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Fluctuation: a common but neglected phenomenon of physical activity behavior

Shang, Borui

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STUDENT'S NAME: SHANG Borui

THESIS TITLE: Fluctuation – A Common but Neglected Phenomenon of Physical Activity Behavior

This is to certify that the above student's thesis has been examined by the following panel members and has received full approval for acceptance in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

Chairman:	Prof Chung Pak-Kwong Professor, Department of Sport and Physical Education, HKBU (Designated by Dean of Faculty of Social Sciences)
Internal Members:	Prof Chow Bik Chu Head, Department of Sport and Physical Education, HKBU
	Prof Cheung Siu Yin Professor, Department of Sport and Physical Education, HKBU
External Members:	Prof Huang Zhijian Professor Institute of Physical Education and Sport Science Hubei University
	Dr Yan Zi Associate Professor Department of Curriculum and Instruction The Education University of Hong Kong
In-attendance:	Dr Duan Yanping Assistant Professor, Department of Sport and Physical Education, HKBU

Issued by Graduate School, HKBU

Fluctuation – A Common but Neglected Phenomenon of Physical Activity Behavior

SHANG Borui

A thesis submitted in partial fulfilment of the requirements

for the degree of

Doctor of Philosophy

Principle Supervisor:

Dr. DUAN Yanping (Hong Kong Baptist University)

March 2019

DECLARATION

I hereby declare that this thesis represents my own work which has been done after registration for the degree of PhD at Hong Kong Baptist University, and has not been previously included in a thesis or dissertation submitted to this or any other institution for a degree, diploma or other qualifications.

I have read the University's current research ethics guidelines, and accept responsibility for the conduct of the procedures in accordance with the University's Research Ethics Committee (REC). I have attempted to identify all the risks related to this research that may arise in conducting this research, obtained the relevant ethical and/or safety approval (where applicable), and acknowledged my obligations and the rights of the participants.

Signature: SHANG Boni 尚博睿

Date: March 2019

ABSTRACT

Introduction: Benefits of regular physical activity (PA) behavior are well-established, yet still many people do not regularly participate in PA. Given this, researchers proposed a PA pattern named "fluctuation" to refer to a phase of sporadic, unstable, or irregular participation in PA behavior. The person who demonstrates the pattern of irregular PA participation is named "fluctuator". So far, research particularly focusing on PA fluctuation and fluctuators is scarce.

Purpose: The main purpose of the thesis was to review and explore the psychosocial and behavioral characteristics of PA fluctuators.

Methods and Results: An exploratory systematic review was firstly conducted in the literature review section. The results showed that fluctuation was mostly defined as a PA stage from the perspective of stage theory and measured by stage algorithms. Common features were extracted from the conceptual definitions as: behavioral irregularity, high risk of drop-out, intention to PA, low habit level, and limited self-regulation. A sequential mixed-methods design consisting of a quantitative study and a qualitative study was subsequently conducted. The quantitative study adopted the design of cross-sectional questionnaire survey. By using the latent profile analysis, 434 fluctuators (M = 32.4 years, SD = 6.9, 55.5% female) from office-based settings were categorized into two profiles of "uncommitted fluctuator" and "moderately committed fluctuator" based on psychosocial indicators. The results from multinomial logistic regression showed that the "moderately committed" profile was associated with more PA energy expenditure, a normal weight range, and a medium managerial position compared with the uncommitted profile. The qualitative study employed the design of "Research Program Subjective Theories" to explore and present fluctuators' cognitions concerning PA participation. 30 interviewees (M = 35.2 years, SD = 9.3, 53.3% female) from the previous quantitative study were invited for semi-structured interview. By inductive and deductive coding, fluctuators' verbal data were converted into word categories for extracting commonalities and comparing differences. By remaining word categories of high frequency and exploring the interrelationships among the remained word categories, a superstructure (i.e. visualized representation of fluctuators' overall cognition) including fluctuators' main PA motivators, barriers, and behavioral outcomes was compiled. Fluctuators' cognitions were primarily differed in motivational configurations. The physically motivated fluctuators (i.e. those predominantly motivated by physically related motivators) were more linked with low PA level, while the mixed motivated fluctuators (i.e. motivated by both physically related and emotionally or socially related motivators) were more likely associated with moderate PA level. Exemplars of the typical fluctuators were also demonstrated in

the end of the qualitative study to reveal their real experiences and situations in the daily life context.

Discussion and Conclusions: To the best of our knowledge, the present research is the first-ever exploration of the psychosocial and behavior features among PA fluctuators. The findings of this thesis revealed that PA fluctuators are common in context; they are planless, motivationally and behaviorally heterogeneous, limited in self-regulation, and impeded by unfavorable circumstances in doing PA. The quantitative study and the qualitative study complement each other and jointly facilitate the understandings of the variability and heterogeneity in fluctuators' psychosocial profiles. Particularly the uncommitted fluctuators in the quantitative study are more likely to be physically motivated fluctuators than mixed motivated fluctuators in the qualitative study, and moderately committed fluctuators are more likely to be mixed motivated fluctuators than physically motivated fluctuators. The present thesis provided an important opportunity to advance the knowledge development regarding the topic of PA fluctuation. Based on the current findings, future interventions to promote fluctuators' regular PA participation are promising.

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TABLE OF CONTENT

CHAPTER I: INTRODUCTION 1

1.1 Background of study 1

1.2 Statement of problem 4

1.3 Research questions 6

1.4 Structure of dissertation and design rationale 6

1.5 Significance of study 8

CHAPTER II: LITERATURE REVIEW 10

2.1 Review method 10

2.1.1 Search strategy 10

2.1.2 Inclusion and exclusion criteria 11

2.1.3 Quality assessment 12

2.2 Characteristics of included articles 15

2.3 Model-based understanding of the definitions of fluctuation 17

2.3.1 Stage model-based definitions 18

2.3.2 Relapse prevention model-based definitions 22

2.4 Measurement of fluctuation 23

2.4.1 Fluctuation identification by stage algorithm 24

2.4.2 Fluctuation identification through detecting lapse and readoption 25

2.4.3 Fluctuation identification by prospective within-person variation in meeting PA guideline 25

2.5 Empirical evidence related to fluctuation 26

2.5.1 Sample distribution 26

2.5.2 Behavioral performance 26

2.5.3 Psychosocial features 27

2.6 Discussion 37

CHAPTER III: STUDY 1: PSYCHOSOCIAL PROFILES AMONG FLUCTUATORS - A LATENT PROFILE ANALYSIS 41

3.1 Study purpose and questions 41

3.2 Selection of psychosocial indicators 42

3.3 Methods 43

3.3.1 Participants 43

3.3.2 Data collection procedures 44

3.3.3 Measurements 44

3.3.4 Data analysis 48

3.4 Results 52

3.4.1 Data cleaning and descriptive statistics 52

3.4.2 Results from latent profile analysis 55

3.4.3 Results from multinomial logistic regression 62

3.5 Discussion 65

CHAPTER IV: STUDY 2: SUBJECTIVE THEORIES OF PHYSICAL ACTIVITY MOTIVATORS AND BARRIERS FOR FLUCTUATORS – A QUALITATIVE STUDY 70

4.1 Study purpose and questions 70

4.2 Brief introduction to the “Research Program Subjective Theories” 71

4.3 Method 73

4.3.1 Interview guide 73

4.3.2 Data collection 76

4.3.3 Data coding 76

4.3.4 Data analysis 80

4.4 Results 82

4.4.1 Demographic information 82
4.4.2 Coding outcomes 82
4.4.3 Superstructure formation 93
4.4.4 Results from sub-group comparison 101
4.4.5 Categorization of fluctuators 103
4.4.6 Exemplary model representation 107
4.5 Discussion 119
CHAPTER V: DISCUSSION AND CONCLUSION 129
5.1 Summary 129
5.2 Synthesis of findings from quantitative and qualitative study 131
5.3 Theoretical implications 134
5.4 Practical implication 136
5.5 Reflection on research methodology and limitations 138
5.6 Suggestions for future research 142
5.7 Conclusion 144
REFERENCES 145
APPENDICES 174
CURRICULUM VITAE 204

LIST OF TABLES

Table 2.1 Abridged version of the Down's and Black's assessment tool……...….13

Table 2.2 Quality rating of eligible studies…….…....14

Table 2.3 Characteristics of included articles…….....16

Table 2.4 Definition of terms related to fluctuation…….…...23

Table 2.5 Summary of psychosocial findings related to fluctuation……...29

Table 3.1 Indicator selection……...43

Table 3.2 Information about participants screening by survey channel……..53

Table 3.3 Descriptive statistics of categorical variables among fluctuators……...54

Table 3.4 Descriptive statistics of continuous variables among fluctuators……...55

Table 3.5 Results model fit indices for profile enumeration…….…….57

Table 3.6 Average latent profile probabilities for most likely latent profile membership (row) by latent profile (column)…….....59

Table 3.7 Results of independent t-test and descriptive statistics for psychosocial indicators by profile……...60

Table 3.8 Results of multinomial regression for predicting profile membership…..64

Table 4.1 Cross-reference between topics in qualitative study and indicators in quantitative study……..…75

Table 4.2 Coding scheme with inductive and deductive approaches…….....… 78

Table 4.3 PA types from 30 fluctuators…….……83

Table 4.4 Aggregated PA types from 30 fluctuators…….……83

Table 4.5 PA participation at individual level…….…..…84

Table 4.6 PA locations from 30 fluctuators…….…..…84

Table 4.7 Aggregated PA locations from 30 fluctuators…….…..…..85

Table 4.8 Aggregated PA location at individual level…….……..85

Table 4.9 Fluctuators' PA plan at individual level…….…...85

Table 4.10 Fluctuators' PA regularity……...86

Table 4.11 Fluctuators' PA companion……86

Table 4.12 Descriptive information about fluctuators' total PA frequency and weekly energy expenditure……...87

Table 4.13 Classification of fluctuators' PA weekly energy expenditure……87

Table 4.14 Motivators from 30 fluctuators……...…89

Table 4.15 PA barriers from 30 fluctuators……...91

Table 4.16 Reasons for lapse……....93

Table 4.17 Aggregated reasons for lapse……..93

Table 4.18 Correlation table based on the BL in the superstructure……..…98

Table 4.19 Summary of significant results in t-tests for fluctuators' PA motivator, barrier, and lapse…….. 102

Table 4.20 Categorization of fluctuators……..…105

Table 5.1 Two by two contingency table by sub-categories from two studies…..…133

LIST OF FIGURES

Figure 1.1 Research organization in the present thesis. ……..……..…8

Figure 2.1 Flow chart of article inclusion.……..…12

Figure 2.2 Theoretical framework of BSM.……...…….…....19

Figure 2.3 Stage framework of adapted TTM.....20

Figure 2.4 Stage framework of MSM…….……21

Figure 2.5. Stage framework in FIT……...…….……22

Figure 3.1. Elbow plot of the information criteria for the latent profile analysis.....58

Figure 3.2. Characteristics of psychosocial indicators across the two profiles…..….61

Figure 4.1. Fluctuators' ST superstructure without associations…….…...…95

Figure 4.2. Fluctuators' ST superstructure with associations among BL.....100

Figure 4.3. Representation of exemplar of the Type I fluctuator. …….....109

Figure 4.4. Representation of exemplar of the Type II fluctuator…….....112

Figure 4.5. Representation of exemplar of the Type III fluctuator……114

Figure 4.6. Representation of exemplar of fluctuator 1 in the type of miscellany…116

Figure 4.7. Representation of exemplar of fluctuator 2 in the type of miscellany.....118

Figure 5.1. Tentative model highlighting the features of PA fluctuators……...134

LISTS OF SYMBOLS

p	Probability
Cronb.α	Cronbach's alpha
CI	Confidence interval
df	Degrees of freedom
e.g.	For example
etc.	And so on
i.e.	In other words
M	Mean
N and n	Sample size
OR	Odds ratio
SD	Standard deviation

LISTS OF ABBREVIATIONS

AIC	Akaike information criterion
ANOVA	Analysis of variance
BIC	Bayesian information criterion
BL	Basic lexica
BMI	Body mass index
BSM	Berlin exercise stage model
EM	*Expectation–maximization*
FIT	Four steps from inactivity to health-enhancing physical activity
GSLTPAQ	Godin-Shephard Leisure-Time Physical Activity Questionnaire
HEPA	Health-enhancing physical activity
IPAQ	International physical activity questionnaire
LMR	LO-MENDELL-RUBIN likelihood ratio
LPA	Latent profile analysis
LSI	Leisure score index
MC	Moderately committed
MSM	Multi-stage model
MVPA	Moderate to vigorous physical activity
PA	Physical activity
RPM	Relapse prevention model
RPST	Research program subjective theories
SABIC	Sample size adjusted Bayesian information criterion
SLT	Struktur-Lege-Technik / Structure-laying technique
ST	Subjective theories
TTM	Transtheoretical model
UC	Uncommitted
WHO	World Health Organization

DEFINITION OF FLUCTUATION RELATED TERMS

Fluctuation	A behavioral pattern of sporadic, unstable, or irregular PA participation. Particularly the fluctuation PA pattern demonstrates as the PA amount fluctuates around a certain PA criterion or guideline.
Fluctuator	The person who demonstrate the PA pattern of fluctuation.
Lapse	Slips of the criterion-related PA behavior that may lead to relapse.
Relapse	An extended period of interruption of regular sustained PA behavior after its initiation and maintenance.
Readoption	The resumption of the sustained PA behavior following a period of relapse
Uncommitted profile	An inferior psychosocial profile among fluctuators with lower scores of psychosocial indicators derived from LPA, representing mentally not ready or not committed to PA participation.
Moderately committed profile	A relatively superior psychosocial profile among fluctuators with higher scores of psychosocial indicators derived from LPA, indicating somewhat mentally ready and committed to PA participation.

CHAPTER I: INTRODUCTION

1.1 Background of study

Since the industrial revolution, scientific and technological development has been continually increasing work productivity and liberating human beings from laborious and strenuous physical activities. As the availability of new machines and devices increases, most areas in our daily lives such as work, transportation, housework, school, and some leisure settings are no longer related to physical activity (PA).

Although scientific and technological development has brought benefits, the side effect of physical inactivity is increasingly recognized as a serious global public health concern (Kohl et al., 2012; Lee et al., 2012). Physical inactivity is a state of relative physical rest that does not provide sufficient stimulus for human biological systems (e.g., circulatory, respiratory, skeletal) to maintain their normal structures, functions and regulations (World Health Organization, WHO, 2007).

Physical inactivity has a series of negative consequences. It is the fourth leading risk factor for global mortality, causing millions of deaths globally (Bull & Bauman, 2011; WHO, 2009). There is ample evidence that physical inactivity increases the risk of many adverse health conditions, including major non-communicable diseases such as coronary heart disease, type II diabetes, breast and colon cancers, and shortens life expectancy (Lee et al., 2012; Wilmot et al., 2013). These physical inactivity-induced productivity losses and diseases place an enormous economic burden on societies. Researchers have estimated that in the year 2013 alone, the total global economic cost of physical inactivity was 67.5 billion American dollars (Ding et al., 2016).

Given the alarming increase in physical inactivity and the severe consequences associated with it, scientific sources, health organizations, and governments are unified in a call for action to promote health-enhancing physical activity (HEPA). HEPA includes any form of PA that benefits health and functional capacity without undue harm or risk. Specifically, it encompasses daily life PAs (e.g., manual labor, gardening, hiking, dancing), physical exercise (e.g., swimming, jogging), and sports (e.g., basketball, soccer) (WHO, 2007). In line with this concept, the WHO (2017) released a

worldwide guideline for adults' participation in HEPA based on accumulated physiological and clinical evidence. It recommends that adults aged 18–64 should carry out the following PA to achieve health-enhancing benefits:

- Adults should engage in at least 150 minutes of moderate-intensity physical activity per week, or at least 75 minutes of vigorous-intensity physical activity per week, or an equivalent combination of moderate- and vigorous-intensity activity.
- For additional health benefits, adults should increase their moderate-intensity physical activity to 300 minutes per week, or equivalent.
- Adults should perform muscle-strengthening activities on at least two days per week.[1]

In China, the National Fitness Guideline was recently released by General Administration of Sport of China (2017), thus placing PA at the national policy level. The National Fitness Guideline acknowledges the first point of the WHO HEPA guideline that adults should at least accumulate sufficient PA per week (150 minutes of moderate intensity, or 75 minutes of vigorous-intensity, or an equivalent combination of moderate and vigorous intensity). It also provides more detailed recommendations for adults across different fitness levels.

Despite the clear guidelines and the health-enhancing benefits, adherence to HEPA guidelines has not been encouraging. A systematic review covering 122 countries estimated that 31.1% of adults globally are not meeting the WHO HEPA guidelines.[2] The proportion varied greatly between regions: 27.5% of people are inactive in Africa, 43.3% in the Americas, 43.2% in the Eastern Mediterranean, 34.8% in Europe, 17.0% in Southeast Asia, and 33.7% in the Western Pacific (Hallal et al., 2012). A 15-year longitudinal national survey on Chinese adults' PA with a large sample size of 616,676 showed that the percentage of participants meeting the PA guideline was 17.2% in

[1] Normally when deciding whether a person is physically active or not, muscle-strengthening activities are often ignored, because the former two recommendations are the minimum conditions for being physically active (Hallal et al., 2012; Tian et al., 2016).

[2] For this research, the guidelines have 3 criteria: 1) 30 min of moderate-intensity physical activity on at least 5 days every week, 2) 20 min of vigorous-intensity physical activity on at least 3 days every week, or 3) an equivalent combination achieving at least 600 metabolic equivalent (MET)-min per week

2000, 18.1% in 2005, and 22.8% in 2014 (Tian et al., 2016). The percentage was as low as 5.4% for Chinese employees in some occupational settings (Liu et al., 2015).

Progress from being physically inactive to habitually meeting HEPA guidelines is a behavioral change process in which old sedentary behavioral patterns are replaced with more physically active behavioral patterns (Biddle & Fuchs, 2009). Over the past three decades, PA behavior has been a thriving research domain. There has been a proliferation of theories and models to explain and promote PA behavioral change. These theories and models can be divided into continuum models and stage models (Schwarzer, 2008).

Continuum models identify a range of variables and combine them in a prediction equation to estimate the likelihood of behavior change, or more commonly, the likelihood of behavioral intention and motivation (Armitage & Conner, 2000; Schwarzer, 2008). Thus, each person is placed on a continuum of the probability of behavioral change (Weinstein, Rothman, & Sutton, 1998). The Health Belief Model (Janz & Becker, 1984), Theory of Reasoned Action (Fishbein & Ajzen, 1975), Theory of Planned Behavior (Ajzen, 1985, 1991), and Social Cognitive Theory (Bandura, 1986) are examples of continuum models and theories in PA studies.

Continuum models certainly have intuitive appeal, and some studies have demonstrated that continuum models can predict PA behavior (Hagger, Chatzisarantis, & Biddle, 2002). However, many applications of these models use intention or motivation as the dependent variable, implicitly assuming a near-perfect link between intention and behavior. Several studies have identified this assumption as the "intention-behavior gap" (Gollwitzer & Sheeran, 2006; Rhodes & Bruijn, 2013). However, people often do not behave in accordance with their intentions. Moreover, this "one-size-fits-all" prediction for behavior change cannot effectively incorporate qualitative changes during the behavior change process such as changing mindsets, phase transition or fluctuations back and forth.

Stage models differ from continuum models in that they assume that there is a discontinuity between qualitatively discrete stages (Weinstein et al., 1998). Variables

influencing the behavior change process are assumed to differ across stages. This is represented by different mindsets across the stages and different prediction patterns for stage movement. The best-known example of the stage model is the Transtheoretical Model (TTM, Prochaska, DiClemente, & Norcross, 1992; Prochaska & Velicer, 1997). The TTM asserts that a successful PA behavioral change process needs to involve at least five distinct stages (Biddle & Mutrie, 2007; Marcus, Selby, Niaura, & Rossi, 1992): precontemplation (no PA intention and not physically active), contemplation (having intention yet physically inactive), preparation (having intention but insufficient and tentative PA), action (physically active for less than 6 months), and maintenance (physically active for more than 6 months).

The TTM has earned a good reputation for its broad applications in PA intervention studies (e.g., Plotnikoff, Hotz, Birkett, & Courneya, 2001; Shirazi et al., 2007, etc.). However, in terms of adherence to the HEPA guideline, the TTM 5-stage-categorization might not exhaustively cover all types of people engaging in PA behavior. One outlier can be shown as many of the people's PA levels sometimes exceed the HEPA guideline and sometimes are below the guideline (Kahlert, 2015). For these individuals with the fluctuating PA pattern rather than being relatively stable over time, they cannot be categorized into neither the stage of "action" nor the stage of "maintenance".

To fill this gap between "action" and "maintenance," in his Berlin Exercise Stage Model (BSM), Fuchs (1999) hypothesized a notion of fluctuation stage to refer to a stage of sporadic, unstable, or irregular participation in PA behavior. The name given to a person in this stage is "fluctuator" (Fuchs, 1999; Seelig & Fuchs, 2011). Some researchers subsequently modified Fuchs' definition and developed measurements and algorithms to identify fluctuators based on their modifications (e.g., Lippke & Ziegelmann, 2006; Duan et al., 2013, etc.).

1.2 Statement of problem

Although the concept of fluctuation has been discussed in PA research for nearly 20 years, research on this topic still has some deficiencies, as outlined below.

First, there has been no attempt to synthesize the definitions and measurements of fluctuation. As fluctuation is a phase with irregular PA behavior, it might be difficult to define it precisely and measure it in a single standard.

Second, little is known about fluctuators' daily PA behavioral performance. Previous research on PA of fluctuators was mostly confined to the general PA-related indicators, such as intensity, duration, frequency and the calculated energy expenditure by the previous three indicators (Conroy et al., 2007; Duan et al., 2013, 2015; Strobl, Duan, Tittlbach, & Brehm, 2016). More details about fluctuators' PA behavioral information, such as what specific PA type they engage in, the location of their PA and how they plan and organize their PA, etc., needs to be known.

Third, it has been still unclear about the psychosocial factors underlying their fluctuating PA behavior. As a specific group of individuals with fluctuating PA behaviors (sometimes active and sometimes not), fluctuators are very likely to simultaneously embrace both motivators (facilitating factors) and barriers (hindering factors) in their PA participation in the daily life context. The motivators might function more in physically active periods, while the barriers have more of an effect in their physically inactive period. To know both fluctuators' motivators and barriers may carry great significance in promoting their regular PA participation in the long run. However, to date no research has explored these underlying motivators and barriers and the interrelationships among motivators, barriers, and PA behaviors.

Last but not least, studies have not deeply explored fluctuators to assess if distinct sub-groups of fluctuators exist. Studies on stage models have merely regarded fluctuation as a single stage and compared it with other PA stages (e.g., Cohen, 2003; Duan et al., 2013, 2015; Strobl et al., 2016). Although inter-stage-comparisons have demonstrated some behavioral and psychosocial distinctions, contradictory findings emerged even under the same theoretical model with large study samples from a similar cultural background. For instance, Duan et al. (2015) showed that fluctuators perceived the highest social support and outcome expectancies of all PA stages. Another article applying the same theoretical model demonstrated that people in the

fluctuation stage perceived the lowest social support among those in all active stages, yet had the highest outcome expectancies (Strobl et al., 2016). Although the contradiction could be partly due to sample differences (university students in Duan et al., 2015; normal adults in Strobl et al., 2016), it still provides the possibility that different sub-categories of fluctuators might exist. In addition, results from some survey studies showed that the ratio of PA fluctuators within the research sample could be as high as 25% (Duan, 2006; Lippke & Ziegelmann, 2006). Such high ratios might also suggest the possibility of underlying sub-groups among fluctuators. However, to date, no attempt has been made to explore PA fluctuators to examine any sub-categories that might exist.

1.3 Research questions

Aiming to resolve the issues above, the main research questions were raised as follows:

1. What definitions, measurements, and empirical findings regarding PA fluctuation as a behavioral pattern have been made in the literature?
2. Can we find distinct sub-categories that best summarize the complexity of PA fluctuators based on psychosocial factors? If so, what characteristics distinguish these sub-categories of fluctuators?
3. What are the fluctuators' PA-related behavioral features (e.g., PA type, frequency, how they organize and implement their PA, etc.)?
4. In daily life contexts, what causes fluctuators' irregular PA participation? What are the motivators and barriers to their irregular PA participation? What are the relationships among fluctuators' PA-related behavior, motivators, and barriers?

1.4 Structure of dissertation and design rationale

Research regarding PA fluctuation has not been well summarized so far. Given this, in the literature review focusing on the research question 1, an exploratory systematic review was first implemented to synthesize definitions, measurements and empirical findings regarding PA fluctuation.

In addition, the present thesis included multiple research questions (research questions 2 to 4) from different aspects aiming to explore the PA fluctuation among fluctuators empirically. The mixed-methods research paradigm fits well with the situation of the present thesis and provides a chance to build organic connections between the findings for different research questions (Malina, Nørreklit & Selto, 2011). Based on the underpinning philosophical rationale of pragmatism (i.e., belief in doing what works best to achieve the desired results, Johnson & Onwuegbuzie, 2004), the mixed-methods research paradigm allows the author to freely choose whatever methods possible to address research questions. The findings obtained with different methods can also be corroborated and combined to provide a holistic view of the topic and thus avoid potentially misleading results associated with the use of a single method (Johnson, Onwuegbuzie & Turner, 2007).

This thesis uses a sequential mixed-methods design to address research questions 2 to 4. This design consists of a quantitative cross-sectional questionnaire survey and a subsequent qualitative semi-structured interview.

Aiming to present an overview of the sub-categories among fluctuators, the quantitative study mainly focuses on identifying sub-categories among fluctuators in a relatively large sample by using data-driven categorization method (latent profile analysis) to answer the research question 2.

To obtain deep and thorough understandings of PA fluctuators (research questions 3 and 4), a subsequent interview study was conducted using the methodology of "research program subjective theories." The qualitative interviews investigated fluctuators' PA-related behavioral features, motivators, barriers and the inter-relationships among them. Finally, the findings from these two empirical studies were synthesized in Chapter V, the general discussion. The structure of this thesis is outlined in Figure 1.1.

