing

the pros and cons from time to time, they will decide the best strategies for themselves. DB is the best method to explain the perceived positive and negative outcome of individuals' behaviour change. According to the individual who successfully changes new behaviour, they will know the pros of behaviour change more than cons and the pros of exercise must appear more than cons (Abbaspour *et al.*, 2017). Normally, people tend to have positive views and belief at the early stage and negative views and belief at last stage.

DB is the perceived of positive aspects as (pros) and negative aspect (cons) that are associated with behavioural change (Bernard *et al.*, 2014). The two components of DB, the pros and cons were taken from decision making model developed by Janis and Mann (1977) and the perceived of positive and negative aspects that are related to individual's behavioural changes. DB was linked with the SOC where it is also theorised that DB increased from pre-contemplation to maintenance (Prochaska and Velicer, 1997; Prochaska *et al.*, 1994) and had become an important construct in TTM.

TTM of behavioural change is among the most comprehensive and integrated models that has been used widely to study exercise behaviour. According to Han *et al.* (2015), the TTM indicated that people will begin to perceive more benefits by adopting positive behaviour changes than the disadvantages as they move through later stages. This statement also supports by Prochaska and Velicer (1997), stating that the cons outweigh the pros in pre-contemplation stage. However, the pros appear to be the same level as the cons in the contemplation or preparation stages. A new behaviour was established and had becomes part of one's lifestyle in action and maintenance stage where the pros outweighing the cons. According to Prochaska *et al.* (2008) on TTM's assumptions and the findings of Fallon *et al.* (2005), the following five hypotheses were established and

tested: Higher SE, higher pros, and lower cons will distinguish precontemplation and contemplation (Prochaska *et al.*, 2008); Higher SE, higher pros, and lower cons will distinguish contemplation and preparation (Prochaska *et al.*, 2008); Higher SE, higher pros, and lower cons will distinguish preparation and action (Prochaska *et al.*, 2008); None of SE, pros, and cons will distinguish action and maintenance (Fallon *et al.*, 2005); SE will distinguish maintenance and termination, but not pros and cons (Fallon *et al.*, 2005).

Persons in action and maintenance have a DB balance favouring the positive features (pros), persons in pre-contemplation have a balance reflecting reasons not to change (cons), and persons in contemplation tend to fall between those in pre-contemplation and action (Marcus *et al.*, 1992a). Examples of pros in the exercise were improved aerobic capacity, self-esteem, and muscular strength (Hausenblas *et al.*, 2002), whereas examples of cons include physical discomfort, cost, and taking time away from other activities (Hausenblas *et al.*, 2002). Within this context, DB scale was used to determine strategies used by university students in perceiving pros and cons of exercise adoption to enhance their PA levels (Karaca *et al.*, 2016).

Students are suitable to be recruited for study because previous research demonstrates that they differ from the college pass-outs in terms of psychological and environmental factors associated with exercise adoption and maintenance (Calfas *et al.*, 1994). Many previous studies in oversea had conducted to examine exercise behaviour using TTM. However, there is still limited study to test TTM model on Malaysian population, not to mention validate the five core components in TTM.

3.6 Self-efficacy (SE)

SE is a person's belief in its own capability to organise and perform the action which could give attainments and to prevent the change of relapsing. SE plays a leading role in assisting individuals with high SE to perform well in the task after they had experienced more positive emotions (Bandura, 1977). SE is the key construct in social cognitive theory which used to elucidate the factors affecting exercise behaviour among older individuals (Bandura, 1977; Bandura, 1982; Bandura, 1986; Bandura, 1997).

According to Bandura's social cognitive theory, SE represents an instrumental psychological construct (i.e., mediator) linked to behaviour change (Bandura, 1997). SE has been proved to be important determinants to influence individuals' performance based on types of activities, the effort committed on the activity, and the capability to overcome the pressure when faced with obstacles (Bandura, 1986). Successful people tend to set challenging goals and maintain a strong commitment to reach it. Although they will face challenges ahead, they never afraid of being a failure. Instead of that, they see these as challenges to be mastered, rather than threats to be avoided (Bandura, 1994).