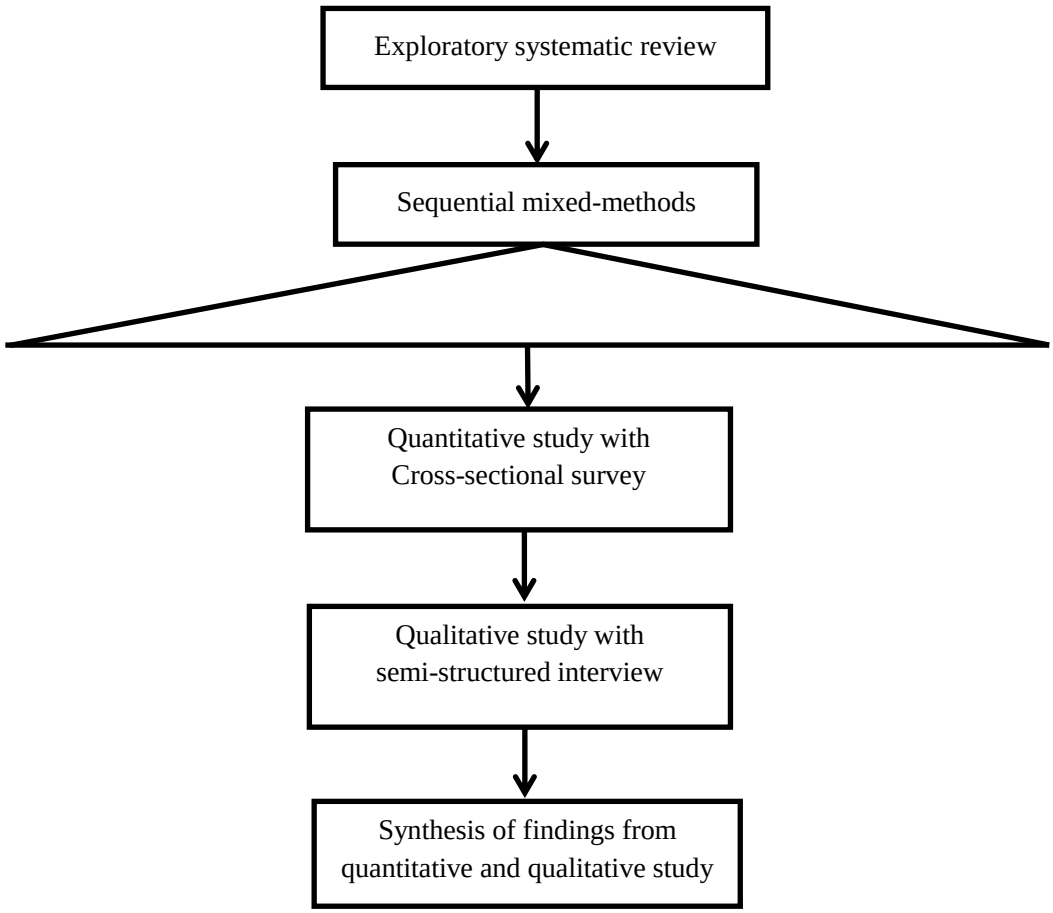


Figure 1.1. Research organization in the present thesis

1.5 Significance of study

The present thesis is one of few studies specifically focusing on the topic of fluctuation in PA. This newly emerging focus stands in contrast to the vast number of studies that have emphasized PA maintenance and prevention against dropout. Fluctuators are of interest because they might reap some health benefits through occasional physical activity, but they might also be at a higher risk for chronic disease than those who are regularly active. In addition, fluctuators are in a critical transition phase that can diverge into either more regularly active or PA or exercise disengagement. This dissertation advances our knowledge of PA fluctuation in the following two respects:

Theoretically, by synthesizing the current literature, it summarizes numerous concepts, measuring methods, and factors related to fluctuation to obtain systematic understandings of this issue. In addition, findings from the literature and the two

empirical studies can be combined to generate an evidence-based hypothesized theory to systematically interpret fluctuators' PA behavior and their underlying psychosocial profiles.

Practically, by using quantitative survey covering a large sample of fluctuators, the sub-categories of fluctuators which assumed of high heterogeneity can be further identified.It helps to discover the variability in psychosocial profiles and adds to our understandings of the complexity of fluctuators. In the future, researchers could purposefully design tailored intervention programs for different sub-categories of fluctuators to improve their adherence to PA guidelines and ultimately achieve the desired health-enhancing effects.

1.6 Delimitation of study

It should be delimited that fluctuation in this dissertation is regarded as a behavioral pattern. It is assumed that only certain individuals (fluctuators) display such a behavioral tendency, rather than treating fluctuation as a phenomenon or intrapersonal variation of PA behavior that every individual possesses.

CHAPTER II: LITERATURE REVIEW

The previous chapter outlined the fundamentals of this thesis, provided a background introduction to PA fluctuation, stated the research questions, and explained how these questions will be addressed. To further elaborate on the PA fluctuation, this chapter presents an exploratory systematic review to synthesize existing knowledge of PA fluctuation. The definitions, explanations, measurements, and empirical evidence regarding PA fluctuation are reviewed according to research question 1, and will serve as a prelude to future research.

In this chapter, we first outline the review method, and then summarize the definitions and measurements of fluctuation. The psychosocial factors related to PA fluctuation are then introduced. Finally, in a discussion, we summarize the findings and link the review to the two empirical studies reported in this thesis.

The literature review in this chapter is mainly based on the author's review article, an exploratory systematic review regarding PA fluctuation (Shang, Duan, Huang & Brehm, 2018). The format and content have been adjusted to meet the dissertation format. Definitions of fluctuation are introduced under the framework of theoretical models.

2.1 Review method

The review strategy in this chapter is exploratory systematic review. In contrast to a standardized systematic review which aims to provide an exhaustive summary regarding one specific research question, the exploratory review serves to identify suitable topics, explore and summarize findings related to the topic. Multiple questions relevant to the study topic are allowed to be included in an exploratory review. Example articles using the same review methodology can be found elsewhere (e.g., French, Bonell, Wellings, & Weatherburn, 2014; Lang, Stahl, Espie, Treasure, & Tchanturia, 2014).

2.1.1 Search strategy

The review was primarily guided by the PRISMA statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses; Moher, Liberati, Tetzlaff, &

Altman, 2009). Electronic searches were conducted in four databases: PsycINFO, PubMed, Scopus, and SPORTDiscus. The search was limited to articles written in English and published between January 1996 and March 2016. Searching keywords and combinations were used as: (physical activity OR exercise) AND (fluctuat* OR lapse OR relapse OR variation OR occasional OR irregular OR intermittent). This initial search yielded the results of a total of 17105 articles.

2.1.2 Inclusion and exclusion criteria

A series of specific inclusion and exclusion criteria were set to check the eligibility of titles, abstracts, and full-text articles:

1) Studies by interviews, literature reviews, commentaries, self-reported questionnaires, and any objective PA measurement devices to investigate fluctuation in PA were included. Articles which included the required keywords but with irrelevant content were excluded (e.g., intermittent training, body bio-clock rhythm fluctuation, relapse in drug or smoke addiction, intrapersonal variation of PA behavior).

2) We focused on PA in a general sense including daily life activity, sport, and exercise. Articles that only addressed one type of PA in one specific setting (e.g., workout in gym, house chores PA at home, etc.) were excluded.

3) Studies focusing on the healthy adult population ($\geq$ 18 yrs) were included. Articles with wrong population such as adolescents, patients with diseases or mobility restrictions, and adults engaging in intense PA in their everyday work (e.g., manual laborer or professional athletes, etc.), were excluded.

Five additional articles were added through manual searching (i.e., scanning reference lists of eligible articles) and expert recommendations. A total number of 15 articles (13 original studies and two studies of review and commentary) were finally included. A flowchart of the systematic literature search and article inclusion is presented in Figure 2.1.

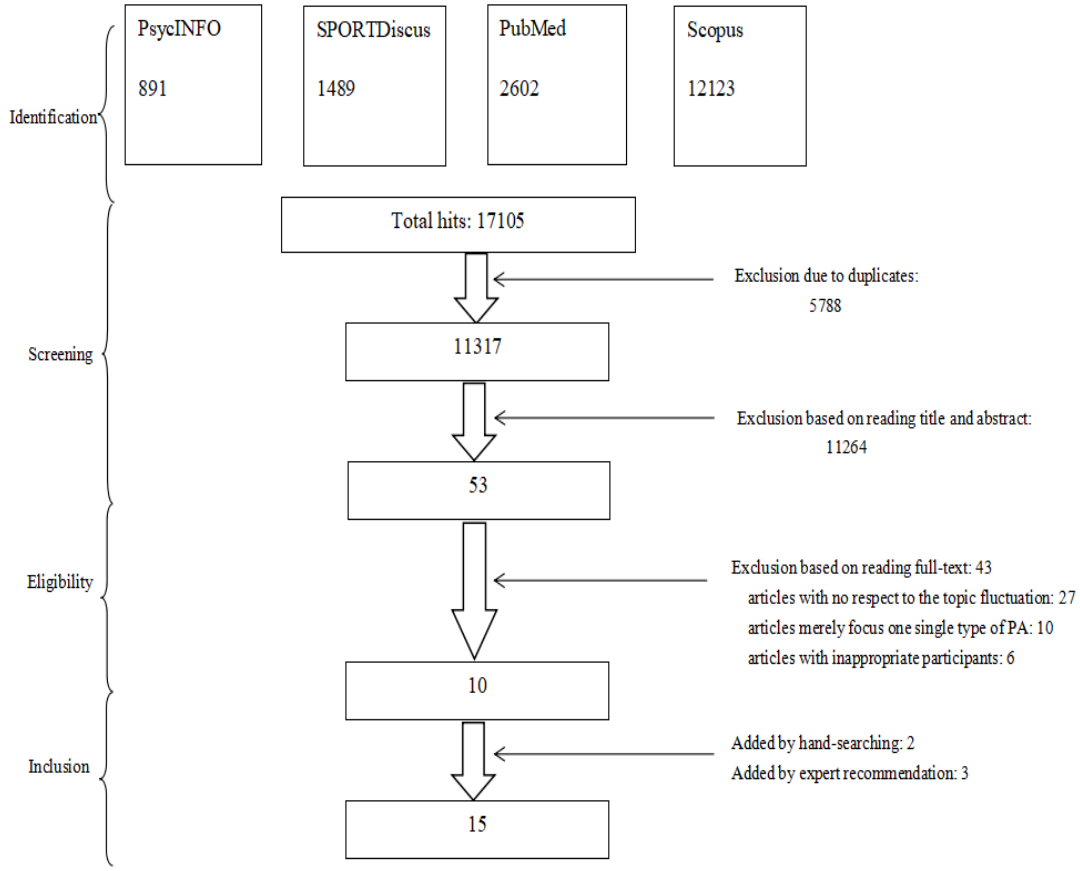


Figure 2.1. Flow chart of article inclusion (Shang et al., 2018)

2.1.3 Quality assessment

An abridged version of Downs and Black's (1998) 22-item assessment tool (see Table 2.1) was used to assess the risk of bias and methodological quality of the selected studies. As no studies included using randomized control trials, seven items particularly for assessing randomized control trials were excluded. As a result, 15 items were used with a total score ranging from 0 to 15. The cut-off point had been established in previous studies with high quality for score 14–15, moderate quality for 10–13, and low quality for the score below 10 (Kirk & Rhodes, 2011; Rhodes & Quinlan, 2015). Two experts assessed the articles and discrepancies were discussed until a consensus was reached. Complete consensus was reached for all articles. In the current systematic review, 11 out of 15 articles adopted a quantitative study design and were rated by the aforementioned assessment tool. The remaining four articles applied

a non-quantitative study design and therefore were not rated. The final rating results can be found in Table 2.2.

Table 2.1

Abridged version of the Down's and Black's assessment tool (Kirk & Rhodes, 2011)

No.	Description
R1.	Hypothesis and aim/objectives clearly described
R2.	Definitions of PA constructs that are validated are clearly described
R3.	Participants described
R4.	Confounders described
R5.	Missing/incomplete data described
R6.	Main findings clearly described
R7.	Information provided about variability of data
R8.	Effect size reported
EV9.	Recruitment sample representative of population (sampling method)
EV10.	Participants' representative of population (representativeness)
IV11.	Appropriate statistical tests used
IV12.	Validation of self-report measure
IV13.	Adjustment for confounding analyses
IV14.	Compliance acceptable (procedure)
P15.	Power of sample size

Note. R= Reporting; EV= External validity; IV= Internal validity; P = Power.

Table 2.2

Quality rating of eligible studies

Author	QS/15	R 1	R 2	R 3	R 4	R 5	R 6	R 7	R 8	EV 9	EV 10	IV 11	IV 12	IV 13	IV 14	P 15
Cohen (2003)	10	1	1	1	0	0	1	1	0	1	0	1	1	0	1	1
Conroy (2007)	10	1	1	1	1	0	1	1	0	1	0	0	1	0	1	1
Dishman (2010a)	12	1	1	1	0	1	1	1	1	1	1	1	1	0	0	1
Dishman (2010b)	14	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
Duan (2006)	11	1	1	1	0	1	1	1	0	1	0	1	1	0	1	1
Duan (2013)	12	1	1	1	0	1	1	1	1	1	0	1	1	0	1	1
Duan (2015)	12	1	1	1	0	1	1	1	1	1	0	1	1	0	1	1
Duan (2016)	13	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1
Lippke (2006)	11	1	1	1	0	1	1	1	0	1	0	1	1	0	1	1
Stetson (2005)	10	1	1	1	1	0	1	1	1	0	0	0	1	0	1	1
Strobl (2016)	12	1	1	1	0	1	1	1	1	1	0	1	1	0	1	1

Note. QS = Quality score (out of 15); R = Reporting; EV = External validity; IV = Internal validity; P = Power

2.2 Characteristics of included articles

As shown in Table 2.3, 12 out of 15 studies provided empirical evidence about fluctuation by various study designs and methods (Cohen, 2003; Conroy et al., 2007; Dishman, Rooks, Thom, Motl, & Nigg, 2010; Dishman, Vandenberg, Motl, & Nigg, 2010; Duan, 2006; Duan et al., 2013, 2015, 2016; Kinnafick, Thogersen-Ntoumani, & Duda, 2014; Lippke & Ziegelmann, 2006; Stetson et al., 2005; Strobl et al., 2016). Among them, two studies by Dishman et al. (2010a, 2010b) adopted a prospective study design, one study used the qualitative methods (Kinnafick et al., 2014), and nine studies used cross-sectional designs (Cohen, 2003; Conroy et al., 2007; Duan, 2006; Duan et al., 2013, 2015, 2016; Lippke & Ziegelmann, 2006; Stetson et al., 2005; Strobl et al., 2016).

Table 2.3

Characteristics of included articles (n=15) (Shang et al., 2018)

Characteristics	Number
Study Focus	
Definition	12
Measurement	11
Evidence	11
Study design	
Cross-sectional	9
Longitudinal/prospective	2
Qualitative	1
Misc	3
Study Locations	
USA	5
UK	1
Germany	1
Hong Kong	1
Mainland China	1
Mixed	3
Participant Gender	
All females	2
Predominantly females (> 70%)	1
Both genders	9
Mean Age	
18-30	2
30-40	5
40-50	4
50 and above	1

Among the nine cross-sectional studies, seven studies used the construct of stage model to assess the psychological and psychosocial factors related to fluctuation, and compared with other PA patterns to find distinctions in those factors (Cohen, 2003; Duan, 2006; Duan et al., 2013, 2015, 2016; Lippke & Ziegelmann, 2006; Strobl et al., 2016). Two cross-sectional studies adopted relapse prevention model constructs to address factors influencing the transition from lapse (short-term no PA) to PA re-adoption or dropout (Conroy et al., 2007; Stetson et al., 2005).

In terms of study context and target populations, five of the identified studies were conducted in the USA (Cohen, 2003; Conroy et al., 2007; Dishman et al., 2010 a,b; Stetson et al., 2005), one in the UK (Kinnafick et al., 2014), one in Germany (Lippke & Ziegelmann, 2006), and two in China (Duan, 2006; Duan et al., 2016). In addition, three studies examined fluctuation in a mixed-culture sample which included Chinese and German participants (Duan et al., 2013, 2015; Strobl et al., 2016). Concerning participant gender, two studies selected only females as participants (Conroy et al., 2007; Kinnafick et al., 2014). Besides, the sample in one study was predominantly female (above 70%; Duan et al., 2016).

A wide age range was covered in all selected articles (mean age = 19.1-56.9 years). In two studies, the mean age range was between 18 and 30 (Duan et al., 2015, 2016), in five studies the age range was between 30 and 40 (Cohen, 2003; Duan, 2006; Duan et al., 2013; Stetson et al., 2005; Strobl et al., 2016), four studies had an age range of between 40 and 50 (Dishman et al., 2010 a,b; Kinnafick et al., 2014; Lippke & Ziegelmann, 2006), and one included participants aged over 50 years old (Conroy et al., 2007).

Noticeably among the selected 15 articles, two pairs of articles shared the same dataset. Specifically, identical datasets were found in Dishman et al. (2010a) and Dishman et al. (2010b), as well as in Duan et al. (2013) and Strobl et al. (2016). Both Dishman et al. (2010a, 2010b) articles placed different emphasis on fluctuation, the articles constituted serial research regarding PA variation; the former (Dishman et al., 2010a) was mainly related to the measurement and distribution of fluctuation, while the latter (Dishman et al., 2010b) addressed factors related to PA variation. Duan et al. (2013) and Strobl et al. (2016) adopted different measures of self-efficacy and analyzed the data by different statistical methods regarding post-hoc comparisons.

2.3 Model-based understanding of the definitions of fluctuation

15 included articles by the systematic search showed that fluctuation is defined from two research perspectives: a) within the stage model constructs (e.g. Fuchs, 1999; Duan et al., 2013) which detail the progression from physical inactivity to habitual PA

behavior and, b) within the relapse prevention model (RPM, Marlatt & George, 1984; Conroy et al., 2007) which helps to identify the PA pattern with lapse and readoption. In the following, definitions of fluctuation are elaborated first from stage model perspective and then from RPM perspectives.

2.3.1 Stage model-based definitions

The stage model in the field of health psychology assumes that there is a discontinuity between qualitatively discrete stages during the process of health behavior change (Weinstein et al., 1998). Different factors are assumed to be important at different stages. Different mindsets and different prediction patterns are assumed across different stages.

To date, the most widely used stage model in health and exercise psychology is the Transtheoretical Model (TTM, DiClemente & Prochaska, 1982; Prochaska et al., 1992). The TTM incorporates cognitive, behavioral, and temporal aspects of behavioral change into five stages of change (precontemplation, contemplation, preparation, action, and maintenance), ten processes of change, and two core constructs of decisional balance (pros & cons) and self-efficacy (Prochaska & Marcus, 1994). However, the TTM did not include a stage of fluctuation. To close this gap, many researchers proposed their stage models and attempted to incorporate a stage characterized by fluctuating PA participation based on the TTM constructs (Fuchs, 1999, Lippke & Ziegelmann, 2006; Duan, 2006; Duan et al., 2013, 2015; Strobl et al., 2016). Next, we follow a chronological order to introduce different definitions of fluctuation within the stage model constructs.

Fluctuation stage in BSM

Fluctuation was first proposed as a conceptually distinct stage in the Berlin Exercise Stage Model (BSM, Fuchs, 1999, see Figure 2.2). The fluctuation in BSM refers to a stage of which "sporadic, only occasionally shown exercise behavior that is practiced sometimes at several occasions per week, and then again not even a single time in a fortnight" (Fuchs, 1999). As shown in Figure 2.2, fluctuation stage appears

between implementation (i.e., short for intention implementation, stands for the initiation of regular PA behavior) and habituation (i.e., the stage where regular PA behavior is a habit). The possible consequences of fluctuation are either becoming habituation or ending up with dropout (disengagement) or then restart with preaction (a stage with both PA intention and detailed plan).

It is hypothesized in BSM that fluctuating PA behavior in the stage of fluctuation may be due to volitional processes of limited self-control and self-regulation (Kuhl, 1992; Muraven & Baumeister, 2000) that are not effective enough to generate the planned physical activity behavior under unfavorable situations. In this case, the exercise behavior is not sufficiently shielded from temptations of not implementing planned PA. From these statements, it can be inferred that two psychological traits for fluctuation: 1) limited self-control or self-regulation; 2) intention to and plan for PA.

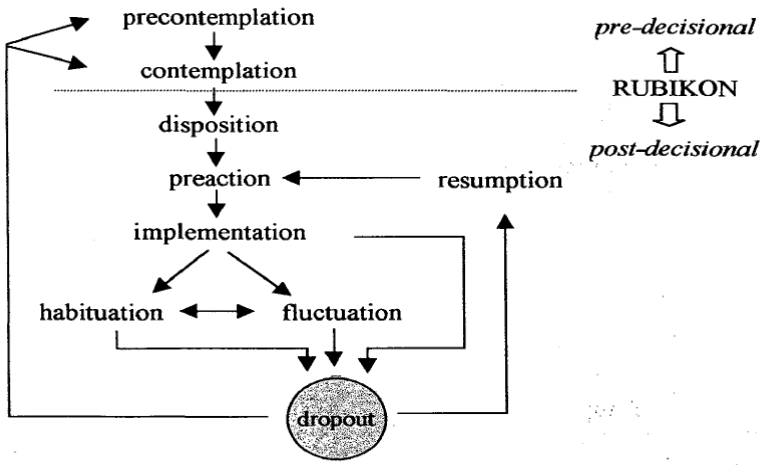


Figure 2.2. Theoretical framework of BSM (Fuchs, 1999)

Relapse stage and Exercuserciser in modified TTM

Cohen (2003) modified the TTM by adding a new stage named "relapse stage", characterized as being sometimes regularly active during the recent one year, but not on a regular basis, and embrace the intention to resume exercising regularly in the future. Although the name is different from "fluctuation", the "relapse stage" and fluctuation stage in BSM are similar in nature.

As shown in Figure 2.3, this relapse stage appears between preparation (insufficient or tentative execution of PA behavior) and action (recent initiation of sufficient and regular PA) stages. Those people in the "relapse stage" were named "excusercisers", which is a self-created compound word of “excuse” and “exerciser”, to their tendency of employing excuses to avoid regular participation in physical activity and exercise when they encounter real or perceived barriers. Thus, it can be inferred from this definition that perceived barriers rather than real barriers could be a feature of “relapse stage”.

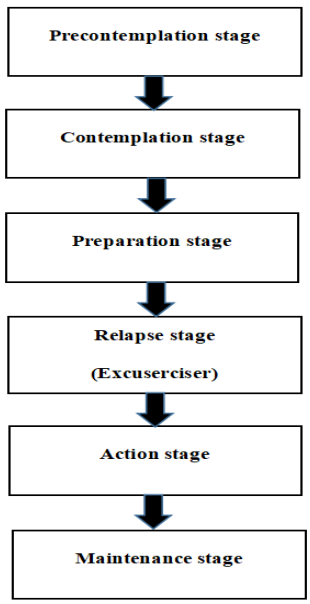


Figure 2.3. Stage framework of adapted TTM (Cohen, 2003)

Fluctuation stage in MSM

Fluctuation stage also appeared in “Multi-Stage Model” (MSM, Lippke, Sniehotta, & Luszczynska, 2005; Lippke & Ziegelmann, 2006), which is developed based on BSM to address on the health behavior change process. As shown in Figure 2.4, the MSM further systemize all the eight stages in BSM into three phases of 1) non-intentional, intentional but inactive, and actional phase.

In the MSM, fluctuation stage is located in the actional phase between two stages of habituation (the stage where regular PA behavior is a habit) and resumption (stage of failing to maintain regular PA behavior but still harbor the intention to continue PA).

Fluctuation in MSM is defined as the stage where "individuals require high levels of volitional control to continue the regular PA participation over time" (Lippke et al., 2005). In this sense, it could be inferred that fluctuation in MSM is featured by 1) behavioral active, 2) yet behind the active behavior, the effortful and unhabituated maintenance of the behavior requires willpower.

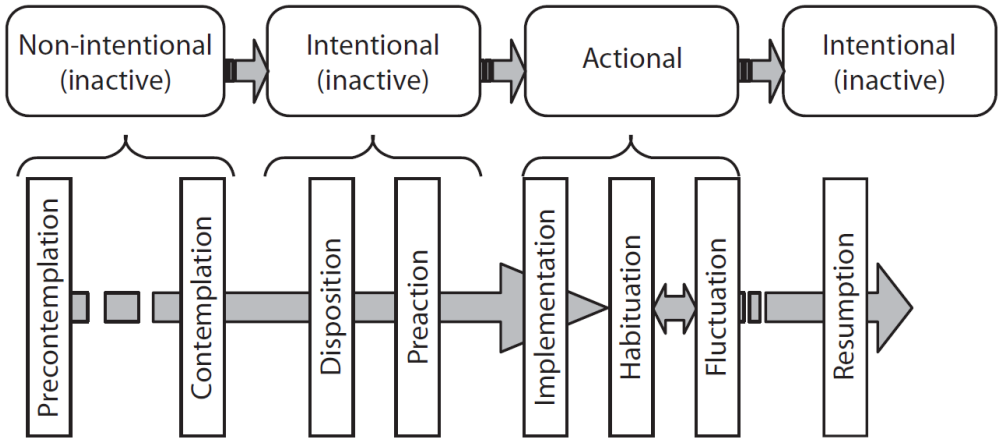
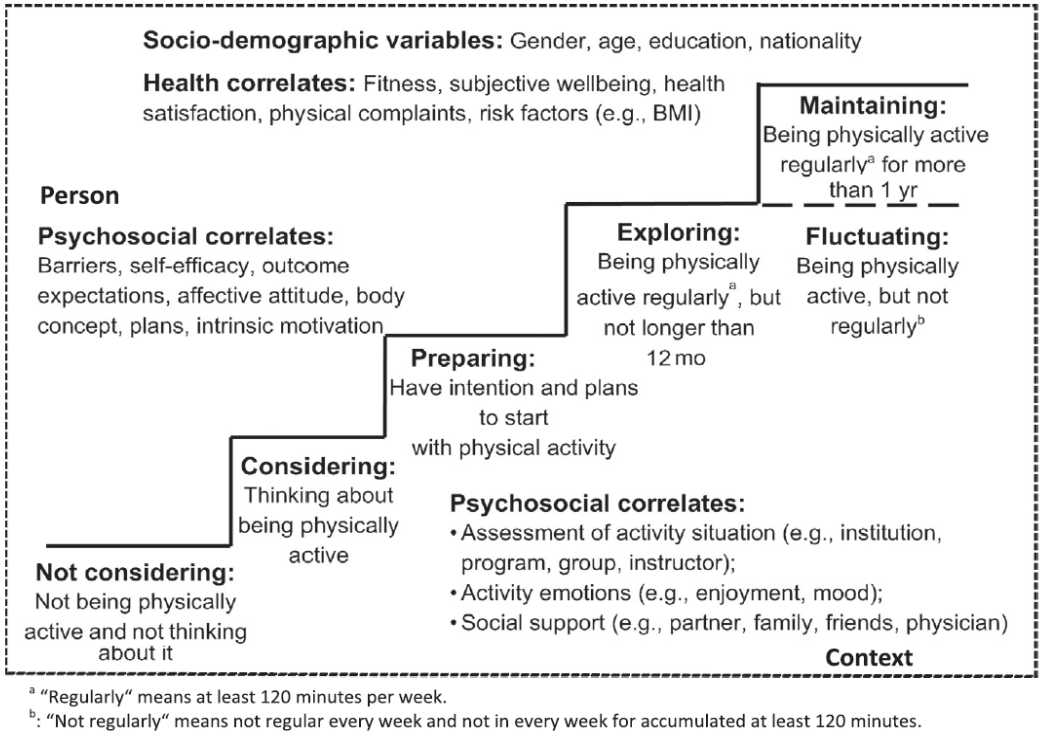


Figure 2.4. Stage framework of MSM (Lippke & Ziegelmann, 2006)

Fluctuating stage in the FIT model

The FIT Model (full name as "Four Steps from Inactivity to Health-enhancing Physical Activity") was specifically developed as a theoretical framework to describe and explain the behavioral change process from sedentary behavior to habitual HEPA behavior. It retains the basic structure of TTM and supplements a new stage termed "fluctuating stage". As shown in Figure 2.5, the six stages proposed in FIT model are named not-considering, considering, preparing, exploring, fluctuating, and maintaining (Duan et al., 2013).

The fluctuating stage in this FIT model refers to a phase in which people occasionally adhere to HEPA guideline (i.e., 150 minutes MVPA per week). The fluctuating stage in FIT model parallels with exploring stage (recent initiation of adhering HEPA guideline), and these two stages may sometimes alternate with each other.



[a] "Regularly" means at least 120 minutes per week.
[b]: "Not regularly" means not regular every week and not in every week for accumulated at least 120 minutes.

Figure 2.5. Stage framework in FIT (Duan et al., 2013)

2.3.2 Relapse prevention model-based definitions

Another type of definitions is based on relapse prevention model (RPM). The RPM was initially developed by Marlatt and George (1994) in behavioral maintenance program in the treatment of addictive behaviors, and then it successfully extended the application in PA domain (Knapp, 1988; Simkin & Gross, 1994; Stetson et al., 2005). In contrast with stage models which focus more on the promoting to behavioral maintenance, the RPM takes a complementary view to provide the insight regarding relapse prevention. Definitions of fluctuation-related terms under RPM constructs are presented in Table 2.4.

Table 2.4

Definition of terms related to fluctuation

Term	Definition
Relapse	1. An extended period of interruption of regular sustained PA behavior after its initiation and maintenance (Seymour et al., 2010). 2. A complete return to sedentary behavior or lifestyle (Conroy et al., 2007)
Lapse	1. Slips of the protocol-related PA behavior that may lead to relapse outright or provide an opportunity to administer and learn better coping strategies prior to complete relapse (Stetson et al., 2005) 2. A PA pattern in which the individuals who drop back to their former behavioural for some days or weeks but then resume a higher activity level again (Kahlert, 2015)
Readoption/Reactivation	The resumption of the sustained PA behavior following a period of relapse (Seymour et al., 2010).
Grace period	A window of time during which lack of adoption of the behavior was not counted as a failure (Seymour et al., 2010).

Based on these definitions within RPM, the behavioral pattern must consist of three elements: 1) periods of regular adherence; 2) short periods of lapse not exceeding the grace period thus do not count as relapses; 3) readoption after the lapse (Seymour et al., 2010). In previous literature, this particular PA pattern was named as "lapse" (Kahlert, 2015), "regular exercise with lapse" (Conroy et al., 2007), "lapse and readoption" (Kinnafick et al., 2014).

2.4 Measurement of fluctuation

The measurement of fluctuation in this part presents what kinds of approaches have been used in previous literature to identify fluctuator from the population. This section can also be regarded as the summary of the operational definitions regarding fluctuation, since both the operational definition and the measurement of fluctuation involve the process of extending the conceptual definitions of fluctuation to more clearly distinguishable, measurable, and quantifiable observation or implementation.

The following three approaches have been found to identify fluctuation in previous literature: 1) using stage algorithm, 2) identifying "fluctuation" through detecting lapse and readoption, 3) and identifying "fluctuation" by prospective with-in person variation.

2.4.1 Fluctuation identification by stage algorithm

A stage algorithm is usually a short retrospective self-report measurement to assign each individual to one of the pre-defined stages (Reed, Velicer, Prochaska, Rossi, & Marcus, 1997). A good PA stage algorithm should at least include three elements of 1) targeted behavior (e.g., PA behavior), 2) clear criteria for the targeted behavior (e.g., doing MVPA of at least 150 minutes per week); 3) pre-defined time span (e.g., in the recent one year). Stage algorithm is a practical and economical approach to identify PA fluctuation in large population; thus it has been widely applied in cross-sectional survey studies (Duan, 2006; Duan et al., 2013, 2015, 2016; Lippke & Ziegelmann, 2006; Strobl et al., 2016).

In stage algorithm of BSM, the fluctuation stage can be identified by the question "In the recent six months, have you been physically active (more than 15 minutes' MVPA per week) at least once per month, but not in every week? " The individuals who met the criteria are assigned into "fluctuation" (Duan, 2006).

In MSM (Lippke & Ziegelmann, 2006), fluctuation stage was identified from both behavioral performance and the habitual level of the PA behavior. Behaviorally, the criteria of fluctuation are engaging in regular PA behavior (20 minutes per week MVPA) less than one year. Psychologically, two questions probing the habitual level are: 1) how easy is it for you to exercise regularly (at least 20 minutes per week moderate to vigorous PA); and 2) how much has it become your habit to exercise regularly. The format of these two questions was on a 4-point Likert scale. Individuals were assigned to fluctuation stage when ratings were not the highest (very easy to do and absolutely a habit) in either of the item.

The stage algorithm in Cohen's adapted TTM used three statements to identify fluctuators. The three statements are shown as below: 1) I was exercising regularly (120 minutes' MVPA per week) at times over the past one year; 2) I am not currently exercising regularly; 3) I intend to resume exercising regularly in the future. Individuals who meet all three criteria are assigned to the fluctuation stage.

In the FIT model, respondents are required to choose one of six statements which best described their current situation of PA participation (Duan et al., 2013). Specifically, the statement describing fluctuation is "I am physically active, but not regular every week, or have not accumulated at least 120 minutes' MVPA every week".

However, it should be noted that stage algorithm only provides a framework or paradigm to identify fluctuation stage. The PA criteria can be adjusted according to the characteristics of the research population. Therefore, even under the same theoretical model such as FIT model, the PA criteria can vary from 120 (Duan et al., 2013; Strobl et al., 2016) to 240 (Duan et al., 2015, 2016.) minutes' MVPA per week.

2.4.2 Fluctuation identification through detecting lapse and readoption

Another approach to identify PA fluctuation is asking about the lapse and readoption in a certain period of an individual's PA participation (Conroy et al., 2007; Kinnafick et al., 2014). Retrospective self-report by both interview (Kinnafick et al., 2014) and survey (Conroy et al., 2007) has been used to assess the occurrence of PA lapse and readoption. For example, in the study conducted by Conroy et al. (2007), two criteria should be met for fluctuation: 1) engaging in regular exercise (three or more times per week) during the past six months; 2) with exercise lapses (no exercise more than two weeks) during the past six months and with readoption.

2.4.3 Fluctuation identification by prospective within-person variation in meeting PA guideline

Fluctuation as a PA pattern can also be identified by objectively classifying with-in person variation in meeting PA criteria across multiple time points (Dishman et al., 2010a). This approach provides a more specific classification by grouping individuals

into a few clusters including a cluster of similar with fluctuation (originally as "occasionally meeting the PA criteria"). Good examples can be found in a series of studies conducted by Dishman et al. (2010a, 2010b). They used the International Physical Activity Questionnaire (IPAQ) to measure PA for totally five times at an interval of six months. People who partially (1-4 times) met the Healthy People 2010 (U.S. Department of Health and Human Services, 2000) guidelines were regarded as the PA pattern of "fluctuation".

2.5 Empirical evidence related to fluctuation

The empirical evidence (summarized in Appendix 4) regarding fluctuation is introduced from the following aspects: 1) sample distribution (the percentage of fluctuators in the study samples); 2) behavioral performance (e.g., energy expenditure); and 3) fluctuator's psychosocial features.

2.5.1 Sample distribution

The fluctuation was found in a substantial proportion of the study sample from 9.9% (Cohen, 2003) to 52% (Dishman et al., 2010a). Most studies (8 out of 11) found that the percentage lay between 15% and 30% (Conroy et al., 2007; Duan, 2006; Duan et al., 2013, 2015, 2016; Kinnafick et al., 2014; Lippke & Ziegelmann, 2006; Strobl et al., 2016). However, since most of the evidence was collected through convenience sampling with various identification approaches, these percentage figures should be interpreted with caution.

2.5.2 Behavioral performance

Four studies investigated the energy expenditure of fluctuators (Conroy et al., 2007; Duan et al., 2013, 2015; Strobl et al., 2016). In three studies[3] based on the FIT model (Duan et al., 2013, 2015; Strobl et al., 2016), the researchers used self-report questionnaires to measure participants' weekly PA energy expenditure. The results

[3] Two studies (Duan et al., 2013; Strobl et al., 2016) share the same dataset, but they differed in methods of statistical analysis.

showed that fluctuator's average energy expenditure is 1197 and 1691 kilocalorie (Kcal)/week, which is higher the HEPA recommended level (800 and 1560 Kcal/week) but less than the average PA energy expenditure of PA explorers (people with recent initiation of sufficient and regular PA, 1620 and 2141 Kcal/week) and maintainers (people with regular and sufficient PA, 2048 and 2566 Kcal/week). In a study conducted by Conroy et al. (2007), the results showed that fluctuators (in this study named "regular exercise with lapse") expended 996 MET-minutes/week and averagely walked 7176 steps per day. The average energy expenditure of fluctuator was also shown higher than those of occasional exercise with lapse (588 MET-minutes/week; 5906 steps/day), and lower than those who regularly exercise without lapse (1182 MET-minutes/week; 7771 steps/day).

2.5.3 Psychosocial features

Eleven studies provided empirical evidence regarding fluctuators' psychosocial features (Cohen, 2003; Conroy et al., 2007; Dishman et al., 2010a; Duan, 2006; Duan et al., 2013, 2015, 2016; Kinnafick et al., 2014; Lippke & Zigelmann, 2006; Stetson et al., 2005; Strobl et al., 2016). These features were mostly demonstrated by statistically analyzing the differences between fluctuation and other PA patterns or stages in various psychosocial variables (e.g., by ANOVA with post hoc analysis; Duan et al., 2013; Lippke & Ziegelmann, 2006). In particular, one study (Kinnafick et al., 2014) explored the psychosocial features of fluctuation by qualitative, semi-structured interviews that were based on the self-determination theory.

The following PA patterns were frequently compared with fluctuation:

- Preparation/preparing: PA pattern of insufficient or tentative execution of PA behavior (Duan et al., 2013; Marcus et al., 1992).
- Action/exploring/implementation: PA pattern of recent initiation of sufficient and regular PA, or short-term maintenance of regular and sufficient PA behavior (Duan et al., 2013; Marcus et al., 1992).

- Maintenance/maintaining/habituation: PA pattern of regular and sufficient PA behavior which has been developed into a habit (Duan et al., 2013; Lippke & Ziegelmann, 2006; Marcus et al., 1992).

In order to maintain consistency, the three PA patterns mentioned above were named preparation, exploration, and maintenance. In the following, the psychosocial features of fluctuation are first introduced in a factor-by-factor manner. Then, these results are summarized in Table 2.5. An index named “distinguishing ratio” was created to elaborate the robustness of psychosocial factors when differentiating different PA patterns. The calculation of this index can also be seen in the notes of Table 2.5.

Table 2.5

Summary of psychosocial findings related to fluctuation (Shang et al., 2018)

	Definition	Number of studies	F VS P	F VS E	F VS M	Distinguishing ratio
Self-efficacy	The confidence in one's own ability to persist with physical activity behaviors in various situations (Marcus et al., 1992).	8	F=P (1); **F>P (2)**	F=E (4); **F>E (1)**	F=M (1); **F<M (7)**	10/16=62.5%
Decisional balance/outcome expectancies	The assessment of the pros (anticipated benefits) and cons (anticipated costs) that are associated with PA behaviors (Duan, 2006).	6	F=P (1); **F>P (2)**	F=E (3); **F>E (1)**	F=M (3); **F<M (3)**	6/13= 46.2%
Perceived barriers	Subjective reasons that prevent people from performing physical activity (Strobl et al., 2016).	5	F=P (1); **F<P (3)**	F=E (2); **F>E (2)**	**F> M (5)**	10/13=76.9%
Planning	An extension of the intention including specific situational parameters ("when", "where") and a sequence of action ("how") / anticipation of barriers and the generation of alternative behaviors to overcome them (Schwarzer, 2008).	5	F=P (2); **F<P (1)**	F=E (2); **F<E (1)**	F=M (1); **F<M (4)**	6/11 = 54.5%
Intrinsic motivation	Being motivated to engage in physical activity from one's inherent satisfactions such as enjoyment, personal accomplishment, and excitement (Strobl et al., 2016).	4	**F>P (4)**	F=E (4)	**F<M (4)**	8/12= 66.7%

Social support	The perception and actuality that one has a network of people supporting the intention to engage in physical activity (Strobl et al., 2016).	4	**F>P (2)**	F=E (4)	**F<M (2)**; F=M (2)	4/10 = 40%
Activity emotion	Activity emotion refers to the emotional experiences (especially positive experiences such as enjoyment, pleasure, and satisfaction) during engaging in PA (Duan et al., 2013).	2	F=P (1)	F=E (2)	**F<M (2)**	2/5 = 40%
Affective attitude	The feelings associated with PA behavior that stem from past experiences (Strobl et al., 2016).	2	F=P (1); **F>P (1)**	F=E (2)	**F<M (2)**	3/6 =50%
Assessment of activity situation	To what degree the three situations (e.g., doing PA with others; under professional guidance; in nice sites) affect one's engagement in PA (Duan et al., 2013).	2	F=P (2)	F=E (2)	F=M (2)	0/6 = 0%
Body Concept	Overall satisfaction with one's body which can be regarded as an antecedent as well as a consequence of PA (Fox & Corbin, 1989).	2	**F>P (2)**	F=E (2)	**F<M (2)**	4/6 = 66.7%
Intention	The motivational decision to engage in PA (Lippke & Ziegelmann, 2006).	1	/	**F>E (1)**	F=M (1)	1/2 = 50%
Risk perception	The subjective judgment that people make about the characteristics and severity of a risk (Schwarzer, 2008).	1	/	F=E (1)	F=M (1)	0/2 = 0%

Stress	The responses to pressure or threat (Conroy et al., 2007).	1	/	/	**F>M (1)**	1/1 = 100%
Total		9	(F VS P): 17/26= 65.4%	(F VS E): 6/34= 17.6%	(F VS M): 32/43= 74.4%	(F VS all): 55/103 = 53.4%

Note. F=fluctuation; P=preparation; E=exploration; M=maintenance.The numbers in the parentheses indicate the number of comparisons between fluctuation and other PA pattern.Distinguishing ratio = (number of significant comparisons between fluctuation and other PA patterns) / (number of total comparisons between fluctuation and other PA patterns)

Self-efficacy: The term self-efficacy in the PA domain is defined as the confidence in one's own ability to persist with PA behaviors under various unfavorable circumstances (Marcus et al., 1992). It is also considered as a mediator in nearly all kinds of behavior change process (Bandura, 1997). Self-efficacy has been associated with fluctuation in 8 studies concerning both stage models and RPM. (Cohen, 2003; Dishman et al., 2010a; Duan,2006; Duan et al., 2013; Duan et al., 2015; Lippke & Ziegelmann, 2006; Strobl et al., 2016). In general, self-efficacy can separate fluctuation with preparation and maintenance well, but not exploration, with an overall distinguishing ratio of 62.5%. Specifically, self-efficacy in fluctuation has been found in an intermediate position which is significantly lower than those in maintenance (seven out of eight comparisons showed significant differences) and higher than those in preparation (two out of three comparisons showed significant differences). Only one out of five studies showed the self-efficacy in fluctuation was significantly higher than that in exploration in a study based on BSM (Duan, 2006).

Decisional balance (pros and cons) / outcome expectancies: Decisional balance and outcome expectancies are similar constructs in PA domain referring to the rational assessment of the pros (anticipated benefits) and cons (anticipated costs) that are associated with PA behaviors (Duan, 2006). It is assumed in the behavior change process that individuals are more likely to change their behavior once the pros outnumber the cons (Janis & Mann, 1977). Totally six studies involved this construct into comparisons between fluctuation and other PA patterns. However, in general, decisional balance/outcome expectancies are not a good psychosocial variable distinguishing fluctuation from other PA patterns (distinguishing ratio = 46.2%). Two (Cohen, 2003; Duan et al., 2015) out of three studies showed decisional balance (or outcome expectancies) in fluctuation was significantly higher than that in preparation, while one (Duan et al., 2013) showed no significant difference. Only one (Lippke & Ziegelmann, 2006) out of four studies showed decisional balance (or outcome expectancies) in fluctuation was significantly higher than that in exploration, while the other three (Cohen, 2003; Duan et al., 2013, 2015) showed no significant difference.

Regarding the difference between fluctuation and maintenance, three studies (Dishman et al., 2010a; Duan et al., 2013, 2015) showed no significant difference, while the other three (Cohen, 2003; Conroy et al., 2007; Lippke & Ziegelmann, 2006) demonstrated decisional balance (or outcome expectancies) in fluctuation was significantly lower than that in maintenance.

Perceived barriers: Perceived barriers refer to the subjective reasons that prevent people from performing physical activity (Strobl et al., 2016). Different from real barriers, perceived barriers pertain to one's opinion or perception of the tangible and psychological obstacles of the behavior (Janz, 1984). Totally five studies have examined perceived barriers as a related factor of fluctuation (Cohen, 2003; Conroy et al., 2007; Duan et al. 2013, 2015, 2016). Overall, the perceived barrier is a sensitive psychosocial variable distinguishing fluctuation from other PA patterns (distinguishing ratio = 76.9%). All of the five studies showed that perceived barriers in fluctuation were significantly higher than those in maintenance. Three studies (Duan et al., 2013, 2015, 2016) based on FIT model showed perceived barrier in fluctuation was significantly lower than that in preparation, while one (Cohen, 2003) showed no significant difference. Two out of four studies showed perceived barriers in fluctuation was significantly higher than those in exploration (Duan et al., 2013, 2016), while the other two showed no significant difference (Cohen, 2003; Duan et al., 2015).

Planning: Planning denotes an extension of the intention including specific situational parameters (“when”, “where”) and a sequence of action (“how”) / anticipation of barriers and the generation of alternative behaviors to overcome them (Schwarzer, 2008). Clear and specific planning is one of the prerequisites for implementing PA behavior and bridges the gap between behavioral intentions and behavior (Sniehotta, Scholz & Schwarzer, 2005). Totally five studies have examined planning as a related factor of fluctuation (Conroy et al., 2007; Duan et al., 2013, 2015, 2016; Stetson et al., 2005). Overall, planning is a sensitive psychosocial variable distinguishing fluctuation from other PA patterns (distinguishing ratio = 54.5%). Compared with people in maintenance, four out of five studies showed that people in

fluctuation scored lower in planning (Conroy et al., 2007; Duan et al., 2013, 2015; Stetson et al., 2005). In two studies conducted by Duan et al. (2015, 2016), no significant difference was shown among the three PA patterns of fluctuation, preparation, and exploration. While in one earlier study (Duan et al., 2013), people in fluctuation conceived worse planning than those of people in preparation and exploration.

Intrinsic motivation: Intrinsic motivation in the context of exercise psychology refers to being motivated to engage in exercise for the sake of one's inherent satisfactions (Strobl et al., 2016). Intrinsically motivated individuals experience feelings of enjoyment, development of their skills, personal accomplishment, and excitement (Deci, 1975). And it has also been widely confirmed intrinsic motivation was predictive for long-term exercise adherence, while exercise behaviors in the long run with extrinsic motivation (e.g., weight loss, better body appearance, gaining social reward, etc.) were strongly correlated with dropout (Richard et al., 1997; Vallerand, Fortier, & Guay, 1997). Four studies involved this construct into comparisons between fluctuation and other PA patterns and contribute a satisfied distinguishing ratio of 66.7% (Cohen, 2003; Duan et al., 2013, 2015, and 2016). The four studies showed the consistent findings that the level of intrinsic motivation in fluctuation was significantly lower than that in maintenance but higher than that in preparation. However, when compared with exploration, no significant difference could be detected regarding intrinsic motivation in all four studies (Cohen, 2003; Duan et al., 2013, 2015, 2016).

Social support: Social support related to PA behavior was defined as the perception and actuality that one has a network of people supporting the intention to engage in PA (Strobl et al., 2016). Social support was evaluated as a factor relevant to PA fluctuation in four studies and contributes to an overall distinguishing ratio of 40% (Duan et al., 2013, 2015, 2016; Lippke & Ziegelmann, 2006). In particular, two studies showed people in fluctuation perceived less social support compared with those in maintenance (Duan, 2006; Duan et al., 2013), whereas no significant differences were found in the other two studies (Duan et al., 2015; Lippke & Ziegelmann, 2006).

Concerning the social support on fluctuation and exploration, no significant differences were found between these two stages among all four studies (Duan et al., 2013, 2015, 2016; Lippke & Ziegelmann, 2006). Regarding the social support on the stage of fluctuating and preparation, two studies based on FIT model detected people in fluctuation perceived higher social support than those in preparation (Duan et al., 2013, 2015).

Activity emotion: Activity emotion refers to emotional experience (especially positive experiences such as enjoyment, pleasure, satisfaction) during PA (Duan et al., 2013). These positive experiences were assumed to be derived from having intrinsic motivation; thus the two terms partially overlap with each other. It has been well established that positive activity emotion (such as fun, enjoyment, and satisfaction) during PA or exercise have been assumed and tested as a critical predictor of maintenance and drop-out (Trost, Owen, Bauman, Sallis, & Brown, 2002). Action emotion was evaluated as a factor of PA relevant to fluctuation in two studies based on FIT model and contribute to an overall distinguishing ratio of 40% (Duan et al., 2013, 2015). It was found in these two studies that people in fluctuation experienced less positive activity emotions (e.g., pleasure and satisfaction) compared with those in PA maintenance. Whereas, no significant difference was found in such positive feelings between people in preparation and exploration (Duan et al., 2013, 2015).

Affective attitude: Affective attitude in PA is defined as the feelings associated with PA behavior that stems from past experiences, e.g., sport at school, or information from others (Strobl et al., 2016). Two studies based on FIT model proved that people in fluctuation stage had worse affective attitude than those in maintenance, but no significant difference on affective attitude compared to those in exploration (Duan et al., 2013, 2015). Regarding the difference between fluctuation and preparation in affective attitude, the results were not consistent with each other. The study of Duan et al. (2013) revealed people in fluctuation had better affective attitude than people in preparation, while the study of Duan et al. (2015) did not show this relationship.

Body concept: Body concept refers to overall satisfaction with one's body which can be regarded as an antecedent as well as a consequence of PA (Fox & Corbin, 1989). Two studies based on FIT model showed consistent results that people in fluctuation value higher in their body than people in preparation, but lower than those people in maintenance. No significant difference was reported between fluctuation and exploration on body concept (Duan et al., 2013, 2015).

Miscellaneous: Intention, which denotes the motivational decision to engage in PA, was examined across all PA stages in a study based on MSM (Lippke & Ziegelmann, 2006). Results indicated that people in fluctuation had higher intention than that in people in exploration, but no significant difference was found between fluctuation and maintenance. Stress indicating the responses to pressure or threat was found higher in people in fluctuation than those in people in PA maintenance (Conroy et al., 2007).

Meanwhile, the assessment of activity situation and risk perceptions were examined in three studies and no significant differences were found between fluctuation and other PA patterns (Duan et al., 2013; Lippke & Ziegelmann, 2006; Strobl et al., 2016).

Additionally, findings provided by the single qualitative study (Kinnafick et al. 2014) emphasized the importance of motivational internalization during PA behavior change. Results suggested that an improvement in autonomy and competence (two critical components of intrinsic motivation), as well as a reduction of relatedness (reliance on other people's company), were evident during the transition from fluctuation to maintenance. These findings were in agreement with findings from previous quantitative studies (Cohen, 2003; Duan et al., 2013, 2015, 2016; Strobl et al., 2016) which found significant differences between fluctuation and maintenance in intrinsic motivation.

In summary, thirteen empirically tested psychosocial variables accumulating a total ratio of significant difference 53.4%. Variables with high distinguishing ratio ≥ 50% were: stress (100%), perceived barriers (76.9%), intrinsic motivation (66.7%),

body concept (66.7%), self-efficacy (62.5%), planning/coping plans (54.5%), affective attitude (50%), and intention (50%). However, decisional balance/outcome expectancies, activity emotion and social support were found to have a relatively lower distinguishing ratio (<50%). Two variables, assessment of activity situation and risk perception, demonstrated zero distinguishing ratios. Table 2.5 also presents the distinctiveness of fluctuation in comparison to the other three PA patterns. Fluctuation was found to be highly distinct from preparation (65.4%) and maintenance (74.4%), for all 13 psychosocial variables, and less distinct from exploration (17.6%).

2.6 Discussion

This review section explored and summarized the definitions, measurements, and empirical evidence related to fluctuation through a systematic study of the literature.

Based on the summary of descriptive definitions of fluctuation, we can extract some common features at a conceptual level:

- Behavioral irregularity. People in fluctuation occasionally meet the recommended PA guidelines with frequent lapses (e.g., Conroy et al., 2007; Duan et al., 2013).
- High risk of drop-out. People in fluctuation are assumed to be on the verge of drop-out from regular PA behavior (Fuchs, 1999; Duan, 2006).
- Intention to PA. Fluctuation within stage models is located in post-intentional phase (e.g., BSM, MSM, Fuchs, 1999; Lippke & Ziegelmann, 2006), which might suggest that a prerequisite of fluctuation is the formation of an intention to be physically active.
- Low automaticity or low habit level. Existing definitions highlight low automaticity (Lippke & Ziegelmann, 2006), accompanied by real or perceived barriers and temptations (Cohen, 2003). In other words, PA behavior might not be a fixture or habit in the individual's daily life, especially under unfavorable circumstances.

- Limited self-regulation or willpower. The literature has highlighted that people in fluctuation have limited self-regulation or willpower to persist in regular PA behavior (Fuchs, 1999; Lippke & Ziegelmann, 2006).

The first two features can be regarded as behavioral performance and tendency, while the other three are more related to psychological characteristics. These five features extracted from the conceptual definitions can guide future study to build sound and comprehensive conceptual definitions of fluctuation.

For the selection of definition of fluctuation in the further two empirical studies, the definition based on FIT model is favored. This consideration is based on two reasons. Firstly, FIT model is the most updated and refined model including fluctuation as a stage in the PA behavior change process. The PA criteria regarding fluctuation is set as 150 minutes' MVPA, which is consistent with the current official HEPA guideline for adults (WHO, 2017). Secondly, the FIT model provided easy but accurate algorithm to identify fluctuators. The FIT algorithm is a self-report multiple-choice question with six statements to assign individuals into stages, which is easy to be implemented for further fluctuation identification (Duan et al., 2013). Meanwhile, this algorithm has been examined as a reliable and valid instrument in previous research among Chinese adults (Duan et al., 2015, 2016).