In contrast, people who doubt their ability to accomplish difficult tasks see these tasks as a threat (Brown *et al.*, 2013). They tend to avoid them based on personal weakness or obstacles that prevent them from being successful. They give up quickly in the face of difficulties or failure, and it do not take much for them to lose faith in their capabilities. Studies also suggest that various affective symptoms can negatively influence exercise SE, such as depression (Clum *et al.*, 2014; Craft *et al.*, 2008; Kangas *et al.*, 2015) and anxiety (Annesi, 2011c). Factors that related to decreased PA of an individual were medical problems, negative experience, fear of activity related past experience, having a

sedentary lifestyle in the past, insufficient understanding of PA, living in an unsafe neighbourhood, and lack of company (Chen, 2010; Rasinaho *et al.*, 2007).

Efforts have been made by researchers to measure people's confidence in sustaining PA when opposing challenges to exercise. A scale, namely Self- Efficacy for exercise scale (SEE) which was developed by Resnick and Jenkins (2000) used to measure aging population's confidence level. The SEE scale was first applied to American older populations (Resnick *et al.*, 2004). The scale was further translated into Chinese (Lee *et al.*, 2009) and Swedish (Rydwik *et al.*, 2013), and used to test among the Taiwanese and the Swedish population for evaluation of the reliability and validity. However, there is no available scale in Malay version of self- efficacy exercise scale (SEE).

There are plenty evidences reported that SE is a powerful element of behavioural intention in addition to actual behaviour (Lewis *et al.*, 2002; Miller *et al.*, 2002; Sargent, 2001; Shin *et al.*, 2001). Previous studies have shown that perceived SE could lead to behaviour change (Di Loreto *et al.*, 2003). According to Kim (2007), individuals with a high level of confidence to engage in PA, despite obstacle, is having high SE for exercise. They are expected to more likely to initiate and maintain PA than individuals with low SE.

3.7 Stages of Change (SOC)

The SOC is the organising construct of the TTM and hypothesise that individuals move cyclically through the stages with periods of progression and relapse (Middelkamp *et al.*, 2017). It is an integrated model that includes cognitive, affective and behavioural constructs that are described in other well-established theories of intentional change

(Floyd *et al.*, 2007). The stage represents a period of time as well as a set of tasks needed for movement to the next stage. The accomplishment of the tasks depending on the time each individual spends throughout each stage. For each SOC, a different change in processes will take place to produce optimal progress (Norcross *et al.*, 2011). It is the recognised and applied a component of the TTM and provides a structure from which relationships among specific cognitive-behavioural and motivational mechanisms and health behaviours, such as smoking cessation (Keller and Mcgowan, 2001).

The SOC consist of five main stages: pre-contemplation, contemplation, preparation, action, and maintenance. Pre-contemplation (PC) is the stage where people have no intention to change behaviour in the foreseeable future and intend to maintain at the current stage, usually within next six months (Norcross *et al.*, 2011). At this stage, the majority people are unaware of the problem as they believe the problem does not exist. Their action may be due to failure after multiple times of trials and have become demoralised about their ability to change (Prochaska and Velicer, 1997).

Contemplation (C) is a stage in which people are aware of the existing problem and thinking about solving it but does not plan to take action in the next six months (Norcross *et al.*, 2011). Contemplators usually struggle with their positive evaluations of dysfunctional behaviour and tend to put lots of effort and energy to overcome it (Norcross *et al.*, 2011). This balance between the costs and benefits of changing can produce profound ambivalence that can keep people stuck in this stage for a long period of time (Prochaska and Velicer, 1997). Preparation (P) is the stage in which individuals intended to take action within 30 days and decide to change their behaviour towards the problem (Norcross *et al.*, 2011). Although they have made some modification in their

problem behaviours, they have yet to reach a criterion for effective action (Norcross *et al.*, 2011). These individuals have a plan of action, such as joining a health education class, consulting a counsellor, talking to their physician, buying self-change approach (Prochaska and Velicer, 1997).

Action (A) is the stage in which individuals modify their behaviour, experiences and/or environment to overcome their problem (Norcross *et al.*, 2011). According to Hausenblas et. al. (2002), action stage is defined as actively engaging in the new behaviour and have successfully altered the dysfunctional behaviour for less than six months. The action involves the most overt behavioural changes and requires a considerable commitment of the time and energy (Norcross *et al.*, 2011).