The review findings also indicated that fluctuation can be identified primarily using self-report stage algorithms. However, the lack of commonly accepted PA criteria as a benchmark and the lack of objective tracking of fluctuators' PA behavior could be major limitations of this study. To build a more comprehensive understanding, future studies could consider a standardized approach to measuring behavioral irregularity by setting widely acknowledged PA criteria (e.g., WHO PA criteria) with objective tracking and assessing habit strength.

The majority of studies from the present review suggest that 15–30% of the adult population is fluctuators (Conroy et al., 2007; Duan, 2006; Duan et al., 2013, 2015, 2016; Kinnafick et al., 2014; Lippke & Ziegelmann, 2006). Considering that many studies based on stage models (e.g., BSM, MSM, and FIT) have divided the PA

behavioral change process into six or more stages, 15-30% is considerable range. This underscores the importance of this study: fluctuation is a commonly discussed but inadequately researched PA pattern. However, because most of the evidence in these studies was obtained through convenience sampling rather than population-based or stratified sampling (e.g., Cohen, 2003; Duan et al., 2013, 2015, 2016), and because of the lack of standardized identification tools, their results could be limited in generalizability and accuracy.

On fluctuator behavioral information, previous literature has shown the distinction of PA energy expenditure of fluctuators between that of preparers and explorers (Duan et al., 2013, 2015). Studies have also shown that fluctuators are quite physically active: in some studies their PA energy expenditure exceeds the criteria, despite their irregular PA participation (e.g., Duan et al., 2013; Strobl et al., 2016).

Psychosocially, it can be summarized that perceived barriers, intrinsic motivation, body concept, self-efficacy, planning, affective attitude, stress, and intention are sensitive variables that distinguish fluctuation from other PA patterns. It should be noted that stress, body concept, affective attitude, and intention have only been found in a limited number of studies (≤2). Further studies are required to ascertain whether they are indeed sensitive distinguishing variables. Additionally, it is revealed that fluctuation is psychosocially distinct from PA patterns of preparation and maintenance. Specifically, fluctuation is an intermediate PA pattern between preparation and maintenance. However, only minimal differences between fluctuation and exploration have been found, and as such, they might be similar in nature.

In summary, previous literature did not put fluctuation in a central part of the research. It focused more on the whole behavioral change process and regarded fluctuation as a particular phase in this process. Therefore, most findings to date about fluctuation have been drawn from the comparisons with other PA patterns (ANOVA with *post hoc* tests). From these comparisons, tailored intervention strategies can be designed to promote PA behavior. This study paradigm of "theory-based inter-stage comparison" did carry its value for designing intervention,

but it also has disadvantages, such as the subjective classification of stages and detachment from individuals in real life settings (West, 2005). To remedy such disadvantages, future studies might take a complementary approach to directly investigate the characteristics of PA fluctuators.

To date, we still know little about fluctuators' daily PA behavioral performance. Fluctuator PA participation should comprise at least two periods: 1) PA participation in the period in which they are active and 2) PA lapse during the period in which they are inactive. However, studies on fluctuator PA have mostly been confined to the general and overall PA-related indicators such as intensity, frequency, and total energy expenditure (Conroy et al., 2007; Duan et al., 2013, 2015; Strobl et al., 2016). Therefore, more details about fluctuators' PA information from both "PA participation" (e.g., what specific PA they engage in, the location of their PA and how they organize) and "PA lapse" (e.g., how often, how many days they lapse) are still needed for future research to explore.

Much of the literature has examined the inter-pattern psychosocial differences between fluctuation and other PA patterns, but there has been little study of intra-pattern differences between fluctuators. No studies have assessed whether there are distinct sub-groups of fluctuators. In addition, the mechanism why the fluctuation happens, especially regarding their main motivators of and barriers to PA engagement still need to be clarified.

The following mixed-methods research with two empirical studies focuses on PA fluctuators and investigates their behavioral and psychosocial characteristics. In quantitative study, it explores the sub-categories of fluctuators through latent profile analysis based on the reviewed psychosocial factors. The qualitative study mainly addresses the characteristics of fluctuators' PA behavior and mindset (e.g., motivators and barriers) via semi-structured interviews. By assessing the relationships between fluctuator behavior and mindset, the qualitative study offers some preliminary and tentative explanations of PA fluctuation.

CHAPTER III: STUDY 1: PSYCHOSOCIAL PROFILES AMONG FLUCTUATORS - A LATENT PROFILE ANALYSIS

3.1 Study purpose and questions

The literature review in the previous chapter summarized the definitions, measurements, and empirical evidence regarding PA fluctuation as a behavioral pattern. It also pointed out an unsolved issue: do fluctuators have distinct psychosocial profiles? In this chapter, we explore the heterogeneity of fluctuators' psychosocial profiles by attempting to classify fluctuators into different sub-categories.

The person-centered approach is well-suited for categorizing individuals according to their characteristics. From the statistical perspective, the person-centered approach and the variable-centered approach differ fundamentally in their assumptions about whether a sample of individuals is from a single population or sub-populations within a single population. The person-centered approach allows the possibility that the sample might reflect multiple sub-populations characterized by different sets of parameters, and vice versa for the variable-centered approach. The person-centered approach can be used to identify subgroups with different mindsets (Meyer & Morin, 2016). In this regard, the person-centered approach appears to fit more naturally with human tendencies to categorize individuals and provides a more holistic representation of individuals with complex interactions among multiple variables. There has recently been an increase in the application of person-centered approaches in the investigation of PA behavior (Gerber, Jonsdottir, Lindwall, & Ahlborg, 2014; Kurka et al., 2015; Richert, Schüz & Schüz, 2013). However, to date no studies have applied a person-centered approach to identifying subgroups of PA fluctuators or any particular PA patterns in stage models.

An assessment of the variability of psychosocial profiles across PA fluctuators is of great significance. First, it facilitates more specific understandings of this group of individuals. Categorization based on psychosocial variables provides detailed information about fluctuators and the mechanism behind their fluctuating PA

behavior. Second, future tailored intervention programs can be designed to promote their PA behavior based on the categorization.

To explore the psychosocial profiles of PA fluctuators, this study addresses the following specific research questions:

1. What are the distinct sub-categories that best summarize the complexity of PA fluctuators, based on psychosocial indicators? Of the psychosocial indicators, what factors differentiate the sub-categories from each other?
2. What demographic and behavioral variables predict the membership of different fluctuator sub-categories?

3.2 Selection of psychosocial indicators

The psychosocial indicators in this study were mainly selected from the FIT model and the psychosocial factors that emerged from the previous exploratory systematic review in Chapter II (see Table 2.5). Six indicators (self-efficacy, planning, affective attitude, social support, perceived barriers, and action control) were selected for the categorization procedure.

Table 3.1 provides an overview of the six selected indicators. Five out of the six psychosocial indicators (self-efficacy, planning, affective attitude, social support, and perceived barriers) were included in the FIT model. These five variables have been proved to be the significant psychosocial predictors of individual's PA behavior in previous systematic review studies (Trost et al., 2002; Kirk & Rhodes, 2011). Moreover, in the literature review provided earlier, these five psychosocial indicators all had a distinguishing ratio over 40%, indicating their associations with substantial PA behavior change.

Table 3.1

Indicator selection

Name	Inclusion in FIT model	Distinguishing ratio in the review (Shang et al., 2018)
Self-efficacy	√	62.5%
Planning	√	54.5%
Affective attitude	√	50.0%
Social support	√	40.0%
Perceived barriers	√	76.9%
Action control	/	/

Note. Distinguishing ratio = (number of significant comparisons between fluctuation and other PA patterns) / (number of total comparisons between fluctuation and other PA patterns).

This study also includes action control, which is not in the FIT model but might be closely related to fluctuation. Action control, a featured construct in the HAPA model (Schwarzer, Lippke & Luszczynska, 2011), refers to mental efforts undertaken to regulate one's behavior (Sniehotta et al., 2005). Self-monitoring, awareness of standards, and effort engagement are three critical components in action control. Within the field of exercise psychology, action control has often been used interchangeably with self-regulation (Sniehotta et al., 2005; Rhodes et al., 2016). As the literature review discussed, action control has been identified as a common feature in many conceptual definitions of fluctuation (Fuchs, 1999; Lippke & Ziegelmann, 2006). Action control has been repeatedly examined as a crucial construct in adherence to long-term plans of health behavior and as a bridge that closes the intention-behavior gap (Scholz, Keller & Perren, 2009; Schüz, Sniehotta & Schwarzer, 2006; Schwarzer et al., 2011), and thus a way that PA fluctuators could progress from irregular PA participation to PA behavior maintenance. In light of this, action control is included in categorization in this study as an important psychosocial indicator.

3.3 Methods

3.3.1 Participants

The participants were recruited from office-based employees with age ranging from 20 to 60 years. In particular, office-based employees in this study refer to people who perform professional, managerial, or administrative work in office or other administrative settings. Their daily jobs should be in sedentary nature and do not require manual labor or intense PA behavior (e.g., carrying heavy loads, walking for long distance).

3.3.2 Data collection procedures

After receiving ethics approval from the research committee at Hong Kong Baptist University, a cross-sectional survey with convenience sampling was conducted both through online and offline channels. Office-based employees were recruited from four types of organizations in mainland China, including state-owned enterprise, private enterprise, educational organization (e.g., university or college), and government sector. The personnel officers in charge of the organizations were first contacted. Upon their permission and according to their preferences, either paper-and-pencil questionnaire or online questionnaire was delivered to the employees with informed consents. Finally, eight organizations (two of each four types) accepted to take survey study.

Since it is very prevalent in mainland China to use mobile phone and computer among office-based employees, online survey by using Wechat (a common communication application in smartphone among Chinese people) and website hyperlink was the primary channel for the survey. The online survey was conducted through the *Sojump* - an online platform specialized in surveys, examinations, and voting. In this platform, participants can be invited to fill out the questionnaires with monetary rewards. This platform allows the researcher to control the quality of response through setting up a series of standards (e.g., minimum time, manual check from questionnaire designer). The *Sojump* has been extensively used for social science research in the context of mainland China, yielding data with satisfactory quality (Chen, Cheng, & Urpelainen, 2016; Shi et al., 2015). As a complementary approach,

the paper-and-pencil questionnaires were delivered to the participants by post. The questionnaires were sent back upon their completion by express delivery.

To ensure anonymity and to encourage honest responses, all study materials were compiled with code numbers, instead of the participant's real name. Additionally, all the participants in this questionnaire survey were notified to leave their contact information (phone number, email address, QQ number, or Wechat account), provided that they intend to participate the semi-structured interview of the subsequent qualitative study.

3.3.3 Measurements

The measurement tools comprise four components covering demographics, FIT stage algorithm, PA behavior and psychosocial indicators in sequence. The detailed information about the items can be referred to the Appendix 1.

- Demographics

Participants were asked to give demographic information regarding gender, age, height, weight, education level, ethnicity, occupation, job position, average daily working hours, marital status, whether or not having children and health status.

- FIT algorithm

The FIT algorithm is a self-report multiple-choice question with six statements aiming to assign individuals into stages according to their thoughts and behaviors regarding PA behavior (Duan et al., 2013). This algorithm has been examined as a reliable and valid instrument in previous research among Chinese adults (Duan et al., 2015, 2016). In the current study, the PA criteria were set as "at least 150 minutes MVPA per week" according to the WHO criteria (WHO, 2017). The FIT algorithm was used to select people in fluctuation stage from the sample participants, if participants select the fifth statement "I am physically active, but not regular every week, or have not accumulated at least 150 minutes every week", they are assigned to fluctuation stage for the further classification.

- Godin-Shephard Leisure-Time Physical Activity Questionnaire (GSLTPAQ)

The GSLTPAQ was developed to assess leisure-time PA participation at three different intensities (mild, moderate, strenuous; Godin & Shephard, 1985). The questionnaire has been translated into multiple languages including Chinese (Li, Lin, & Lu, 2002). The Chinese version of GSLTPAQ has been found to have acceptable test-retest reliability of 0.74 and validity compared with the results using accelerometer ($r = 0.32$, $p < 0.05$, Li et al., 2002). In the present study, the answering form was slightly changed from blank-filling to multiple choice for the better adaption with the online survey platform. To represent the overall weekly PA energy expenditure, an indicator named Leisure Score Index (LSI) was calculated by the following formula (Godin, 2011):

$$\text{LSI} = (\text{frequency of mild} \times 3) + (\text{frequency of moderate} \times 5) + (\text{frequency of strenuous} \times 9)$$

The cut-point values for the classification scoring are based on the North American public health PA guidelines, that are LSI (only for moderate and strenuous) ≥ 24[4] is classified as active, whereas LSI (only for moderate and strenuous) ≤ 23 is classified as insufficiently active (Amireault et al., 2015).

- Questionnaire package for assessing psychosocial indicators

The questionnaire package consists of six scales measuring the psychosocial indicators of self-efficacy, planning, action control, affective attitude, social support, and perceived barriers. The reliabilities (internal consistency of Cronb.α) of all six scales were pilot-tested in a sample of 73 office employees (male=38, 52.1%; *M* = 31.0 yrs, *SD* = 7.6). Noticeably, we did not change the format of the original questionnaire, thus the rating levels of Likert scales in the questionnaires may differ from each other. We also did not implement the data normalization or standardization later, because these treatments would not affect the final profile generation and the profile membership (Asparouhov & Muthén 2014). Detailed information is shown as follows.

Self-efficacy

[4] LSI= 24 is equivalent to 14 Kcal/kg/week, or 840 MET-minutes/week.

In the present study, the scale for measuring self-efficacy was originated from Marcus et al. (1992), and it has been adapted into Chinese version by Duan et al. (2010). It consists five items asking how confident one is in his/her ability to successfully perform PA under five unfavorable circumstances (tired, bad mood, lack of time, on vacation, bad weather) in 5-point Likert from 1= not at all true, to 5= exactly true (Cronb.α = .845).

Planning

The scale for measuring planning was originated from Lippke, Ziegelmann, and Schwarzer (2005) and it has been adapted into Chinese version by Duan et al. (2013). It consists of five items asking how precise one's PA plan regarding which PA, when, where, with whom, and how often to do (Cronb.α = .927). The options are anchored in 5-point Likert from 1= not at all true, to 5= exactly true.

Action control

The scale for measuring action control was originated from Sniehotta, Schulz, and Schwarzer (2005). It consists of six items asking how much effort one exerts in regulating his/her PA behavior. Since no Chinese version has been adapted for this scale, a simple translation was conducted by two bilingual exercise psychologists following the back-translation protocol (Zhao & Kanda, 2000). Results from the pilot test showed this translated version of action control scale was with good internal consistency (Cronb.α = 0.896) according to the standard elsewhere (DeVellis, 2012).

Affective attitude

The scale for measuring affective attitude was originated from Brand (2006), and it has been adapted into Chinese version by Duan et al. (2010). It consists of four items asking how comfortable, satisfied, happy, and cozy one feels at the thought of doing PA (Cronb.α = .962). The options are anchored in 7-point Likert from 1= not at all true, to 7= exactly true.

Social support

The scale for measuring social support was originated from Jackson, Lippke, and Gray (2011) and it has been adapted into Chinese version by Duan et al. (2017).

It consists of three items asking how much support one receives from 1) spouse (or boy/girlfriend), 2) parents and children, and 3) colleagues in doing PA (Cronb.α = .822). The options are anchored in 5-point Likert from 1= not at all true, to 5= exactly true.

Perceived barriers

The scale for measuring perceived barriers was originated from Li et al. (2014). Six items were selected to inquire about the frequencies of barriers concerning time, resource, and weather in performing PA (Cronb.α = .766). Three options are provided as 1= never, 2= sometimes, and 3= very often.

3.3.4 Data analysis

The process of data analysis incorporates two sequential steps: 1) data screening and cleaning, 2) statistical analysis. The first step comprises data entry and screening, missing data replacing, and data integration. The second step incorporates two statistical analyses: firstly a latent profile analysis (LPA) for the classification, and a multinomial logistic regression for assessing the adequacy of this classification.

- Data entry and screening

Data from both online and offline channel were input into the SPSS 24.0. For the online data, the Sojump platform offers the service which can automatically transfer the original response to the SPSS data file. For the offline data, the responses were input manually by a research assistant.

According to the responses of the participants, a series of exclusion criteria were set. Participants who met either one of the exclusion criteria above was deleted list-wise from further procedures.

1) Participants who provided less than 50% responses;

2) Participants with inappropriate occupation (e.g., students, athletes);

3) Participants with disease (e.g., poliomyelitis, myocarditis) which impede their PA behavior;

4) Participants with inappropriate age (under 18 or above 60 years);

5) Participants with the answering time less than 2.5 minutes (note: only the participants provided answers from online channel can be checked with the answering time).

- Missing data

For the online responses, missing data were prevented automatically during the answering process by sojump platform. For participant's careless responses such as mistakenly report height using meter as the unit, mistakenly report weight using catty as the unit, the researcher corrected their responses according to common sense. Missing data of psychosocial indicators from the paper and pencil questionnaires were replaced by arithmetic mean values within the indicator (Allison, 1999).

- Fluctuator selection and data integration

Prior to the classification, fluctuator selection was implemented by using the FIT algorithm. Participants who selected "I am physically active, but not regular every week, or have not accumulated at least 150 minutes every week", were considered as fluctuators for the further statistical procedures. Before the statistical analyses, each of the psychosocial indicators for further classification was arithmetically averaged. Total LSI and body mass index (BMI) were calculated by the formulas provided in previous references (Godin, 2011; Turconi et al., 2006).

- Latent Profile Analysis

In the present study, the latent profile analysis (LPA) was used as the statistical approach to identify sub-groups (profiles) of PA fluctuator. LPA is a type of finite mixture model with the aim to discover latent groups from observed data. LPA is particularly useful when there is a need to reduce a large number of continuous variables to a few subgroups (Oberski, 2016).

Given the exploratory nature of the current study, the expectation-maximization (EM) algorithm in the LPA is well-suited to determine the appropriate number of latent subgroups among PA fluctuators. Simply stated, the EM algorithm is a data-driven estimation approach which starts with random split of people into classes followed by

reclassifying based on an improved classification. In statistics, the EM algorithm is an iterative method to identify maximum likelihood of parameters or indices (Dempster, Laird, & Rubin, 1977). The procedures of EM iteration alternates between performing an expectation (E) step, which creates a function for the expectation of the log-likelihood evaluated using the current estimate for the parameters, and a maximization (M) step, which computes parameters maximizing the expected log-likelihood found on the E step (Moon, 1996).

In the present study, to determine the appropriate number of latent profiles of PA fluctuators, model with one latent profile (original default model) was first examined. Subsequently, models with two latent profiles and more were examined and compared until the model of the best solution was identified. This type of iterative EM method has been widely applied in previous LPA studies (Chen, 2015; Gerber et al., 2014; Lanza & Rhoades, 2013).

Following the suggestions from previous reference (Asparouhov & Muthén, 2014; Fosnacht, McCormick, & Lerma, 2018; Oberski, 2016), a variety of model fit indices such as Bayesian information criterion (BIC), sample size adjusted Bayesian information criterion (SABIC), Akaike information criterion (AIC), LO-MENDELL-RUBIN likelihood ratio (LMR) and entropy were considered to determine the appropriate number of latent groups.

For the indices of information criteria AIC, BIC, and SABIC, larger values suggest a relatively poorer model fitness (Lanza & Rhoades, 2013). The entropy indicates the precision with which the cases are classified into the profiles (Magidson & Vermunt, 2002), it is not used to determine the optimal model, but provides a useful summary of the classification accuracy of a model. A larger value of entropy (closer to 1) indicates fewer classification errors and entropy value more than 0.8 suggests a satisfied separation of the latent profiles (Celeux & Soromenho, 1996). The index of LMR is to determine whether or not a more complex model (model with k profiles) fits the data significantly better than a more parsimonious model (model with k-1 profiles).

A significant p-value associated with the likelihood ratio test support the retention of a more complex solution with at least k profiles (Asparouhov & Muthén, 2014).

All the statistical analyses of LPA were conducted in Mplus 8, which is a latent variable modeling program with a wide variety of applications regarding data processing and plotting (Muthén & Muthén, 2012). The popularity of using Mplus for latent class modelling has increased substantially in the last decade among researchers from a wide range of areas (Osborne & Weiner, 2015; Weman-Josefsson, Lindwall, & Ivarsson, 2015; Tein, Coxe, & Cham, 2013). Specifically, all models were estimated using a maximum likelihood estimator with robust standard errors. In order to avoid converging on a local or suboptimal solution (i.e., a false maximum likelihood), model estimation was started with multiple random sets of start values (Hipp & Bauer, 2006). Within-class means and variances of the observed variables were estimated, with residual covariances between the indicators fixed to zero. This is consistent with the assumption of local independence in classical LPA that indicators within groups are uncorrelated and associations among indicators are explained regarding the grouping variables (Uebersax, 1999). The syntaxes to implement the current LPA in Mplus 8 (2-profile solution as the template) was attached in the Appendix 2.

Furthermore, after determining the best model, subsequent descriptive analyses and discriminant analyses (e.g., average posterior probabilities, independent t-tests) were conducted to provide information about each profile and to detect the differences between profiles. These descriptive and discriminant analyses were conducted in SPSS 24.0.

- Multinomial logistic regression

Methodologically, logistic regression is a statistical approach to predict the membership of categorically distributed dependent variables (Starkweather & Moske, 2011). This approach has been widely used as a supplementary approach after the implementation of latent class analyses (Amato, King, & Thorsen, 2016; Fosnacht et al., 2018; Jackson et al., 2014; Swanson, Olide & Kong, 2017). In the present study, multinomial logistic regression is applied to address the question what demographic

and PA behavioral variables can well predict the profile membership of PA fluctuators. Demographic variables (e.g., gender, age, marital status, working hours, etc.) and PA behavioral variable (energy expenditure) were regarded as independent variables in the predicting model. Though it is not common, the cases of using behavioral indicators as independent variables to predict and separate psychosocial outcome variables (e.g., attitude, subjective well-being) still can be found elsewhere (Gerber et al., 2014; Moreno et al., 2014). The rationale behind is the assumption in self-perception that our own behavior can be as a guide to help us determine our own thoughts and feelings (Olson & Stone, 2005). A series of important statistical values (e.g., odds ratio, pseudo R-square, Chi-square, p-value) were calculated for the model assessment. All analyses regarding multinomial logistic regression were implemented in SPSS 24.0.

3.4 Results

3.4.1 Data cleaning and descriptive statistics

Information about data cleaning is demonstrated in Table 3.2. Totally 1746 participants joined this study from both online and offline channels. 1427 valid questionnaires were finally collected, leaving an overall effective response rate of 81.7%. Reasons for invalid questionnaire included too quick responses (less than 150 seconds answering time; n = 89, 27.9%), participants with disease impeding normal PA (n = 69, 21.6%), inappropriate occupation (n= 61, 19.1%), insufficient response (< 50% response; n = 25, 7.8%), inappropriate age (age under 18 or above 60, n = 17, 5.3%), and other miscellaneous reasons (e.g. questionnaires foreign areas, and answering every questions with the same choice; n = 58, 18.2%).

Table 3.2

Information about participants screening by survey channel

	Online	Offline	Total
Total response	1401	345	1746
Valid response	1148	279	1427
Invalid response	253	66	319
1) < 50% response rate	/	25	25
2) inappropriate occupation	42	19	61
3) disease impeding PA	63	6	69
4) inappropriate age	16	1	17
5) answering time ≤ 150s	89	/	89
6) other reasons	43	15	58
Number of Fluctuators	381	53	434

Note. Other reasons including answering from foreign areas, and providing answers from all the same option.

By using the FIT algorithm, 434 fluctuators from both online (n = 381, 87.8%) and offline channels (n = 53, 12.1%) were qualified for the subsequent LPA analysis. Table 3.3 and Table 3.4 shows the descriptive information about the final sample of 434 PA fluctuators. Female participants (55.5 %, n = 241) consisted of over half of the sample, and the overwhelming majority of participants were of Han ethnicity (97.2%, n = 422). Fluctuators' age ranged from 19 to 59 years, with an average of 32.4 (SD = 6.9) years, and nearly half of the participants were in the age group of 30-39 years (47.3 %, n = 201).

Table 3.3

Descriptive statistics of categorical variables among fluctuators (N = 434)

Note. BMI classification criteria are from World Health Organization (2004); The LSI classification uses only moderate and strenuous scores, those with a leisure score index ≥ 24 were classified as sufficiently active; those with a score ≤ 23 were classified as insufficiently active (Amireault & Godin, 2015)

		N	%
Age		425	
	<30	168	39.5
	30-39	201	47.3
	≥40	56	13.2
Gender		434	
	Male	193	44.5
	Female	241	55.5
Education		434	
	High school or below	17	3.9
	Bachelor	334	77.0
	Post-graduate or above	83	19.1
Job position		433	
	Senior managerial position	19	4.4
	Middle managerial position	155	35.8
	Non-managerial staff	259	59.8
Ethnicity		434	
	Han	422	97.2
	Minority	12	2.8
Marital status		434	
	Married	308	71.0
	Unmarried	126	29.0
Children status		434	
	Have children	273	62.9
	Do not have	161	37.1
BMI status*		427	
	Underweight (BMI<18.5)	36	8.4
	Normal weight (18.5≤ BMI<25)	326	76.3
	Overweight (BMI>25)	65	15.2
Leisure score index (LSI) classification*		434	
	Sufficiently active (≥ 24)	222	51.2%
	Insufficiently active (< 24)	212	48.8%

Table 3.4

Descriptive statistics of continuous variables among fluctuators (N = 434)

	N	*M* ± *SD*	Range
Demographics			
Age (years)	425	32.4 ± 6.9	19-59
Daily working hours	398	7.6 ± 1.5	1-14
BMI	427	22.0 ± 3.2	14.8-38.1
PA in leisure time			
LSI for all 3 PA levels	434	38.2 ± 17.8	0-119
LSI only for MVPA	434	25.5 ± 15.7	0-98
Psychosocial indicators			
Self-efficacy	434	2.59 ± 0.79	1-5
Planning	434	3.24 ± 0.85	1-5
Action control	434	2.84 ± 0.63	1-5
Affective attitude	434	5.02 ± 1.34	1-7
Social support	434	3.15 ± 0.95	1-5
Perceived barriers	434	2.00 ± 0.37	1-3

For other demographic and behavioral information, 96.1% (*n* = 417) of fluctuators were with education level equal to or higher than bachelor degree. 59.8% (*n* = 259) of fluctuators were non-managerial office-based employees, while 40.2% (*n* = 174) were with high or medium managerial positions. 71% (*n* = 308) of fluctuators were married and 62% (*n* = 273) of fluctuators were with children. Most of the fluctuators (*n* = 326; 76.3%) were in normal weight range, followed with weight status of overweight (*n* = 65; 15.8%), and underweight (*n* = 36; 8.4%). Nearly half (*n* = 222; 51.2%) of fluctuators were sufficiently active and the other nearly half (*n* = 212; 48.8%) were insufficiently active. For the descriptive statistics, mean score of self-efficacy, planning, action control, affective attitude, social support and perceived barriers was 2.59 (*SD* = 0.79), 3.24 (*SD* = 0.85), 2.84 (*SD* = 0.63), 5.02 (*SD* = 1.34), 3.15 (*SD* = 0.95), and 2.00 (*SD* = 0.37) respectively.

3.4.2 Results from latent profile analysis

Profile enumeration

To determine the appropriate number of latent profiles, assessment of models were started from the default model of a single profile to the model with the best solution. The results of model fit indices (log likelihood, AIC, BIC, SABIC, LMR, and entropy) were summarized in Table 3.5. For the three information indices (AIC, BIC, and SABIC), the values continued to decrease while the number of profiles increased. Comparisons of the AIC, BIC, and SABIC for different models were contrasted in an elbow plot (see Figure 3.1). As illustrated, the elbow plot suggested that the improvement in model fitness reaches a plateau at the two-profile model (AIC = 5680.768; BIC = 5758.156; SABIC = 5697.860). In other words, despite the improvement of model fit indices as the number of profile increases, the improvement gradually become more and more negligible after reaching the 2-profile model. In the current study, we stopped analyzing the models with more than six profiles because a steady trend in elbow plot has been established indicating it is unlikely to find a better model thereafter.

Table 3.5

Results model fit indices for profile enumeration

Model	Log-likelihood	AIC	BIC	SABIC	LMR	*p* value of LMR	Entropy	Number of people in each profile
1-Profile Default Model	-2993.282	6010.56	6059.44	6021.36	/	/	/	434
2-Profile Model	-2821.384	5680.77	5758.16	5697.86	335.90	0.000	0.804	88, 346
3-Profile Model	-2765.714	5583.43	5689.33	5606.82	108.78	0.387	0.803	76, 316, 42
4-Profile Model	-2731.728	5529.46	5663.87	5559.14	66.41	0.470	0.807	60, 282, 18, 74
5-Profile Model	-2698.771	5477.54	5640.47	5513.53	64.40	0.232	0.791	49, 172, 33, 174, 6
6-Profile Model	-2668.888	5431.78	5623.21	5474.06	58.40	0.250	0.803	16, 55, 143, 182, 32, 6

Note. AIC= Akaike Information Criterion; BIC= Bayesian Information Criterion; SABIC= Sample-size Adjusted BIC; LMR= LO-MENDELL-RUBIN likelihood ratio test.

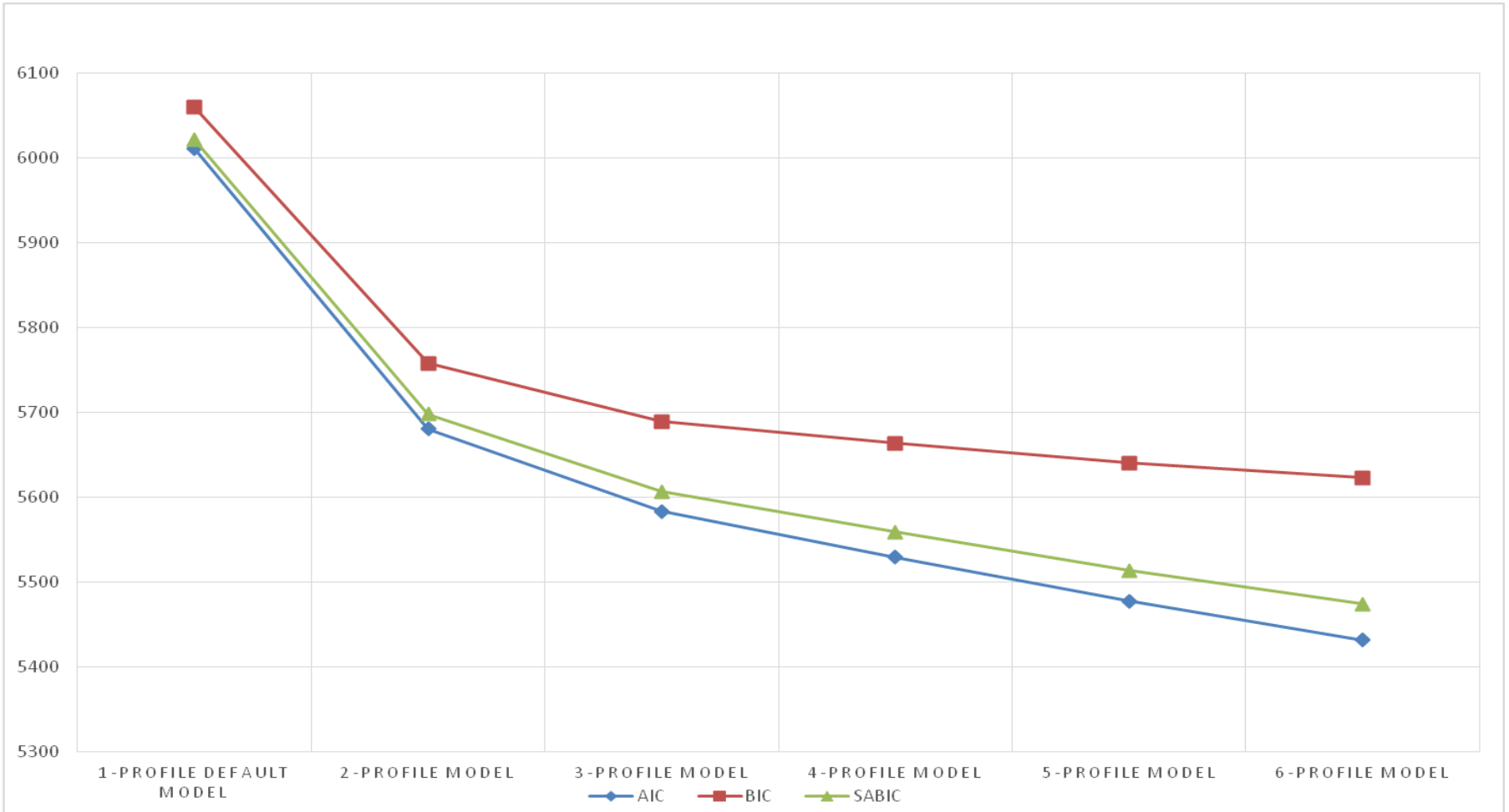


Figure 3.1. Elbow plot of the information criteria for the latent profile analysis

The results based on the LMR tests and entropy also supported the 2-profile solution. Specifically, the LMR likelihood ratio tests only demonstrated significant results when comparing the two-profile model versus the default one-profile model (LMR = 335.895, p <.001). It was shown that entropy values across all possible solutions were satisfactory (over 0.8, Celeux & Soromenho, 1996), only except the 5-profile model.

Moreover, the 2-profile model did not result in an extreme distribution of profiles (under 5% of either one of the profiles; Chen, 2015). In the current 2-profile solution, numbers of fluctuators in each were 88 (20.3%) and 346 (79.7%), avoiding the extreme distribution with profile membership less than 5 %.

Furthermore, this 2-profile model provided a useful distinction between the two profiles as revealed in Table 3.6. In this table, each figure represents the average of the posterior probabilities for those observations for each profile. Information in Table 3.6 indicates that given a fluctuator was assigned into Profile 1, the misclassification ratio on average would be 0.08; while given that a fluctuator was categorized into Profile 2, the misclassification ratio on average would be 0.05.

Given the results as mentioned above, the 2-profile model was finally chosen as the best representation of the data.

Table 3.6

Average latent profile probabilities for most likely latent profile membership (row) by latent profile (column)

	Profile 1 (Uncommitted)	Profile 2 (Moderately committed)
Profile 1 (Uncommitted)	0.92	0.08
Profile 2 (Moderately committed)	0.05	0.95

Profile interpretation

Descriptive results of psychosocial indicators were presented in Table 3.7 and Figure 3.2. Profile 1 (n = 88) with 20.3% of the sample fluctuators demonstrated comparatively lower mean scores across all of the psychosocial indicators; while

profile 2 (n = 346) with 79.7% of the sample exhibited relatively higher scores across all of the psychosocial indicators. Table 3.8 also presents the results of independent t-tests. It shows that except from perceived barriers (t(432) = 1.10, p =. 272), all of the other 5 psychosocial indicators (self-efficacy, t(432) = 9.42, p< .001; planning, t(432) = 16.33, p< .001; action control, t(432) = 14.55, p< .001; affective attitude, t(432) = 13.31, p< .001; social support, t(432) = 11.50, p< .001) were significantly different between the two profiles.

Table 3.7

Results of independent t-test and descriptive statistics for psychosocial indicators by profile

	Profile				Independent t-test	
	Profile 1 (n= 88)		Profile 2 (n= 346)			
	Mean	*SD*	*Mean*	*SD*	*t*	*df*
Self-efficacy (1-5)	1.94	0.66	2.75	0.74	9.42***	432
Planning (1-5)	2.21	0.73	3.51	0.65	16.33***	432
Action Control (1-4)	2.13	0.45	3.02	0.53	14.55***	432
Affective Attitude (1-7)	3.59	1.51	5.39	1.02	13.31***	432
Social Support (1-5)	2.23	0.74	3.38	0.86	11.50***	432
Perceived Barriers (1-3)	1.96	0.40	2.01	0.37	1.10	432

Note. *** p < .001

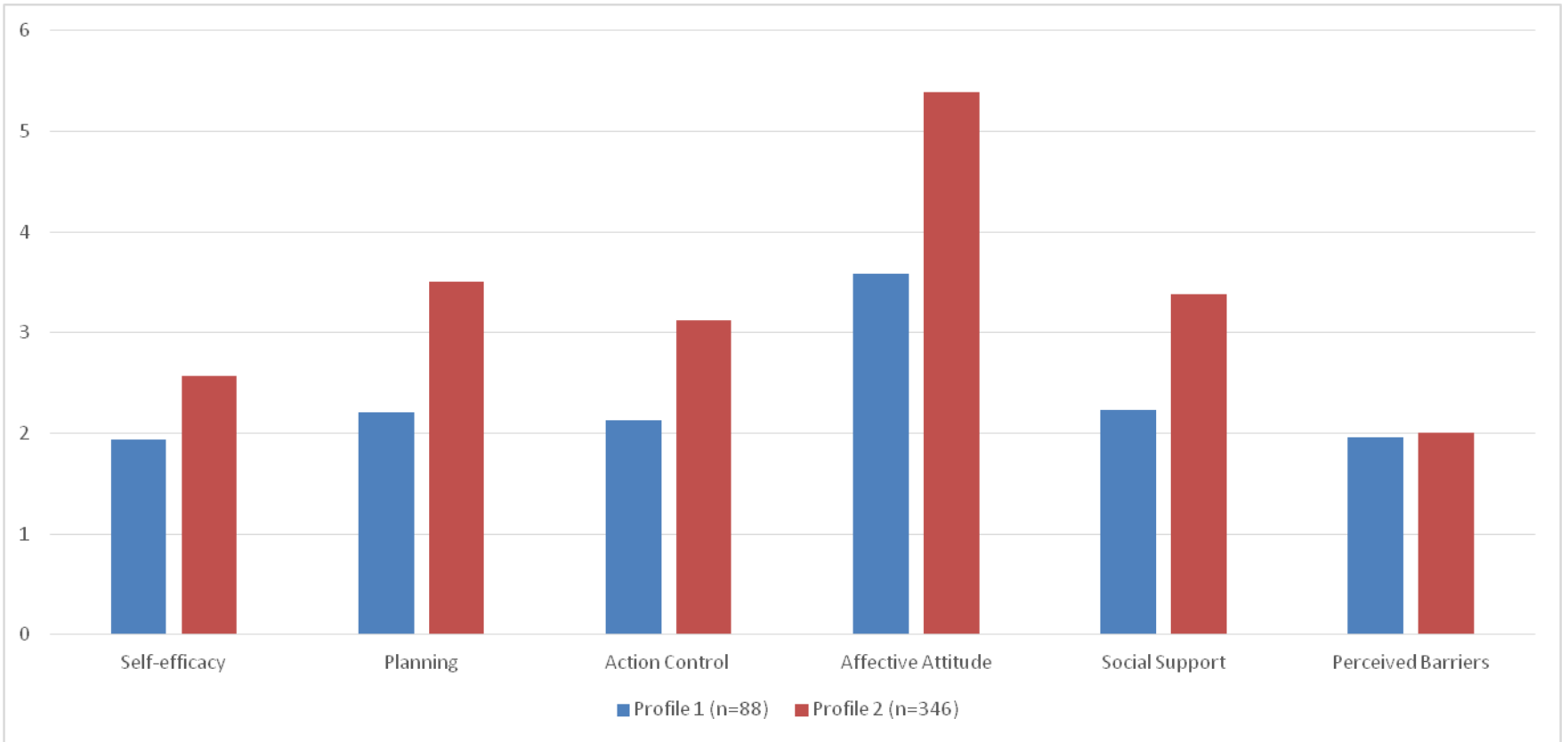


Figure 3.2. Characteristics of psychosocial indicators across the two profiles

For the profile labeling, it was suggested that three aspects need to be considered (Meyer & Morin, 2016): 1) shape (pattern of high and low mean scores on various indicator, such as one indicator is outstanding among the others); 2) elevation (average mean scores across indicator); and 3) scatter (degree of differentiation of the mean scores on various indicators).

The present 2-profile solution satisfied the elevation criterion since one profile (the second profile) posited relatively higher mean scores in every psychosocial indicator than those in the other profile (the first profile). No particular findings supported the other two criteria (shape and scatter). Given this, profile 1 with relatively lower scores of psychosocial indicators was labeled as “uncommitted” fluctuators. This label of “uncommitted (UC)” indicates that these fluctuators might not be mentally ready or committed to PA participation. Whereas, the profile 2 with relatively higher scores of psychosocial indicators was labeled "moderately committed (MC)" fluctuators.

3.4.3 Results from multinomial logistic regression

Multinomial logistic regression was implemented to predict the profile membership. Predictors of profile membership included variables of age, gender, weight status (BMI), education, job position, marriage, whether or not having children, and energy expenditure for moderate and vigorous intensity PA. Among these predicting variables, age, weight status (BMI), energy expenditure for moderate and vigorous intensity PA were coded into categorical variables (see Table 3.3 for the coding criteria) in the regression model. Noticeably, the ethnicity was not included as a predictor because the overwhelming majority (97.2%) of fluctuators were of Han ethnicity. In the regression model, the UC fluctuators were set as the reference group for the dependent variable. For the predicting variables, “age group ≥ 40 years”, “gender of female”, “education of post-graduate and above”, “job position of non-managerial staff”, “marital status of married”, “having children”, “overweight with BMI ≥ 25”, “MVPA energy expenditure of LSI < 24”, were set as reference groups in the regression model.

Results from the multinomial logistic regression are summarized in Table 3.8. These results showed that the regression model significantly predicted the profile membership of PA fluctuators (Cox and Snell Pseudo *R*-square= 0.12; Nagelkerke Pseudo *R*-square= 0.19; McFadden Pseudo *R*-square= 0.13, *Chi*-square= 54.99, p< .001). Job position, BMI, MVPA energy expenditure were shown as three significant predictors. Specifically, fluctuators of middle managerial position were more likely than non-managerial fluctuators to be the members of MC profile (*OR* = 2.54, 95% *CI* = 1.35 to 4.77, $p < .01$). Moreover, compared with the overweight fluctuators (BMI $\geq$ 25), fluctuators in normal weight status (18.5 $\leq$ BMI < 25) were significantly related with the membership of MC profile (*OR* = 2.00, 95% *CI* = 1.03 to 3.90, $p < .05$). As might be expected, being more relatively active (LSI $\geq$ 24) was significantly related with MC profile rather than the UC profile (*OR* = 4.85, 95% *CI*= 2.77 to 8.47, $p < .001$).

Table 3.8

Results of multinomial regression for predicting profile membership (n=434)

Name of variable	*OR*	95% *CI*	Wald test
Age (≥40 years as the reference group)			
30-39 years	1.14	0.53 - 2.45	0.12
≤ 29 years	1.04	0.43 - 2.51	0.01
Gender (female as the reference group)			
Male	0.94	0.54 - 1.62	0.05
Education (post-graduate and above as reference group)			
Bachelor degree	1.48	0.80 - 2.73	1.56
High school diploma or below	2.20	0.51 - 9.42	1.12
Job position (Non-managerial staff as the reference group)			
Middle managerial staff	2.54	1.35 - 4.77	8.35**
Senior managerial staff	0.46	0.15 - 1.40	1.86
Marital status (married as reference group)			
Not married	0.83	0.33 - 2.07	0.16
Children status (not having children as the reference group)			
Having children	0.86	0.36 - 2.08	0.11
Weight status (overweight BMI ≥ 25 as the reference group)			
Underweight BMI< 18.5	1.96	0.62 - 6.14	1.33
Normal 18.5 ≤ BMI <25	2.00	1.03 - 3.90	4.20*
PA energy expenditure (LSI < 24 inactive as reference group)			
LSI ≥ 24	4.85	2.77 - 8.47	30.58***

Note. The reference group of dependent categorical variable is set for "uncommitted fluctuators" Model fit: likelihood ratio *Chi*-Square = 54.99. $p < .001$; Cox and Snell Pseudo *R*-square = 0.12; Nagelkerke Pseudo *R*-square = 0.19; McFadden Pseudo *R*-square = 0.13. * $p < .05$; ** $p < .01$; *** $p < .001$.

3.5 Discussion

This section summarizes the findings of the chapter, provides interpretations, and discusses the implications of these findings. A more general discussion of limitations and recommendations for the future research can be found in Chapter V of the general discussion.

This study explored the complexity of PA fluctuator mindset that emerges from a latent profile analysis. Subsequently, the demographic and behavioral features of each subgroup were examined using the multinomial logistic regression. By using the person-centered approach, this study provides a more holistic view of PA fluctuators' psychosocial profile. This approach provides a more comprehensive understanding of the association between fluctuators' psychosocial profiles, behavioral performance, and demographic characteristics.

Based on the results from the fit indices (e.g., AIC, BIC, SABIC) in LPA, a two-profile model ("UC" VS "MC") was chosen as the most appropriate solution. Results based on a two-profile model revealed that two latent profiles varied significantly across the five psychosocial indicators. Specifically, the MC group possessed a more active mindset than the UC group. The MC profile was also associated with more PA energy expenditure, a normal weight range, and a medium managerial position.

Based on the previously summarized findings, we identify some issues that worth particular attention and discussion.

1) Profile labeling and the implications of the two-profile model.

The two-profile solution indicates that the sampled fluctuators demonstrate heterogeneity on psychosocial profiles, yet the heterogeneity is only quantitative in nature (Bergman, 2000; Weinstein et al., 1998). In other words, there was no specific configuration with dominant indicators (i.e., outstanding indicators with very high or low average scores) across the two profiles. Therefore in labeling the two profiles, we used the same morpheme "committed" to indicate the similarity across the two profiles. Because one subcategory of fluctuators was superior to the other

subcategory in terms of psychosocial indicator scores, the prefix “moderately” was added to the superior one, and the prefix “un” was used to label the inferior one. For the morpheme selection of “committed,” we referred to a source from the previous literature that discusses using LPA to classify working attitude (Meyer & Morin, 2016), where committed was used to label the sub-categories of employee working attitude. Furthermore, the meaning of “committed” was also carefully checked using the Cambridge Dictionary: “loyal and willing to give one’s time and energy to something that one believes in.” For the inferior UC group with lower scores in psychosocial indicators, it implies that these fluctuators do not believe that PA will bring benefits to them, and they are not loyal and willing to spend their time doing it. For the other MC group with above average score of psychosocial indicators, it means that they believe that regular PA is beneficial, and show a certain level of willingness and loyalty to it. Though subjectivity was involved during the labeling process, the difference between these two profiles was established.

2) Similar level of perceived barriers across two profiles.

Perceived barrier is the only psychosocial indicator of all six indicators that is not significantly different across the two profiles. It might mean that fluctuators in either profile perceived a similar level of difficulty in PA participation. A considerable amount of the literature on PA fluctuation has suggested that perceived barrier is one of the most sensitive variables distinguishing fluctuation with other PA patterns (Duan et al., 2013; Shang et al., 2018; Strobl et al., 2016). We can thus infer that a medium level of perceived barriers is a psychosocial feature for fluctuators. Unlike maintainers with long-term regular PA participation (who perceive few barriers) and those physically inactive individuals (who perceive massive barriers), fluctuators perceived neither very high nor very low barriers.

3) Profile distribution within fluctuators

In the results, nearly 80% of fluctuators belonged to the MC profile, and 20% belonged to the UC profile. These results show that the majority of fluctuators are in general mentally well-prepared for PA participation. These results agree with the

prediction in the conceptual definition that fluctuators are mentally intented and ready for PA participation (Fuchs, 1999; Lippke & Ziegelmann, 2006). For most MC fluctuators, the primary impediments to regular PA participation could be mainly due to environmental and situational constraints (time, resource, and economic constraints). Research has shown that situational constraints (e.g., bad weather, lack of access to facilities) are the main factors for PA lapses or short-term interruptions (Larimer, Palmer & Marlatt, 1999; Stetson et al., 2005). Thus, removal of external impediments or constraints could be the most effective approach to increase the MC fluctuators' PA participation.

For most UC fluctuators, their intermittent PA participation might not require a committed mindset. Their PAs in daily life contexts might be involuntary or mandatory (e.g., group physical activity events organized by the company). Because this study focused on PA in the daily life context, rather than one PA type in a particular setting such as a programmed exercise in gym, it is inevitable that the individuals are sometimes involved in large amount of PAs in their daily life context (Barton, Wood, Pretty & Rogerson, 2016). Thus, compared with MC fluctuators, the UC fluctuators were associated with a low level of PA participation. Due to their uncommitted mindset, they are more likely to regress to physical inactivity if they do not receive sufficient intervention or external support (Kinnafick et al., 2014).

Misclassification could also account for this minority of fluctuators in the UC profile. In this study, the FIT stage algorithm was used to select fluctuators. Though this instrument has been identified as a valid stage algorithm, it could still be possible that the FIT misclassified non-fluctuators as fluctuators due to the wrong perception of PA intensity, duration, recall bias, and social desirability (Duan et al., 2016).

4) Demographic and behavioral predictors

Results from a multinomial logistic regression showed that only two demographic variables (BMI and job position) effectively predicted the profile membership. Fluctuators with normal weight status and middle managerial positions are more likely to be categorized into the MC profile. Studies have shown that people

within the normal BMI range (18.0-24.9) tend to have more favorable attitude toward physical exercise than those who are under- or over-weight (Sampasa-Kanyinga et al., 2017). In addition, researchers have recently suggested that overweight and obese individuals often experience weight stigma (i.e., negative attitudes and beliefs derived from abnormal weight that make people feel ashamed or disgraced), and the experience of weight stigma could in turn undermine their motivation for PA (Vartanian, Pinkus & Smyth, 2018). In this study, fluctuators in the normal BMI range could experience less weight stigma and be associated with more active mindset than fluctuators in the abnormal BMI range.

Interestingly, this study found that fluctuators in the middle managerial position are associated with a more active mindset. Previous studies, especially in Western cultural backgrounds, generally do not take managerial positions as a socio-economic variable to predict PA participation or mindset, and we cannot find any relevant literature to support this finding. It might be that compared with middle managerial staff, non-managerial staff might make more effort to work for promotion, working longer hours, and senior managerial staff such as executive officers might focus on leading the entire organization (Parks, Housemann, & Brownson, 2003). Thus, middle managerial staff might focus less on work hours and leadership, allowing them to engage in more PA.

Interestingly, some demographic variables (e.g., gender, age, education, marital status) that have been repeatedly examined as correlates of active mindset and regular PA behavior did not significantly affect the psychosocial profile membership (Trost et al., 2002; Yin & Boyd, 2000). These results also suggest that the two psychosocial profiles could be independent of the individual's demographic background (e.g., age, gender).

Finally, it is not surprising that this study has found that PA participation predicts profile membership. Fluctuator's more PA participation is shown associated with the more active psychosocial profile (MC profile). These results corroborate the findings of many previous studies, showing that the increase in PA behavior and the

improvement of psychosocial correlates are intertwined (Biddle & Fuchs, 2009; Biddle, Hagger, Chatzisarantis & Lippke, 2007).

CHAPTER IV: STUDY 2: SUBJECTIVE THEORIES OF PHYSICAL ACTIVITY MOTIVATORS AND BARRIERS FOR FLUCTUATORS – A QUALITATIVE STUDY

This chapter mainly addresses research questions 3 and 4 (see Chapter I) using the methodology of "Research Program Subjective Theories." The chapter first specifies study purposes and questions. It then presents a brief introduction to "Research Program Subjective Theories" because this methodology has not been widely applied in English-speaking countries. The study results are demonstrated with discussion in the end of this chapter.

4.1 Study purpose and questions

The results outlined in the previous chapter provide an overview of the sub-categories of PA fluctuators and their characteristics established through a cross-sectional survey study. To achieve holistic understandings, this thesis now switches to a qualitative perspective to deeply explore fluctuators' psychosocial and behavioral characteristics through interviews.

The main purpose of the present study is to explore subjective theories of fluctuators with respect to their PA behavior, motivators, barriers, and the relationships between them. Here, it should be noted that the term "subjective theories" indicates the aggregation of cognition of one's view toward an event or a phenomenon, it can be simply understood using the everyday term of "mindset." Thus, the "motivators" and "barriers" can be regarded as the fluctuators' perceived facilitating factors and impeding factors to their daily life PA participation. The detailed research questions in this study were as follows:

1. In fluctuators' subjective theories, what are the behavioral characteristics of their PA participation (e.g., PA type, frequency, intensity, how they organize their PA, PA interruptions / lapses etc.)?
2. In their subjective theories, what are the motivators of and barriers to PA participation?

3. In their subjective theories, what specific reasons cause their PA interruptions or lapses?

4. What are the relationships between their PA behaviors, motivators, and barriers?

5. Are there any distinct sub-categories of fluctuators' subjective theories? If so, how do these sub-categories differ from each other? What are the exemplars of each sub-category like?