Maintenance (M) is a stage in which people work to prevent relapse and consolidate the gains attained during the action (Norcross *et al.*, 2011). Maintenance requires sustained attention and effort over a long period of time to prevent people who attempted to fail to maintain behaviour or relapse (Floyd *et al.*, 2007). This stage extends from six months to an indeterminate period past the initial action.

Termination is the last construct in TTM. However, it is not realistic for the majority people (Prochaska *et al.*, 2008) and studies examining termination was limited (Johnson *et al.*, 2013). This is probably because of no systematic changes in TTM variables are assumed between maintenance and termination in the originally proposed model (Prochaska *et al.*, 2008). Termination is a stage in which individuals have zero temptation and hundred percent of SE (Prochaska and Velicer, 1997) and had exercised regularly for more than five years (Horiuchi *et al.*, 2012). In this stage, people feel depressed, anxious, stress, angry with past event and no plan to resume previous unhealthy habit as a way of coping.

A study conducted by Fallon *et al.* (2005) and Horiuchi *et al.* (2012) used to separate maintenance and termination for studying continuance of regular exercise has great potential because previous studies' findings suggest that the variables important for maintaining regular exercise might differ from action to maintenance to termination. Usefulness of dealing with Maintenance and Termination stages is also highlighted by Adams and White (2005) that inconsistent results of long-term stage-matched intervention studies have been found. Some studies have reported significant effects (Johnson *et al.*, 2006; Johnson *et al.*, 2008), whereas others were not significant (Kirk *et al.*, 2009).

In general, SOC model assumes that movement through the stages is not linear, but spiral and most people will experience relapse and regression to an earlier stage (Prochaska *et al.*, 1992). Hence, individual does not recycle through the stages endlessly. Instead of that, they learned from prior mistakes and tends to move through each stage more quickly the "second time around" (Floyd *et al.*, 2007).

3.8 Godin Leisure-Time Exercise Questionnaire (GLTEQ)

The GLTEQ is used to assess individuals' Leisure-time physical activity (LTPA) based on self-report (Godin and Shephard, 1985). According to Amireault *et al.* (2015), the LTPA refers to activity taken by individual's during their leisure time with at least 15 minutes in a week and could increase the total energy expenditure.

It consists of four-item self-administered questionnaire that seeks information on the frequency which individual participates in mild, moderate, and strenuous LTPA (Amireault and Godin, 2015). Each frequency score was multiplied by three, five and nine Metabolic Equivalent of Task (MET) value for mild, moderate and strenuous

LTPA. The total weekly LTPA was summed to obtain a leisure score index (LSI) expressed in arbitrary units (Amireault and Godin, 2015).

The LSI was used by Godin (2011) to classify people into active and insufficiently active categories by referring to the American College of Sport Medicine physical activity guidelines (Garber *et al.*, 2011). The physical activity guideline was widely used among American (U.S. Department of Health and Human Services, 1996; U.S. Department of Health and Human Services, 2008) and Canadian population (Canadian Society for Exercise Physiology, 2011). By using moderate and strenuous components in GLTEQ, people who score 24 or more than 24 units are classified as active, while those who score less than 24 are classified as insufficiently active.

3.9 Past literature review

Table 3.1 Psychometric properties of TTM constructs

Authors and instrument's name with original authors	No. of participants	Reliability	Validity	Number of items & Measurement Scales	Results
Dishman *et al.* (2010) Processes of change Marcus *et al.* (1992b)	1429 undergraduate students	Cronbach's alpha values ranged from 0.21 to 0.82	X^2=890.1, df=263, p<0.001, CFI=0.952, RMSEA=0.042 (95% CI, 0.039–0.045), SRMR=0.039	26 items and 9 factors	The original 39-item was not support in this study. After removing 13 items that had large cross loadings on other factors or large covariances with other items, re-specified models of nine first-order factors subordinate to two correlated hierarchical factors or nine first-order correlated factors had adequate fit the data
Lee *et al.* (2006) Processes of change Nigg *et al.* (1999)	434 women aged 40 to 64 years.	Cronbach's alpha values ranged from 0.76 to 0.89	No EFA or CFA reported	30 items and 10 factors 5-point Likert scale from 1 (never) to 5 (repeatedly)	All PC had significant difference in each stage. Cognitive processes were used more than behavioural processes in first stage and in