In line with these five questions, the main procedures of this study involved the following:

1) Collecting relevant information about fluctuators' PA behavior, lapses, motivators, and barriers;

2) Extracting the features based on the information above;

3) Exploring the relationships among these features;

4) Classifying fluctuators into different sub-categories based on these features;

5) Demonstrating examples of each sub-category

4.2 Brief introduction to the "Research Program Subjective Theories"

The current study adopts the methodology of "Research Program Subjective Theories" (RPST). The RPST has been developed in Germany since 1980s and has been widely applied in health, sports and physical education studies especially in Germany (Brehm, 1990; Brehm & Voitländer, 2000; Groeben & Scheele, 1988; Haag & Mischio, 2003; Weidemann, 2009). However, the RPST was less commonly applied in English-speaking countries, thus leaving a necessity to elaborate the rationale and procedures of RPST before jumping directly to the study design.

The philosophical rationale for RPST is based on the humanistic assumption of "man the scientist" (Kelly, 1955). This idea implies that human beings are not only research subjects but are also assumed as thoughtful agents with the characteristics of intentionality, reflectivity, potential rationality, and communicative ability (Groeben & Scheele, 2000; Grotjahn, 1991).

Within the RPST constructs, the concept of "subjective theory" (ST) denotes an aggregation of complex cognition of one's view toward an event or a phenomenon (Wagner, 2003). Specifically, the ST can be characterized as:

- Cognitions relating to oneself and the external world or environment;
- A complex aggregation of a mental structure with systematic reasoning;
- Functions of explanation and prediction of one's behavior.

The explication of an individual's ST requires a two-phase RPST research design that encompasses content extraction by semi-structured interview and content construction by structure-laying technique (translated from German, Struktur-Lege-Technik, SLT, Wagner, 2003; Flick, 2014).

The first phase of RPST is to determine the relevant content of cognitions, usually completed by a semi-structured interview (Flick, 2014). During the semi-structured interviews, three types of questions need to be asked. Firstly, structured questions should be designed and oriented to the previous scientific literature about the topic or based on the researcher's theoretical presuppositions. Interviewees are usually provided with the options for them to select. Secondly, open-ended questions should be asked to allow participants to freely express their idea. Thirdly, conformational questions by offering competing alternatives or re-addressing their notions should be asked to make participants critically re-examine their ST (Flick 2014).

After achieving mutual agreement between interviewer and interviewee, the SLT is employed to reconstruct and visualize the relevant interview contents (Flick, 2014). Specifically during the SLT process, topics involving the interviewee's cognitions and basic lexica (BL, plural form of "basic lexicon", indicating a family of predetermined or post-determined content which is all related to the topic, Ö hman, 1953) need to be generated in a graphic structure to representing the interviewee's ST.

4.3 Method

This study used a simplified RPST design. In a simplified RPST, the semi-structured interview and the SLT are integrated in a single phase (Scheele, 1992). This design has successfully been used in previous studies (Brehm & Voitländer, 2000). The semi-structured interview was intended to extract the content of fluctuators' ST toward PA participation, motivators, and barriers, while the SLT was used to compile the graphic structure of the ST.

4.3.1 Interview guide

A guide was prepared to direct the whole interview process. In line with the research questions, four main topics were chosen: PA-related, motivator-related, barrier-related, and lapse-related (see Appendix 3). Sub-topics and questions were then specified under each of the main topics. Under the PA-related topic, questions covered PA type, location, amount (frequency, duration, and intensity), plan, implementing time, and companion. The lapse-related topic covered two sub-topics of lapse behavior (e.g., how many lapses and how long for each) and reasons for lapses.

The sub-topics under motivator- and barrier-related topics were obtained from the Bulletin of National Physical Activity Surveillance in China (General Administration of Sport of China, 2015). The National Physical Activity Surveillance is supported by the Chinese government and collects sports and PA-related information at a national level across 12 aspects (e.g., PA participation, PA motivators, barriers, money expenditure on sports and exercise, etc.), which can be a reliable source for the inclusion of PA motivators and barriers. Specifically, we selected the top seven cited motivators and top seven cited barriers in the surveillance.[5]

[5] Because the surveillance provides age-specific motivators and barriers, we selected only the motivators and barriers for the over-20 age group. The bulletin provided a total of 10 motivators and 10 barriers. We selected the top 7 motivators and barriers, which contribute 97.4% of the total cites of motivators and 96.9% of the total cites of barriers.

The seven motivators are: M1 = better fitness; M2 = fun; M3 = health preservation & disease prevention; M4 = tension release & mood regulation; M5 = weight control & good body shape; M6 = skill improvement; M7 = social interaction.

The seven barriers are: B1 = lack of time; B2 = lack of interest; B3 = lack of facilities; B4 = lack of willpower; B5 = physical reasons (e.g., discomfort, injury, physically weak etc.); B6 = much economic cost; B7 = lack of social support or organization.

In addition, the topics and sub-topics in the present qualitative study and the indicators addressed in the previous quantitative study overlap (see details in Table 4.1). Topic and sub-topic selection based on indicators from previous quantitative work allows researchers to later compare the results from different study designs. This qualitative study also explored some new topics (e.g., PA type, companion, motivators of social interaction and improving skills, physical barriers, lapse behavior and reasons, etc.) which were not covered in the previous quantitative study, allowing broader and deeper investigation to PA fluctuation.

Table 4.1

Cross-reference between topics in qualitative study and indicators in quantitative study

Indicators in quantitative study	How they addressed in qualitative interview
PA frequency, intensity, duration, and energy expenditure	1. PA frequency, intensity, and duration were directly asked. 2. Energy expenditure is calculated after the interview (see Table 4.2 coding scheme).
Self-efficacy	1. Conversely addressed in B4 (Lack of willpower). Rationale: People have low self-efficacy tend to attribute their PA lapse to internal unchangeable factor such as lack of willpower (Larimer, Palmer & Marlatt, 1999) 2. Judging from how many barriers participant select. Rationale: People of low self-efficacy tend to overestimate the effect of the barrier and select more barriers.
Planning	Directly asked
Affective attitude	1. Indirectly associated with M2 (fun) 2. Indirectly associated with M4 (tension release & mood regulation) Rationale: These affective motivators and the construct of affective attitude in quantitative study were suggested very closely related to and highly interdependent with each other (Peak, 1955).
Social support	Conversely asked in B7 (lack of social support or organization).
Perceived barriers (e.g., no time, facilities, bad weather)	Directly addressed in B1 (Lack of time), B3 (Lack of facilities), B8 (participants can provide their own barriers).
Action control	Conversely addressed in B4 (Lack of willpower) Rationale: Within the field of exercise psychology, action control was often used interchangeably with self-regulation to refer to the same psychological construct (Sniehotta, Scholz & Schwarzer, 2005; Rhodes et al., 2016).

Note. M = motivator; B = barrier

In this interview guide, three different variations of questions (open-ended, structured, and confirmational) are prepared. The open-ended questions covered fluctuators' daily PA participation (e.g., type, frequencies, location, planning, lapse, and lapse reasons) and the self-selected PA motivator and barriers (provided in the blank cards regarding motivators and barriers). The structured questions were presented in cardboard with the selected motivators and barriers from the national surveillance. Finally, a brief summary of the interview was provided to give the interviewee a recap of the interview, and the confirmational questions were asked to ensure the authenticity of the interview.

4.3.2 Data collection

The interviewees in the present study were recruited from the fluctuators who voluntarily left their personal contact in the previous quantitative survey study in Chapter III. The author contacted them and provided them with brief introduction of the interview, including the study aim, duration, reward, and other relevant information. Those who wished to participate were provided with the location and time slot for the interview. To avoid disturbance, each interview was conducted in a secluded and quiet environment.

The interviews followed the prepared interview guide (see Appendices). During the interview, the interviewer noted useful information on the prepared card boards. Each card board with useful information was glued on a large blank paper to generate the individual picture of each interviewee's ST. Upon the interviewee's confirmation, the interview was finished. In the end, each interviewee was asked to provide personal background information such as their age, job, and marital status.

4.3.3 Data coding

After obtaining the content of each interviewee's ST, coding was conducted to present the fluctuators' superstructure (i.e., a visualized representation showing fluctuators' overall ST based on each individual's ST). The coding procedures were

guided by the coding scheme (see Table 4.2), which combined both inductive and deductive approaches.

Table 4.2

Coding scheme with inductive and deductive approaches.

	Inductive coding	Deductive coding
PA-related		
PA type	PA types should be primarily inductively coded by counting the frequencies of indigenous typologies of PA.	If the number of primary categories by inductive coding exceed 10, PA types should be then deductively aggregated in three categories: 1) daily life PA; 2) exercise (a subset of PA that is planned, structured, and repetitive and aims to improve or maintain physical fitness; Caspersen, Powell, & Christenson, 1985); and 3) sport (competitive PA or games which aims to use, maintain or improve physical ability and skills while providing enjoyment to participants; Loy, 1968).
PA location	1. Locations for PA should be firstly inductively coded by counting the frequencies of indigenous typologies. 2. If more than 10 indigenous typologies of PA locations are derived, the indigenous typologies should be further merged into secondary categories.	/
PA plan	/	PA plan should be judged from two aspects (Gollwitzer, 1999): 1. Criteria specificity (aware of how much I need to do) 2. Inclusion of situational cues (e.g. when, where to do) Two categories are generated as 1) no clear plan (involving none or only one of the previous two aspects in detail); 2) clear plan (involving both of the two aspects in detail).
PA regularity		PA regularity directly classified into two categories (regular and not regular) directly from the interviewee's self-report on whether they perform PA in regular time slots and locations.
PA amount (estimated with frequency, intensity,	/	PA frequency, intensity and duration are used to estimate the weekly energy expenditure (IPAQ Research Committee, 2005). According to the official cutoff point, individual's weekly energy

duration)		expenditure is further classified in 3 categories: Low PA level (< 600 MET-minutes/week); Moderate PA level (600-3000MET-minutes/week); High PA level (> 3000 MET-minutes/week).
PA companion	/	Three categories were generated according to the interview guide: 1) by self, 2) with others (non-professional), and 3) with professional instructor
Motivators & Barriers		
Motivator	For the motivator that cannot be classified into predetermined categories, new motivator categories were generated by inductive approach aggregating the indigenous typologies.	Originally, 7 motivator were derived from General Administration of Sport of China (2015). For the scoring, the most important motivator is scored 3 points, followed by the second most important motivator as 2 points, and third most important motivator as 1 point.
Barrier	For the barriers that cannot be classified into predetermined categories, new barrier categories are generated by inductive approach aggregating the indigenous typologies.	Originally, 7 barriers were derived from General Administration of Sport of China (2015). For the scoring, the most important barrier is scored 3 points, followed by the second most important barrier as 2 points, and third most important barrier as 1 point.
Lapse-related		
Reasons of lapse	1. Reasons for lapse should be primarily inductively coded by counting the frequencies of fluctuators' reported reasons of lapse. 2. If more than 10 primary categories are derived, the secondary categories should be generated by further merging the primary categories.	
Lapse behavior	Based on the information of frequency and duration of lapse, total days of lapse should be calculated. Categories of long and short lapse are separated according to the median. Equal or larger than median = group of "long lapse"; Less than median= group of "short lapse".	

All the inductive approaches involved familiarization with the material and grasping the general understanding through repeated reading. Indigenous typologies were then developed by carefully reading, highlighting, and rephrasing the material. Finally, if too many indigenous typologies emerged (more than 10), they were assigned to secondary categories by analyzing their relationships and links with each other (Morgan, 1993).

The deductive approach was more structured. Fluctuators' responses were coded into categories according to the pre-determined criteria. Data that cannot be deductively coded were identified and analyzed later to determine if they represent a new category or a subcategory (Hsieh & Shannon, 2005).

It should be noted that some of fluctuators' PA-related information (PA type, location, plan, and companion) was ultimately coded at the individual level. This meant regarding each fluctuator as an independent individual; each fluctuator was categorized into a certain category according to the information they provided. Take coding of PA type as an example. Four categories were set: 1) only doing daily life PA; 2) only exercise; 3) only sports; 4) mixed (doing at least two types of different physical activities).

To ensure coding validity and to avoid coding subjectivity, all of the codings were conducted by two exercise psychologists (the author and a German expert in exercise psychology). The two coders discussed any coding discrepancies until they reached a consensus.

4.3.4 Data analysis

The qualitative systematic aggregation method was used to develop the superstructure of fluctuators' ST (Stössel & Scheele, 1992). This method helps to extract commonalities among each individual's ST and gather them in a superstructure. In this study, the process involved assessing the frequencies of coded BL (i.e., basic lexica, word categories) from the 30 interviewed fluctuators.

Only the coding outcomes of high frequencies and percentages were included in the superstructure. Three specific criteria were used to decide which kinds of BL were included in the superstructure.

1) BL (related to PA participation, motivators and barriers) cited by fluctuators no less than 25% were included;

2) Lapse reasons cited at least 5 times were included;

3) Average scores that describe the overall information about fluctuators' PA and lapse features were included in the superstructure.

In addition, the associations between the included BL in the superstructure were explored using statistics of correlation. The procedures for constructing superstructures with relationships between the selected BL involved:

1) Re-coding the selected BL into binary variables in SPSS 24.0. For each fluctuator, each presence of the BL was coded as a "1," while each absence of the BL was coded as a "0" (e.g., assume that "lack of time" is an included BL, coding fluctuators reported it as "1," and vice versa).

2) Calculating the effect size of phi coefficients using Chi-square tests to scale the associations between binary variables.

3) Summarizing all the phi coefficients into an association table. A relatively lax significance level (p=.10) was chosen to determine the inclusion of associations in the superstructure. The reason for using p = .10 instead of the conventional significance level of .05 was because it can help to discover more meaningful relationships between BL in a small sample size, yet with a relatively low chance of type-1 errors. Setting a significance level at p = .10 was also not rare in previous literature (Schmidt, Tittlbach, Bös & Woll, 2017).

4) Including relationships between BL lower than the pre-determined significance level (p= .10) and constructing the superstructure manually.

To test the difference between sub-groups of fluctuators (e.g., by age, gender, etc.), independent t-tests (significant level p = .10) were conducted by setting the

continuous variables (e.g., weighted scores of each motivator and barrier, lapse days, PA energy expenditure, etc.).

4.4 Results

The following presentation of results begins with a summary of demographic information of the interviewees, followed with coding outcomes, superstructure of fluctuators' ST, differences of ST between sub-groups of fluctuators, and a demonstration of the exemplars.

4.4.1 Demographic information

In total, 32 fluctuators from the previous questionnaire survey volunteered to take part in this interview. Two participants were excluded from the interview because they reported no MVPA in their daily life during the previous half-year. 30 participants (14 male, 16 female) from 4 cities (Shijiazhuang, Xiaogan, Shenzhen, and Hangzhou) completed the interview. Participants were aged between 22 and 56 years (M = 35.2, SD = 9.3). Twenty-one interviewees were married. The interviewees' daily working time ranged from 5.5 hours to 10 hours (M = 7.9, SD = 1.1).

4.4.2 Coding outcomes

- PA type

In total, 30 fluctuators provided 56 PAs. Nine fluctuators provided a single type of PA, 16 fluctuators provided two types of PA, and five fluctuators provided three types of PA. These 56 PAs were inductively coded into 15 PA types (see Table 4.3). Of the 15 PA types, fluctuators' favorite PAs (frequency at least 5) were: running (8), basketball (6), gym-based exercise programs (6), badminton (5), brisk walking (5), and hiking (5).

These 15 PA types were further deductively aggregated into three PA categories of daily life PA, exercise, and sport (see Table 4.4). The results revealed that the most common PA type for the interviewed fluctuators were exercise (n = 31, 55.4%), followed by sport (n = 16, 28.6%) and daily life PA (n = 9, 16.1%). Table 4.5 outlines

the fluctuators' PA participation at the individual level. The results showed that most fluctuators (n = 13, 43.3%) only engaged in exercise and few fluctuators involved PA in their daily life activities (n = 2, 6.7%).

Table 4.3

PA types from 30 fluctuators

PA type	Frequency	Percentage
1. badminton	5	8.9
2. basketball	6	10.7
3. brisk walking	5	8.9
4. commuting PA	2	3.6
5. cycling for exercise	6	10.7
6. dancing	2	3.6
7. gym-based programmed exercise	6	10.7
8. hiking	5	8.9
9. resistance training	1	1.8
10. running	8	14.3
11. soccer	2	3.6
12. stretching	1	1.8
13. swimming	2	3.6
14. table tennis	3	5.4
15. yoga	2	3.6
Total	56	100.0

Note. 30 fluctuators totally reported 56 physical activities. The 56 physical activities were aggregated into 15 PA types.

Table 4.4

Aggregated PA types from 30 fluctuators

Category	Frequency	Percentage	PA types from Table 4.2*
daily life PA	9	16.1	4, 6, 8
exercise	31	55.4	3, 5, 6, 7, 9, 10, 12, 13, 15
sport	16	28.6	1, 2, 11, 14
Total	56	100.0	

Note. Coding criteria were referred to definitions from previous articles (Caspersen, Powell, & Christenson, 1985; Loy, 1968).

Table 4.5

PA participation at individual level

PA participation	Frequency	Percentage
only daily life PA	2	6.7
only exercise	13	43.3
only sport	6	20.0
mixed	9	30.0
Total	30	100.0

Note. This table shows how many fluctuators do "only daily life PA", "only exercise", "only sport", and "mixed PAs"

- PA locations

Based on the original responses from 30 fluctuators, 12 PA locations (including one category of "not fixed") are primarily summarized in Table 4.6. Of all the PA locations, gym was the most frequently reported. Because the number of indigenous categories of locations exceeded 10, another round of aggregation was implemented (see Table 4.7), resulting in three secondary categories of PA locations: 1) indoor, 2) outdoor, and 3) not fixed. Table 4.8 shows that fluctuators do not have special preference for indoor or outdoor PAs. Seven fluctuators only did indoor PA, 13 fluctuators only did outdoor PA, and 10 fluctuators did both indoor and outdoor PA.

Table 4.6

PA locations from 30 fluctuators

PA locations	Frequency	Percentage
1. swimming pool	1	1.8
2. public park	5	8.9
3. city suburban area	5	8.9
4. in community	4	7.1
5. home	2	3.6
6. in the way from home to office	5	8.9
7. work site nearby	3	5.4
8. gym	15	26.8
9. university	6	10.7
10. outdoor area	5	8.9
11. riverside	1	1.8
12 not fixed	4	7.1
Total	56	100.0

Table 4.7

Aggregated PA locations from 30 fluctuators

	Frequency	Percentage	PA locations from Table 4.5
Indoor	23	41.1	1, 2, 5, 8
Outdoor	29	51.8	2, 3, 4, 6, 7, 9, 10, 11
Not fixed	4	7.1	12
Total	56	100.0	

Table 4.8

Aggregated PA location at individual level (N= 30)

	Frequency	Percentage
Only indoor	7	23.3
Only outdoor	13	43.3
Do both indoor and outdoor	10	33.3
Total	30	100.0

- PA plan and regularity

Table 4.9 and Table 4.10 respectively show the coding outcomes of fluctuators' PA planning and regularity. Most fluctuators did not clearly plan (had no plan or only a rough plan) for their PA behaviors (n = 26, 87.7%), and only 4 fluctuators reported clear plans for their PA behavior. Only four fluctuators regularly engaged in PA.

Table 4.9

Fluctuators' PA plan at individual level (N= 30)

PA plan	Frequency	Percentage
No clear plan	26	86.7
Clear plan*	4	13.3
Total	30	100.0

Note. For fluctuators with multiple PA behaviors, planning category should be counted for a higher level (e.g. For a fluctuator with two PA behaviors of running and hiking, running with clear plan, hiking with no plan, this fluctuator should be classified into the category of "clear plan").

Table 4.10

Fluctuators' PA regularity (N= 30)

Regularity	Frequency	Percentage
Irregular	26	86.7
Regular	4	13.3
Total	30	100.0

Note. For fluctuators with multiple PA behaviors, regularity category should be counted for a higher level.

- PA companion

As Table 4.11 shows, the majority of fluctuators (n = 26, 86.7%) performed at least one of their PA behaviors with others (friends, colleagues, family members, or professional instructors). Only four fluctuators implemented their all PA behaviors by themselves.

Table 4.11

Fluctuators' PA companion (N= 30)

	Frequency	Percentage
Only by self	4	13.3
Only with others	14	46.7
Mixed*	12	40.0
Total	30	100.0

Note. In the category of "mixed", three fluctuators implemented at least one of their PA under the instruction from professionals.

- Weekly PA expenditure

Based on fluctuators' reports of their PA frequency, intensity, and duration, the weekly PA expenditure was calculated using the following formula (IPAQ Research Committee, 2005):

Total weekly PA energy expenditure (MET-minutes/week) =

Weekly total minutes for moderate PA * 4 + Weekly total minutes for vigorous PA * 8

Table 4.12 shows that the energy expenditure of fluctuators ranged from 80 to 2520 MET-minutes/week (M = 677.97, SD = 500.46). Following standards published elsewhere, 15 fluctuators were classified as low level in PA and the other 15 were

classified as moderate level in PA (IPAQ Research Committee, 2005). No participant had a high level of PA behavior (see Table 4.13).

Table 4.12

Descriptive information about fluctuators' total PA frequency and weekly energy expenditure (N= 30)

	N	*Min*	*Max*	*Mean*	*SD*
PA weekly frequency	30	0.50	10.00	3.18	2.38
Weekly energy expenditure (MET-minutes/week)	30	80	2520	677.97	500.46

Table 4.13

Classification of fluctuators' PA weekly energy expenditure (N= 30)

	Frequency	Percentage
Low	15	50.0
Moderate	15	50.0
High	0	0.0
Total	30	100.0

Note. High category refers to 1) accumulation of weekly PA energy expenditure ≥ 3000 MET-minutes/week or 2) accumulation of weekly PA at vigorous intensity for at least 3 times over 1500 MET-minutes/week. Moderate category refers to 1) vigorous-intensity PA at least 20 minutes for at least 3 times; or 2) moderate-intensity PA at least 30 minutes for at least 5 times; or 3) accumulation of weekly energy expenditure ≥ 600 MET-minutes/week. Low category: Doing PA not enough to meet the requirements of high category or moderate category (IPAQ Research Committee, 2005).

- **PA Motivators**

Table 4.14 presents the coding outcomes of fluctuators' PA motivators. The results show that fluctuators mainly selected five motivators: maintaining health and disease prevention (M3), weight control & good body shape (M5), tension release & mood regulation (M4), better fitness (M1), and fun (M2). Of these five motivators, three were physically related (M1, M3, M5), jointly contributing 62.2% of the unweighted score (56/90; all the fluctuators selected motivators 90 times, and 56 of those times they selected M1, M3, and M5), and 66.7% (122/183) of the weighted score.

Considering that some fluctuators were very much motivated by physically related factors, we further differentiate those of more physically motivated from those of less physically motivated by setting two categories:

1) Physically motivated fluctuators: choosing two of M1, M3, or M5 as their top two reasons for being active;

2) Mixed motivated fluctuators: fluctuators not belonging to the physically motivated group.

Based on the previous criteria, 16 fluctuators were identified as physically motivated fluctuators and the other 14 were categorized as mixed motivated fluctuators.

Table 4.14

Motivators from 30 fluctuators

Name of motivator	Frequency of 1st motivator (scored 3 pts)	Frequency of 2nd motivator (scored 2 pts)	Frequency of 3rd motivator (scored 1 pts)	Total frequency	Weighted score
M1: Better fitness	8	3	4	15	34
M2: For fun	4	2	4	10	20
M3: Health & Preventing disease	6	12	3	21	45
M4: Tension release & mood regulation	4	6	8	18	32
M5: Weight control & good body shape	8	7	5	20	43
M6: Improving skills	0	0	0	0	0
M7: For social interaction	1	1	3	5	8
M8: Other motivators*	0	0	1	1	1
Total	31	31	28	90	183

Note. The total number of some motivator categories were not 30 (consistent with number of interviewees) because a few of them raised some motivators equally important, and a few of them selected only 2 motivators and did not choose 3rd motivator. pts= points; The only one other motivator was “doing PA forced by his wife”.

- **Barrier-related information**

Table 4.15 shows the coding results regarding PA barriers. The results indicated that the top five barriers were lack of time (B1), lack of willpower (B4), physical reasons (B5), lack of social support (B7), and lack of facilities (B3). Of the 30 fluctuators, 6 indicated that bad weather (not listed in the interview guide) is a barrier to their PA behavior.

Table 4.15

PA barriers from 30 fluctuators

Name of barrier	Frequency of 1st barrier (scored 3 pts)	Frequency of 2nd barrier (scored 2 pts)	Frequency of 3rd barrier (scored 1 pts)	Total frequency	Weighted score
B1: Lack of time	15	6	3	24	60
B2: Lack of interest	0	0	2	0	2
B3: Lack of facilities	2	4	1	7	15
B4: Lack of willpower	7	5	5	17	36
B5: Physical reasons	2	5	6	13	22
B6: Much economic cost	0	0	0	0	0
B7: Lack of social support or organization	1	5	4	10	17
B8: Other barriers (e.g., bad weather)	3	4	4	11	21
Total	30	29	25	84	173

Note. The total number not 22 (number of interviewees) because a few of them selected only 1 or 2 barriers. For the B8 (Other barriers), 6 fluctuators reported bad weather was their PA barrier.

- **Lapse-related information**

Thirty fluctuators reported 48 lapses during the previous half year, making a total of 885 lapse days. Most fluctuators reported one (n = 12) or two (n = 12) lapses. Four fluctuators reported three lapses, and two fluctuators reported no lapses during the last half year. Of the 28 fluctuators who indicated at least one lapse during the previous half year, 15 who reported lapses of at least four weeks were categorized into a "long lapse" group, and the other 13 fluctuators were categorized into a "short lapse" group.

In total, 28 fluctuators provided 64 reasons for their lapse, which can be inductively classified into 18 categories (see Table 4.16). In accordance with the coding scheme in Table 4.2, because the number of indigenous categories of lapse reasons exceeded 10, the indigenous categories were aggregated into two secondary categories, "internal reasons" and "external reasons." Internal reasons were personal affective, physical and psychological reasons (e.g., bad mood, disease or illness, fear of getting sick), while the external reasons were contextual and environmental (e.g., busy work schedule, bad weather, gym membership expired). The results in Table 4.17 reveal that the fluctuators tended to report more external reasons (n = 42, 65.6%) and relatively fewer internal reasons (n = 22, 34.4%). At the individual level, more than half of fluctuators reported both internal and external reasons for their lapses (n = 17, 60.7 %), 10 fluctuators (35.7%) only provided external reasons, only one fluctuator indicated only internal reasons for his lapse.

Table 4.16

Reasons for lapse

Reasons for lapse	Frequency	Percentage
1. Bad mood	1	1.6
2. Bad weather	4	6.3
3. Busy work schedule	9	14.1
4. Disease or illness	3	4.7
5. Disturbed bio-clock	2	3.1
6. Exam preparation	1	1.6
7. Engaged in social activities	3	4.7
8. Fear of getting sick	1	1.6
9. Feeling tired	8	12.5
10. Gym membership expired	2	3.1
11. Injury	1	1.6
12. Lazy	5	7.8
13. No people accompany	2	3.1
14. On holiday	9	14.1
15. On trip	7	10.9
16. Over-exercise	1	1.6
17. Taking care of family members	4	6.3
18. Too many people in swimming pool	1	1.6
Total	64	100

Note. 64 lapse reasons provided by 28 fluctuators were initially aggregated into 18 categories.

Table 4.17

Aggregated reasons for lapse

	Frequency	Percentage	Reasons for lapse from Table 4.15
Internal reasons	22	34.4	1, 4, 5, 8, 9, 11, 12, 16
External reasons	42	65.6	2, 3, 6, 7 , 10, 13, 14, 15, 17, 18
Total	64	100	

4.4.3 Superstructure formation

Figure 4.1 summarizes all key descriptive information about fluctuators' ST in a superstructure. The core motivators (> 25% selection) for fluctuators' physical activity were health and disease prevention (M3), followed by weight control and

pursuit of good body shape (M5), tension release and mood regulation (M4), better fitness (M1), and fun (M2).

The core barriers (>25% selection) preventing them from being physically active were: lack of time (B1), lack of willpower (B4), physical reasons (B5), and lack of social support (B7). Regarding fluctuators' PA plan and perceived regularity of PA behavior, 86.7% of the interviewees indicated that they had no clear plan and did not regularly perform PA.

Each fluctuator committed 1.6 lapses in the previous half -year, and on average each lapse lasted 18.4 days. Over half (53.6%) of fluctuators accumulated days of lapse longer than 4 weeks during the previous half-year. Fluctuators' specific reasons for lapses were "on holiday," "busy work," "feeling tired," "on a trip," and "being lazy."

The main PA type of fluctuators was exercise, which contributed 55.4% of their PA. The three most cited PAs were running, gym-based exercise program, and cycling. On average each fluctuator implemented 3.2 sessions PA per week. The ratio of fluctuators who engage in PA of at least three sessions / week was 56.7%. According to the standard set by the IPAQ Research Committee (2005), 15 fluctuators had a low PA level and the other 15 had a moderate level.

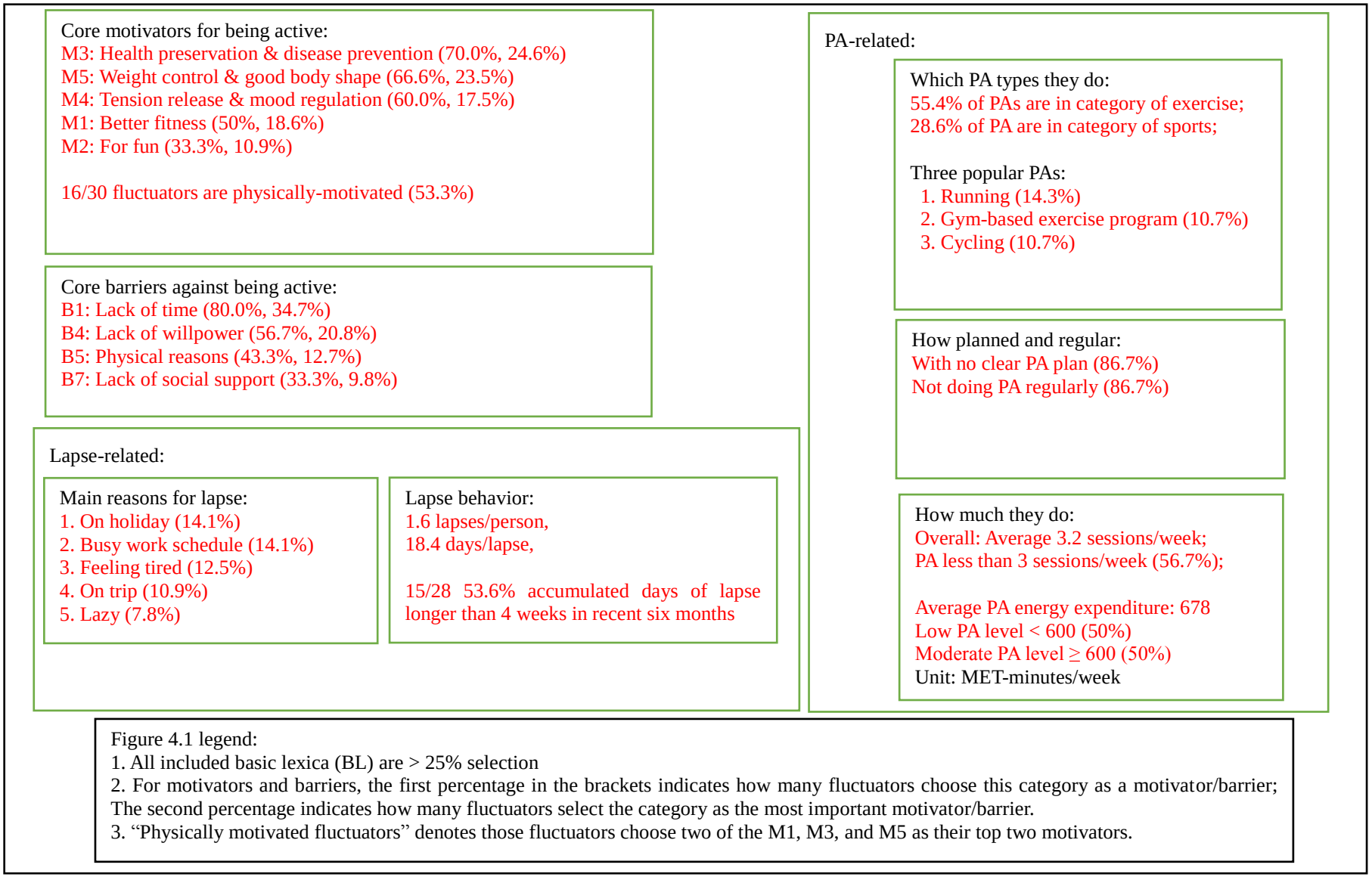


Figure 4.1. Fluctuators' ST superstructure without associations (N= 30)

The Table 4.18 presents the associations between fluctuators' BL of PA behavior, motivators, barriers, and lapses. Figure 4.2 visually demonstrates the significant associations. As Table 4.18 and Figure 4.2, show, 22 associations between fluctuators' BL were marked. Of these, 5 associations were negatively correlated and 17 were positively correlated. Regarding the strength of the association, six associations had a *phi* coefficient of no less than 0.4 and were thus considered strong associations. Six associations were considered to be moderate, with *phi* coefficients between 0.3 and 0.39. Ten associations were regarded as weak associations, with *phi* coefficients between 0.24 and 0.29.

The motivators in fluctuators' ST are mostly negatively related. The negative associations appear in four pairs of motivators:

1) Better fitness (M1) and fun (M2), *phi* = -0.36, *p* = .03;

2) Better fitness (M1) and health preservation & disease prevention (M3), *phi* = -0.45, *p* = .01;

3) Health preservation & disease prevention (M3) and weight control & good body shape (M5), *phi* = -0.27; *p* = .08

4) Tension release & mood regulation (M4) and weight control & good body shape (M5), *phi* = -0.29; *p* = .06

The results also show that fluctuators with the "fun" motivator were more likely to participate in sport (*phi* = 0.31, *p* = .05), while fluctuators with the motivators of weight control and good body shape were more likely to engage in exercise (*phi* = 0.77, *p* = .00). In addition, fluctuators' motivator of achieving better fitness (M1) was weakly associated with unclear PA plan (*phi* = 0.24, *p* = .09). The motivator of weight control and good body shape (M5) was strongly related to lack of willpower (B4) (*phi* = 0.81, *p* = .00). Finally, the two body-related motivators, better fitness level (M1, *phi* = 0.36, *p* = .03) and weight control & good body shape (M5, *phi* = 0.28, *p* = .07), were associated with long periods (≥ 4 weeks) of lapse.

Figure 4.2 also shows that fluctuators' barrier-related BL were associated with no clear plan, perceived irregularity, PA type of exercise, and longer lapses. In particular,

lack of time (B1, *phi* = 0.37, *p* = .02) and physical reasons (B5, *phi* = 0.27; *p* = .07) were associated with no clear PA plan. Lack of time (B1, *phi* = 0.29, *p* = .06) and lack of willpower (B4, *phi* = 0.25, *p* = .09) were related to perceived irregularity of PA. Engaging in exercise was often related to lack of willpower (B4, *phi* = 0.60, *p* = .00) and physical reasons (B5, *phi* = 0.28, *p* = .07). Lack of social support (B7, *phi* = -0.28, *p* = .07) was negatively associated with longer duration (≥ 4 weeks) of lapse.

In addition, a lack of clear plan was associated with perceived irregularity (*phi* = 0.40, *p* = .01) and low PA level (*phi* = 0.34, *p* = .03). Perceived irregularity of PA was associated with PA type of exercise (*phi* = 0.39, *p* = .02) and longer periods of lapse (*phi* = 0.44, *p* = .01).

Table 4.18

Correlation table based on the BL in the superstructure

		M1	M2	M3	M4	M5	B1	B4	B5	B7	No-CP	PI	Exercise	Sport	LL	Low PA
M1	*phi*	/	**-.36**	**-.45**	-.14	.14	.00	.20	-.07	-.14	**.24**	.20	.07	-.07	**.36**	.20
	p	/	.03	.01	.23	.22	.50	.14	.36	.22	.09	.15	.35	.36	.03	.14
M2	*phi*	**-.36**	/	-.10	-.21	.00	-.04	-.16	-.13	.00	-.10	-.17	-.21	**.31**	.11	-.22
	p	.03	/	.30	.13	.50	.42	.19	.24	.50	.28	.18	.13	.05	.28	.12
M3	*phi*	**-.45**	-.10	/	-.19	**-.27**	.08	-.07	.07	.11	-.13	-.02	-.23	.07	-.11	.15
	p	.01	.30	/	.16	.08	.34	.35	.35	.28	.23	.47	.11	.35	.28	.21
M4	*phi*	-.14	-.21	-.19	/	**-.29**	.10	-.17	.17	-.14	.15	**.28**	-.09	.03	-.10	.00
	p	.23	.13	.16	/	.06	.29	.19	.19	.22	.19	.07	.32	.44	.31	.50
M5	*phi*	.14	.00	**-.27**	**-.29**	/	.00	**.81**	.05	-.10	.05	.14	**.77**	-.24	**.28**	-.14
	p	.22	.50	.08	.06	/	.50	.00	.40	.30	.40	.23	.00	.10	.07	.22
B1	*phi*	.00	-.04	.08	.10	.00	/	.07	-.07	.00	**.37**	**.29**	.04	.10	.04	.00
	p	.50	.42	.34	.29	.50	/	.36	.36	.50	.02	.06	.42	.29	.42	.50
B4	*phi*	.20	-.16	-.07	-.17	**.81**	.07	/	-.05	.05	.10	**.25**	**.60**	-.05	.21	-.07
	p	.14	.19	.35	.19	.00	.36	/	.39	.40	.28	.09	.00	.39	.14	.36
B5	*phi*	-.07	-.13	.07	.17	.05	-.07	-.05	/	-.19	**.27**	-.05	**.28**	-.22	-.23	.20
	p	.36	.24	.35	.19	.40	.36	.39	/	.15	.07	.39	.07	.12	.11	.14
B7	*phi*	-.14	.00	.11	-.14	-.10	.00	.05	-.19	/	-.13	-.14	.00	-.19	**-.28**	.00
	p	.22	.50	.28	.22	.30	.50	.40	.15	/	.23	.23	.50	.15	.07	.50
No clear plan	*phi*	**.24**	-.10	-.13	.15	.05	**.37**	.10	**.27**	-.13	/	**.40**	.10	.11	.24	**.34**
	p	.09	.28	.23	.19	.40	.02	.28	.07	.23	/	.01	.28	.27	.10	.03

Perceived	*phi*	.20	-.17	-.02	**.28**	.14	**.29**	**.25**	-.05	-.14	**.40**	/	**.39**	.05	**.44**	.00
	p	.15	.18	.47	.07	.23	.06	.09	.39	.23	.01	/	.02	.39	.01	.50
Exercise	*phi*	.07	-.21	-.23	-.09	**.77**	.04	**.60**	**.28**	.00	.10	**.39**	/	/	/	/
	p	.35	.13	.11	.32	.00	.42	.00	.07	.50	.28	.02	/	/	/	/
Sport	*phi*	-.07	**.31**	.07	.03	-.24	.10	-.05	-.22	-.19	.11	.05	/	/	/	/
	p	.36	.05	.35	.44	.10	.29	.39	.12	.15	.27	.39	/	/	/	/
Long lapse	*phi*	**.36**	.11	-.11	-.10	**.28**	.04	.21	-.23	**-.28**	.24	**.44**	/	/	/	/
	p	.03	.28	.28	.31	.07	.42	.14	.11	.07	.10	.01	/	/	/	/
Low PA level	*phi*	.20	-.22	.15	.00	-.14	.00	-.07	.20	.00	**.34**	.00	/	/	/	/
	p	.14	.12	.21	.50	.22	.50	.36	.14	.50	.03	.50	/	/	/	/

Note. M1= better fitness; M2= fun; M3= health preservation and disease prevention; M4= tension release and mood regulation; M5= weight control and good body shape; B1= lack of time; B4= lack of willpower; B5= physical reasons; B7= lack of social support; No-CP= lacking of specific PA goal or situational cues; PI= perceived irregularity; LL= long lapse, lapse duration no less than 4 weeks; Low PA= < 600 MET-minutes/week. The yellow highlighted blocks show the significant relationships between pairs BL (all p <.10). Blocks with "/" are not applicable for implementing correlation.

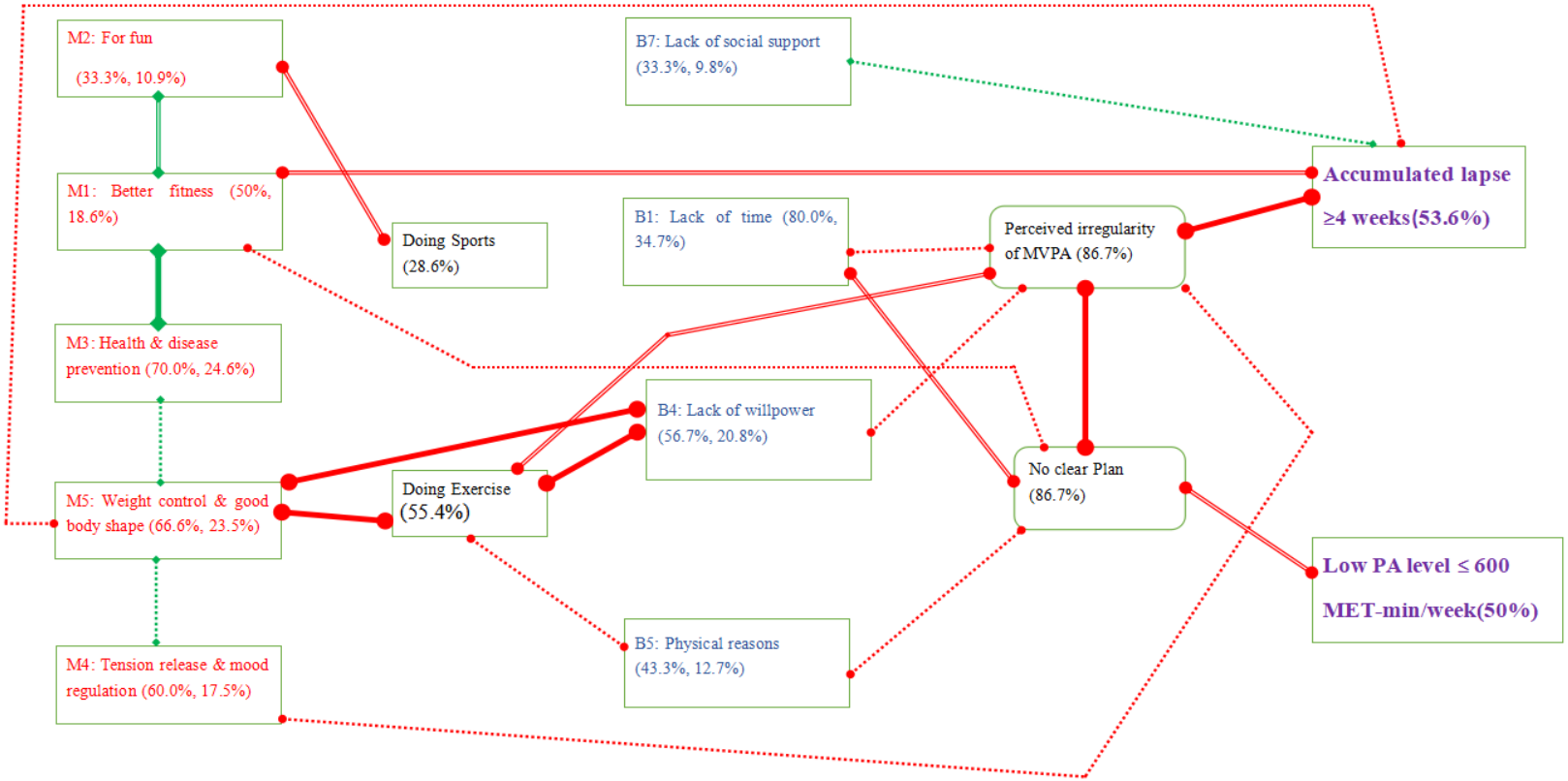


Figure 4.2 legend: 1. All included basic lexica are > 25% selection

2. For motivators and barriers, the first percentage in the brackets indicates how many fluctuators choose this category as a motivator/barrier; The second percentage indicates how many fluctuators select the category as the most important motivator/barrier

Positive associations: : ≥ 0.4; : 0.3-0.39; : 0.2-0.29; all for phi coefficient

Negative associations: : ≥ 0.4; : 0.3-0.39; : 0.2-0.29; all for phi coefficient

Figure 4.2. Fluctuators' ST superstructure with associations among BL (*N*=30)

4.4.4 Results from sub-group comparison

The sub-group differences were compared by implementing independent t-tests between the following five pairs: 1) male versus female; 2) younger (≤ 30 years) versus older (> 30 years); 3) moderate PA level (≥ 600 MET-minutes/week) versus low PA level (< 600 MET-minutes/week); 4) short period of lapse (< 4 weeks) versus long period of lapse (≥ 4 weeks); 5) physically motivated versus mixed motivated.

The outcome variables for these comparisons were as follows:

1) Motivators (all transferred to continuous weighted score, not applicable only when comparing physically motivated and mixed motivated fluctuators);

2) Barriers (all in continuous weighted score);

3) Total days of lapse (not applicable when comparing fluctuators of shorter period of lapse and longer periods of lapse);

4) PA energy expenditure (not applicable when comparing group of moderate PA level and group of low PA level).

Significant differences ($p < .10$) with the effect size (Cohen's d) were all summarized in Table 4.19, while the insignificant findings were intentionally omitted in this table.

Table 4.19

Summary of significant results in t-tests for fluctuators' PA motivator, barrier, and lapse

Outcome	Group									
	Young (≤ 30 yrs)			Old (> 30 yrs)						
	Mean	*SD*	*N*	*Mean*	*SD*	*N*	*t*	*p*	Cohen' s *d*	*df*
M3	0.93	0.92	14	2.00	1.10	16	-2.88	.008	1.06	28
B1	2.50	0.94	14	1.56	1.26	16	2.28	.031	0.85	28
Outcome	Group									
	Short lapse (<28 days)			Long lapse (≥ 28 days)						
	Mean	*SD*	*N*	*Mean*	*SD*	*Mean*	*t*	*p*	Cohen's *d*	*df*
M7	0.62	0.96	13	0	0	15	2.49	.020	0.91	26
B7	0.92	1.12	13	0.27	0.59	15	1.98	.058	0.73	26
Outcome	Group									
	Physically motivated			Mixed motivated						
	Mean	*SD*	*N*	*Mean*	*SD*	*N*	*t*	*p*	Cohen's *d*	*df*
B4	1.64	1.15	14	0.81	1.22	16	1.92	.067	0.70	28
Total lapse days	39.46	26.72	13	24.80	13.99	15	1.86	.075	0.69	26
PA WEE	518.7	375.4	14	817.4	563.6	16	-1.73	.096	0.62	28

Note. M3= Health preservation & disease prevention; B1= Lack of time; M7= Social interaction; B7= Lack of social support; B4: Lack of willpower; PA WEE= weekly PA energy expenditure. For the cutoff points of Cohen's *d*, 0.2 is considered a 'small' effect size, 0.5 a 'medium' effect size, 0.8 a 'large' effect size, and 1.2 a very large effect size. (Cohen, 1992, Sawilowsky, 2009).

- In terms of gender, there was no significant difference between male and female fluctuators in all outcome variables.
- In terms of age group, only two significant differences were revealed. Younger fluctuators (≤ 30 years) were less motivated by disease prevention and health preservation ($t(28) = -2.88$, $p = .008$, Cohen's $d = 1.06$) than older fluctuators (> 30 years). Younger fluctuators also more frequently reported "lack of time" (B1) than older fluctuators ($t(28) = 2.28$, $p = .031$, Cohen's $d = 0.85$).
- Unexpectedly, no significant difference was found between fluctuators with a moderate PA level and those with a low PA level.
- Several significant differences were found between fluctuators with shorter periods of lapse (< 4 weeks) and longer periods of lapse (≥ 4 weeks). Specifically, fluctuators with shorter lapses were more motivated by social interactions (M7) than fluctuators with longer lapses ($t(26) = 2.49$; $p = .020$, Cohen's $d = 0.91$). At the same time, fluctuators with shorter lapses were more likely to consider lack of social support (B7) as barriers than fluctuators with longer periods of lapse ($t(26) = 1.98$, $p = .058$, Cohen's $d = 0.73$).
- Physically motivated fluctuators were more bothered with a lack of willpower (B4) than mixed motivated fluctuators ($t(28) = 1.92$, $p = .067$, Cohen's $d = 0.70$). Physically motivated fluctuators reported longer durations of lapse ($t(26) = 1.86$, $p = .075$, Cohen's $d = 0.69$) and lower MVPA energy expenditure ($t(28) = -1.73$, $p = .096$, Cohen's $d = 0.62$) than the mixed motivated fluctuators.

4.4.5 Categorization of fluctuators

To produce exemplary models from the 30 interviewed fluctuators, the first step is to classify them into distinct and representative categories. The categories were selected on the basis of previous results in the superstructure and sub-group comparison. This study has revealed behavioral distinctions between physically motivated fluctuators and mixed motivated fluctuators (see Table 4.19). Therefore,

motivator was considered as a primary factor in the classification. The 30 interviewed fluctuators were initially separated into two motivational categories (physically motivated and mixed motivated). Those in each initial category were then compared and analyzed case by case in terms of PA level, lapse duration, plan clarity, barriers, and PA regularity. By comparison and synthesis, 3 types of fluctuators (Types I, Ⅱ, and Ⅲ) were classified (See Table 4.20).

- The Type I (physically motivated) fluctuator has these characteristics: 1) physically motivated, 2) low PA level, 3) no clear plan for PA, 4) irregular PA participation, 5) either lack of time or lack of willpower. Eleven fluctuators belonged to this type.
- The Type Ⅱ (mixed motivated) fluctuator has these characteristics: 1) Mixed motivated, 2) moderate PA level, 3) no clear plan for PA, 4) irregular PA participation. Twelve fluctuators belonged to this type.
- The Type Ⅲ (impeded) fluctuator has these characteristics: 1) mixed motivated, 2) low PA level, 3) no clear plan for PA, 4) lack of time (caused by critical life event, newborn baby's mother and father). Three fluctuators belonged to this type.

Four special cases could not be categorized into any of the above types, and were grouped into the type of "miscellany."

Table 4.20

Categorization of fluctuators

Serial number	Low PA level	Long lapse duration	Clear plan	Regular PA	B1	B4	B5	B7	Type
Physically motivated (n= 14)									
SJZ-1	√	√	×	×	0	3	2	0	I
SJZ-6	√	/	×	×	3	2	0	1	I
XG-3	√	×	×	×	3	0	1	0	I
XG-6	√	√	×	×	3	2	1	0	I
XG-10	√	√	×	×	2	1	0	0	I
HZ-1	√	×	×	×	3	1	2	0	I
HZ-2	√	√	×	×	2	3	0	0	I
HZ-3	√	√	×	×	3	2	0	0	I
HZ-5	√	√	×	×	0	2	1	0	I
HZ-6	√	√	×	×	1	0	3	0	I
HZ-7	√	×	×	×	3	1	0	2	I
SJZ-3	×	√	√	√	0	0	0	0	/
SJZ-5	×	×	√	×	1	3	0	2	/
HZ-4	√	×	√	√	0	3	0	2	/
Mixed motivated (N= 16)									
SJZ-2	×	×	×	×	3	1	2	0	Ⅱ
SJZ-8	×	√	×	×	3	1	2	0	Ⅱ
SJZ-9	×	×	×	×	0	0	1	2	Ⅱ
SJZ-10	×	√	×	×	3	0	0	2	Ⅱ

SJZ-11	×	×	×	×	2	0	3	1	Ⅱ
XG-1	×	×	×	×	3	0	2	0	Ⅱ
XG-2	×	√	×	×	3	2	0	1	Ⅱ
XG-5	×	×	×	×	3	0	0	0	Ⅱ
XG-7	×	×	×	×	1	3	1	0	Ⅱ
XG-8	×	√	×	×	2	3	0	1	Ⅱ
XG-9	×	√	×	×	2	3	0	0	Ⅱ
SZ-1	×	√	×	×	3	0	0	0	Ⅱ
SJZ-4	√	×	×	√	2	0	1	3	Ⅲ
SJZ-7	√	/	×	×	3	0	0	0	Ⅲ
XG-4	√	√	×	×	3	0	0	0	Ⅲ
HZ-8	×	×	√	√	0	0	0	0	/

Note. "√" = meeting the requirement; "×"= not meeting; "/"= not applicable or cannot be categorized; SJZ= Shijiazhuang; XG= Xiaogan; SZ= Shenzhen; HZ= Hangzhou; P=physically motivated; M= mixed motivated; Low PA level = weekly PA energy expenditure < 600 MET-minutes; Long lapse period = total lapse days ≥ 28 days; Clear plan = plan with specific goal and situational cues; B1= lack of time; B4= lack of willpower; B5= physical reasons; B7= lack of social support.

4.4.6 Exemplary model representation

In the following discussion, one individual structure in each type (Type Ⅰ, II, and III) are chosen as a representative to demonstrate the characteristics of this type. For the type of miscellany, two individual cases are displayed.

- Individual case representation of Type I fluctuator

The exemplary model of the Type I fluctuator is shown in Figure 4.3. The serial number of this case is SJZ1, indicating that he was the first interviewee in the city of Shijiazhuang. The interviewee was a 27-year-old unmarried male teacher who worked for 8 hours each weekday. This fluctuator was purely motivated by physical reasons for better fitness level, health preservation and disease prevention, and weight control. Motivated by these reasons, he developed a rough plan for indoor swimming three times per week. However, in reality his swimming activities occurred on average once per week on an irregular basis. He also indicated that he has no swimming partner.

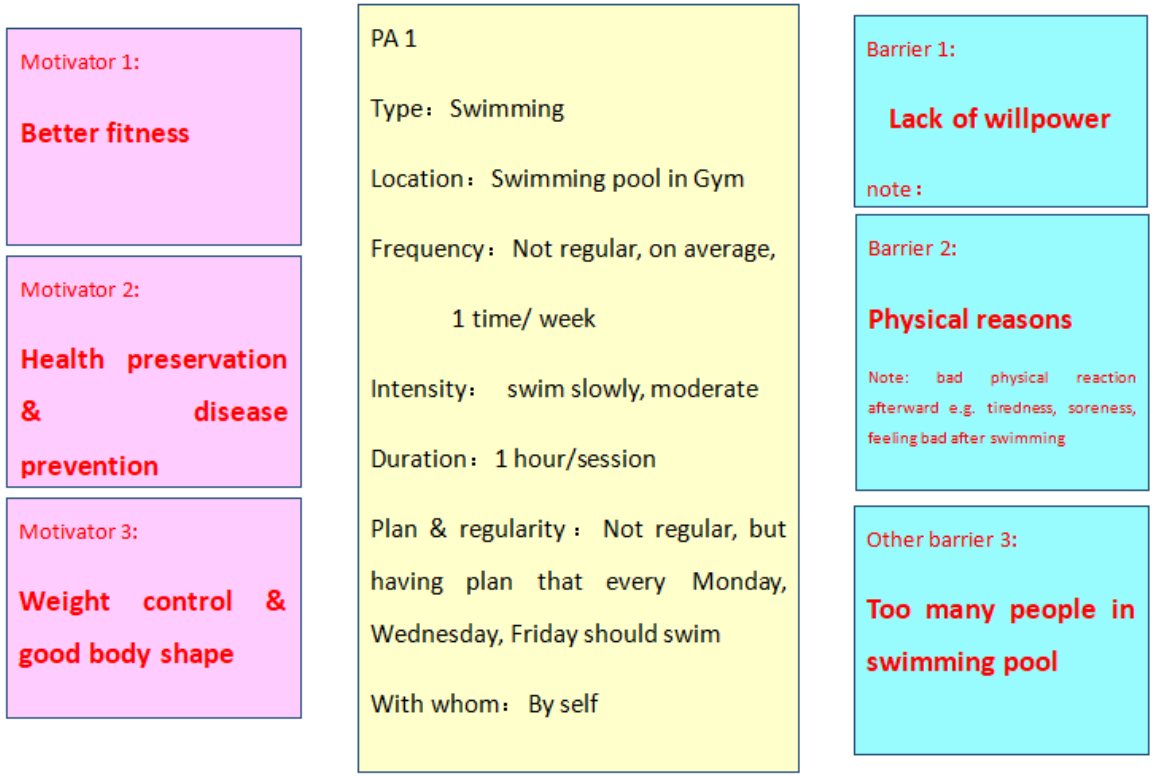
In terms of barriers, he attributed his irregular exercise to lack of willpower, physical discomfort, and the bad environment of the exercise location. He mainly self-criticized his lack of willpower to adhere to his exercise plan. When mentioning the physical barriers, he added that he was always suffering from physical discomfort such as muscle soreness and tiredness, which made him feel negative about exercise. He also pointed out that he did not enjoy swimming in the particularly hot summer when the pool is crowded and more likely to be contaminated.

This fluctuator had two long lapses. The first lasted about two months. He thought the main reason for this lapse was the external reason that the pool was too crowded. The second lapse lasted about one month and was due to exam preparation and a perceived lack of time for swimming.

To summarize, this interviewee typifies a group of fluctuators who might be not mentally ready for PA participation. These fluctuators are motivated by

health-enhancing reasons (e.g., better fitness, weight control), but they do not enjoy PA. Their PA plans are easily affected by external unfavorable circumstances. As a result, they are very susceptible to long PA lapses.

Serial number: SJZ 1



Interruption / Lapse	Yes/No: Yes		Times: 2		
	Lapse 1: How long: 2 months		Lapse 2: How long: 1 month		
	Reason 1 (External): Too many people in swimming pool		Reason 1 (External): Exampreparation		
	Reason 2: (Internal): Feeling disgusted when swimming		Reason 2:		
	Note:		Note:		
Age	Gender	Job	Working hours	Marriage & Children	Living status
27	Male	Teacher	8	Not married	Living with family members

Figure 4.3. Representation of exemplar of the Type I fluctuator

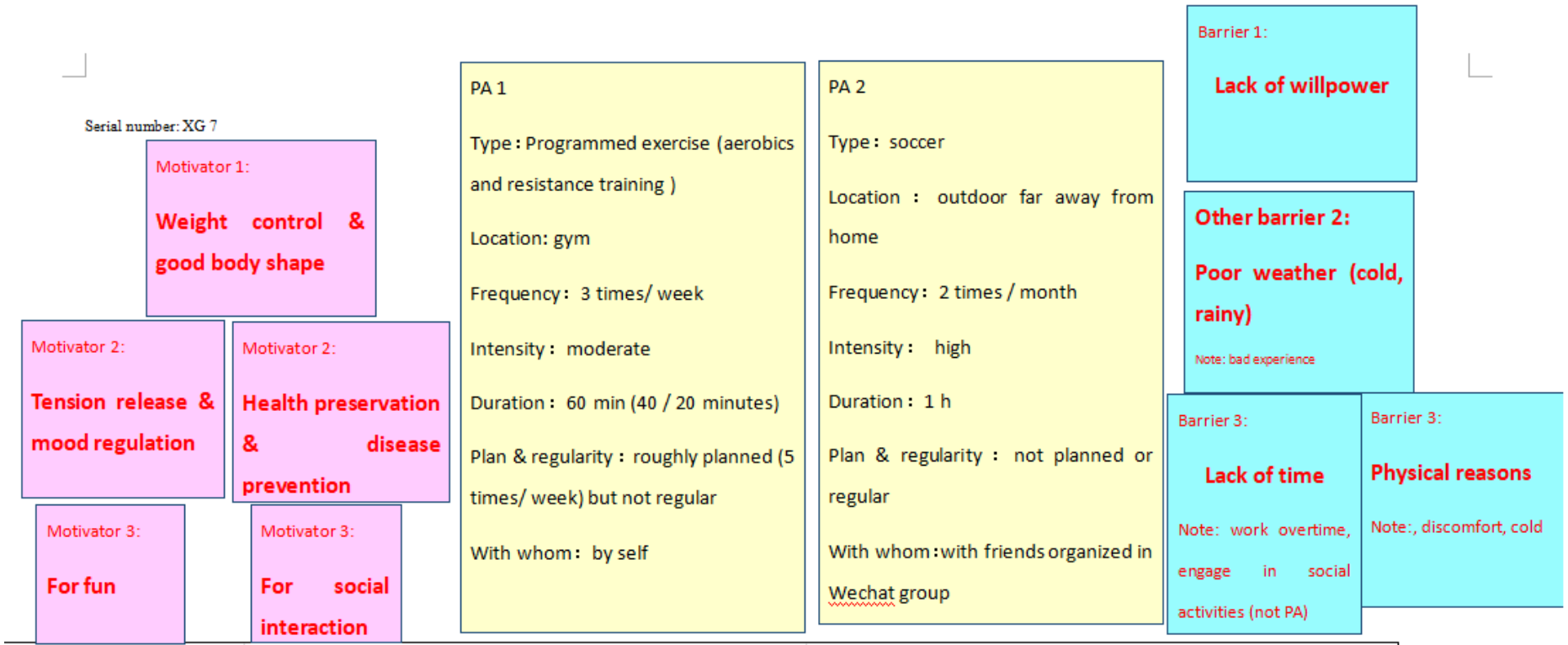
- Individual case representation of Type II fluctuator

The exemplary model of the Type II fluctuator is displayed in the Figure 4.4. This fluctuator was a 31-year-old male married public servant who worked nine hours a day. In terms of his PA motivators, despite the suggestion to select only one to three motivators for the PA behavior, he insisted on choosing five of the seven motivators because he thought he was truly motivated by all five reasons. All his selected motivators included physical-related motivators (weight control, health preservation, and disease prevention), and social (social interaction) and emotional-related motivators (fun, tension release, and mood regulation).

Motivated by the above reasons, he engaged in both programmed exercise and soccer in his leisure time. For the programmed exercise, he roughly planned five sessions per week, but this was just in ideal situations. He did not make a specific plan in terms of the precise activity or day of the week. He reported that he could only perform his physical training three times per week on average. He was quite knowledgeable about fitness training and separated his exercise into two main parts, aerobic training and resistance training. A typical session lasted for about one hour at moderate intensity: 40 minutes for aerobic exercise and 20 minutes for the resistance training. In addition to the programmed exercise, he also occasionally (on average once every two weeks, not regularly) played soccer with his friends for about one hour. The play was organized in the WeChat interest group (a social network that connects people with similar interests).

However, he said that in his daily life, he was confronted with both internal (lack of willpower, physical discomfort, and disease) and external (poor weather and lack of time) barriers. During the last six months, he committed two short lapses lasting about 7-10 days. He explained that the reasons for the first lapse were due to a business trip and bad weather conditions. During the business trip, he thought he would compensate by doing some calisthenics, but did not. The other lapse was caused by a physical reason, catching a cold, which caused physical discomfort and interrupted his exercise routine.

To sum up, this individual represents a group of fluctuators who are relatively well-prepared mentally but encounter unfavorable circumstances for PA. They are somewhat knowledgeable about exercise, PA and body training, sufficiently motivated, and willing to do PA under favorable conditions. They are on the way to PA maintenance. However, they do not have a concrete plan or strong willpower to support regular implementation. Thus, when faced with various obstacles in life, they struggle to sustain regular PA.



Interruption / Lapse	Yes/No: Yes	Times: 2
	Lapse 1: 7-10 days	Lapse 2: 7-10 days
	Reason 1 : business trip + bad weather	Reason 1 : physical discomfort (catching a cold)
	Reason 2: lazy	Reason 2:
	Note: have a thought of compensation by doing calisthenics	Note:

Age	Gender	Job	Working hours	Marriage & Children	Living status
31	male	Public servant	9 hours	Married no kid	Living alone

Figure 4.4. Representation of exemplar of the Type II fluctuator

- Individual case representation of Type Ⅲ fluctuator

The exemplar of the Type III fluctuator is demonstrated in the Figure 4.5. This individual was a 30-year-old female public servant. In addition to the normal seven-hour day working in an office, she needed to take care of a 1.5-year old baby after work and during weekends. Her PA motivators were improving fitness, releasing tension, and having fun. She also identified the relationships between the motivators of "fun" and "mood regulation and tension release," which might indicate that she experienced positive feelings by doing PA.

In line with her motivators, she engaged in brisk walking and hiking. For the brisk walking, she had a rough plan to walk instead of driving the car from her home to the office each working day. In reality, she performed brisk walking as her commuting activity very irregularly: the frequency ranged from 1 to 5 times per week. For the other PA, she went hiking 2-3 times per month by herself without any plan.

She considered lack of time as her main barrier to irregular PA participation. Her lack of time was mainly due to childcare needs. Another barrier she indicated was lack of facilities. She thought that she would be more active if she could more easily access to exercise facilities. During the previous 6 months, she had committed one long lapse for 6 weeks. Her reasons for this lapse were childcare demands and overwork.

Overall, this individual illustrates how critical life evens such as giving birth and parenting can greatly affect one's normal PA behavior, at least for a relatively short period (i.e., six months). For this sufficiently motivated woman, childcare demands inevitably meant that her PA engagement would be reduced.

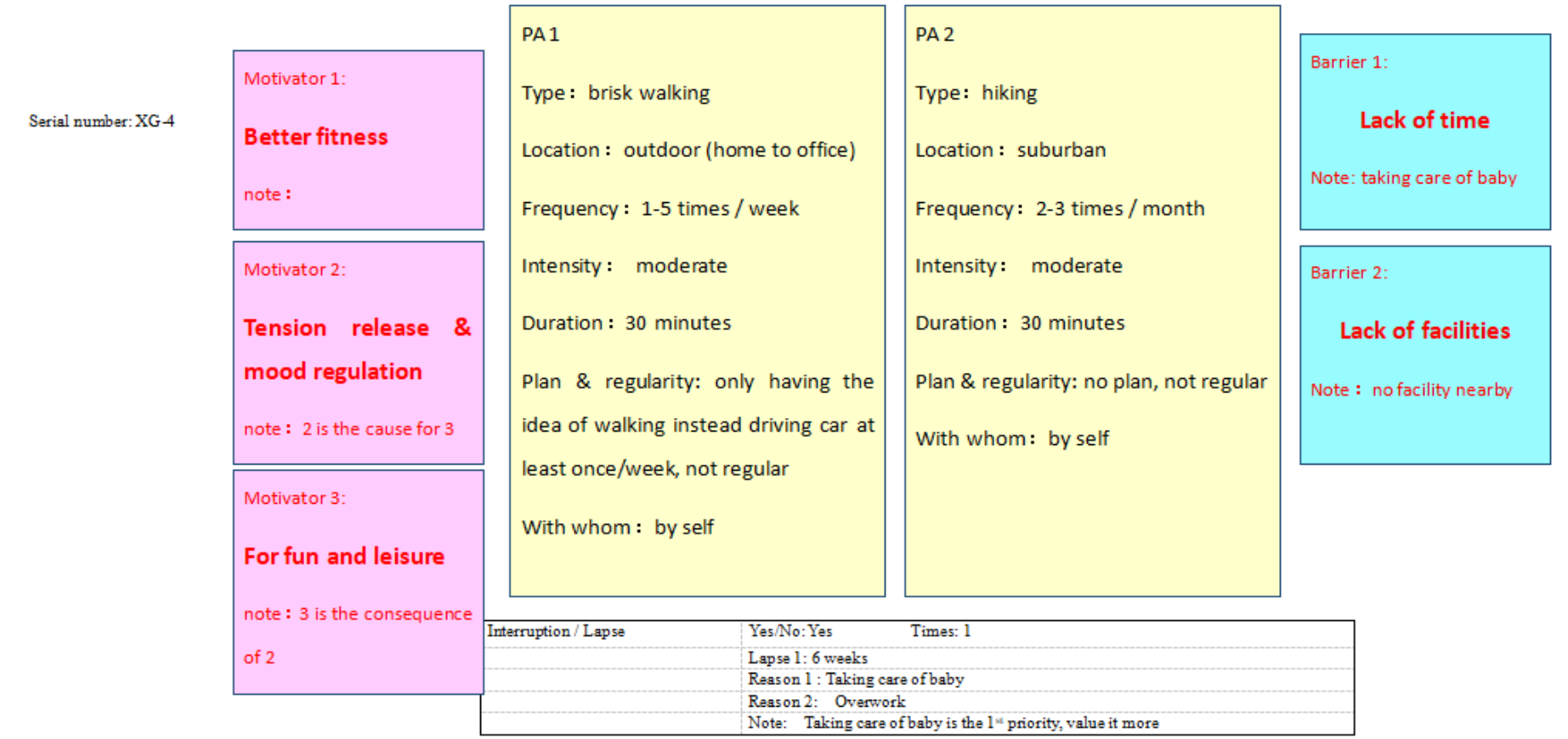


Figure 4.5. Representation of exemplar of the Type III fluctuator

- Individual case representation of fluctuator 1 in the type of miscellany

This individual case is outlined in Figure 4.6. She was a 56-year-old female security employee who had previously suffered from physical diseases and poor fitness levels. However, only judging by her interview and her individual structure, she was the most active fluctuator of all the interviewees. She developed a thorough and concrete PA plan for herself and generally adhered to the plan.

She noted that she was very emotionally motivated to do exercise. She experienced pleasure and fun by doing exercise. By doing it, she recovered from the disease, improved her fitness level, and felt younger both physically and mentally. She even wanted to add an additional sport (table tennis) to her daily routine. However, due to a lack of facilities, she could not do so.

From her verbal report, she was not a perfect maintainer, only due to some external reasons. First, because her routine exercise was only outdoors, bad weather sometimes prevent her regularly doing exercise. She reported two lapses during the previous six months, both because she needed to care for her elderly mother.

To these so-called fluctuators (to some extent, they are almost maintainers) with sufficient motivation and clear plan, only special cases such as family members' illness alter their plans. For these fluctuators (and maintainers), PA is hindered more by the external environment than psychological or mental attributes.

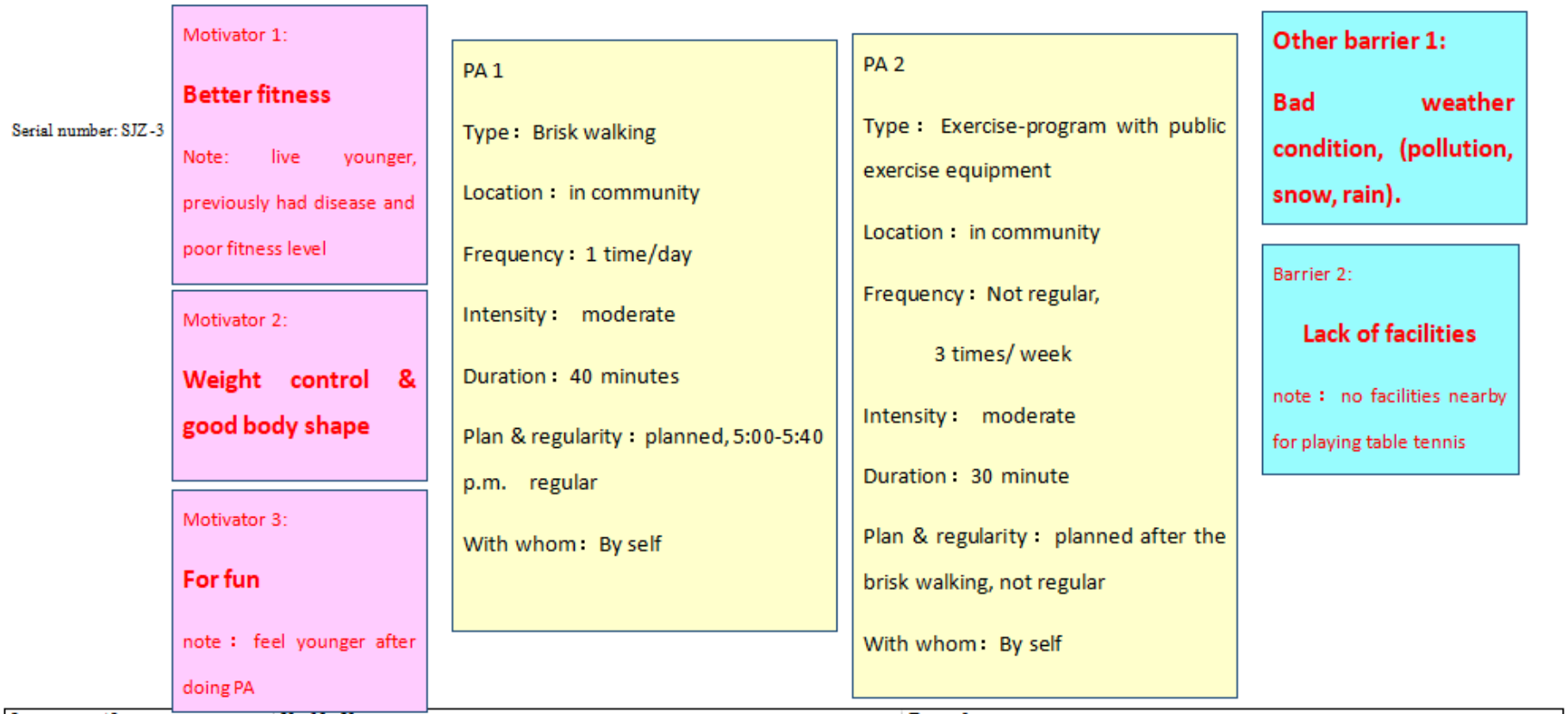


Figure 4.6. Representation of exemplar of fluctuator 1 in the type of miscellany

- Individual case representation of fluctuator 2 in the type of miscellany

The individual structure of this individual case is demonstrated in Figure 4.7. He was a 36-year-old married IT employee. This interviewee was primarily physically motivated with the intention to control weight and prevent disease. Fun was a secondary motivator to participate in PA.

The only PA he engaged in daily life was table tennis. Each normal weekday he played table tennis with his colleague for 20 minutes at a moderate intensity level. He made detailed plans for the activity and it had become a ritual. However, his overall PA amount (100 minutes/week) did not meet the WHO suggested minimum (150 minutes of moderate PA per week).

In terms of PA barriers, he stressed that he did not integrate more PA into his life because he was lazy and lacked willpower. He had thought to participate in additional exercise or sports other than table tennis but did not do so. He also stated that when his table tennis partner was absent, he could not play by himself or change to other kinds of sports or exercises. His PA participation was reliant on the participation of others.

During the previous six months he had lapsed two times. The first lapse lasted for 2 weeks and was due to his partner's personal reasons. The second lapse lasted for about one week during the spring festival. During the national spring festival holidays, the table tennis room at his work site closed. He also took this opportunity to visit his relatives and have family gatherings. Thus, his table tennis was postponed during that period.

To sum up, this fluctuator represented a group of people who do PA somewhat regularly but not sufficiently. They might have detailed plans and almost perfectly adhere to this plan for exercise or sports. In this regard, as a special case this interviewee might represent people who mis-identified themselves in the questionnaire survey in the previous quantitative study. Meanwhile, this interviewee also shares similarities with other fluctuators such as physical motivation, occasional lapses, lack of willpower, and lack of self-reliance in PA.

Serial: HZ-4

Motivator 1:

Weight control & good body shape

Motivator 2:

Health preservation & disease prevention

Motivator 3:

For fun

PA 1

Type：Table tennis

Location：Fitness center in company

Frequency：3 times - 5 times /week

Intensity：moderate

Duration：20 minutes

Plan & regularity： clearly planned, every weekday, 5 times/ week, after work for 30 minutes' playing

With whom ： with fixed partner (colleague)

Barrier 1:

Lack of willpower

Note: too lazy to do more PA other than table tennis.

Barrier 2:

Lack of social support or organization.

Note: cannot do without other's support.

Interruption / Lapse	Yes/No: Yes	Times: 2
	Lapse 1: about 2 weeks	Lapse 2: How long: 1 week
	Reason 1 (External): Without Partner, partner's wife is about to giving birth	Reason 1 (External): spring festival (visiting relatives)
	Reason 2:	Reason 2: the table tennis room is closed during the weekends and holidays.

Age	Gender	Job	Working hours	Marriage & Children	Living status
36	male	Information technology staff	8 hours	Married and has children	Living with family

Figure 4.7. Representation of exemplar of fluctuator 2 in the type of miscellany

4.5 Discussion

To the best of the author's knowledge, this study is the first to specifically explore fluctuators' ST with regard to their PA behavior, motivator, barriers, and lapses. Using the RPST, fluctuators' verbal data from the interviews were converted into graphical representations. The fluctuators were then classified into three representative types and each type was described with an exemplar. All of the findings from this study enrich our understandings of PA fluctuation.

Like the discussion of the previous quantitative study in Chapter III, this discussion section summarizes the findings from the current study, makes interpretations, and discusses their implications. A general discussion of limitations and recommendations for the future research and a comparison of the results between the qualitative and quantitative studies are provided in the next chapter.

PA motivators

According to the findings from this study, the common motivator in fluctuators' ST can be differentiated into two main types: 1) physically-related motivators, including health preservation and disease prevention, weight control, and better fitness, and 2) emotionally related motivators, including fun, tension release, and mood regulation. Of these two types of motivators, being physically motivated is a predominant characteristic of fluctuators. Nearly three quarters of fluctuators in the study sample reported at least one of the aforementioned physically related motivators as their main PA motivator, and more than half reported both the most and second most significant motivators as physically related.

In the previous national surveillance on Chinese adults' PA behavior (N = 81828), 51.8% of the surveyed adults selected the aforementioned 3 physically-related motivators as their primary PA motivator, while 26.0% of the surveyed adults chose the aforementioned 2 emotionally related motivators as their primary PA motivator (General Administration of Sport of China, 2015). According to the present thesis, fluctuators are more physically motivated than normal adults.

Several tentative reasons are proposed to explain why compared with ordinary adults; fluctuators are more likely to be motivated by physical rather than emotional reasons.

1) Fluctuators might be more bothered by diseases or physical discomfort. According to the results in the current study, 19 fluctuators indicated that they were or had been suffering from physical diseases, discomfort, or were overweight. They might consider PA to be an instrument to improve their poor physical status rather than a source of relaxation and fun.

2) Although more than half of interviewed fluctuators stated that they were motivated by physically related expectations, these findings might only indicate that they have superficial knowledge about the benefits of regular PA engagement. In recent years, there has been an increasing amount of publicity in social and public media in China to advocate the benefits of physical exercise (Chen, 2015; He, 2009). In this study, the interviewed fluctuators are mostly office-based employees with high education levels. They can easily access information about the benefits by PA from various channels. We can speculate then when asked for the PA motivators, they might refer to the physical benefits due to social desirability[6] (Van de Mortel, 2008) and availability heuristic[7] (Schwarz et al., 1991). However, these physical benefits might only stay at the knowledge or motivational level and might not necessarily be converted into a more robust experiential level (e.g., "by doing PA, I really feel that my fitness level has been improved and my weight regulated").

3) Negative emotion or feeling during or after PA implementation. Simply speaking, a majority of fluctuators in current interview may not feel good during and after exercise. They are not able to savor fun, pleasure, or release of tension by doing PA. In contrast, more of tiredness, discomfort and stress they experienced. It has been repetitively showed that negative experiences (e.g., tiredness, discomfort, stress) are

[6] Social desirability is the tendency of some respondents to provide an answer that is more "socially acceptable" than their "true" answer (Van de Mortel, 2008).

[7] The availability heuristic is a mental shortcut that relies on immediate examples that come to a given person's mind when evaluating a specific topic, concept, method, or decision (Schwarz et al., 1991).

associated with PA or exercise interruption (Backhouse, Ekkekakis, Biddle, Foskett, & Williams, 2007; Stults-Kolehmainen & Sinha, 2014).

PA barriers

Fluctuators face common barriers such as lack of time, lack of willpower, lack of social support and physical reasons (discomfort, injuries, or diseases). Lack of time is the most frequently cited barrier among fluctuators. 80% of the interviewed fluctuators considered lack of time as a barrier to being active, and half regarded it as their biggest barrier. Similar findings have been found for populations other than fluctuators in the national surveillance in China (General Administration of Sport of China, 2015), large sample surveys in countries in the European Union (Eurobarometer, 2014), interview studies (Mathews, Lakshmi, Ravindran, Pratt, & Thankappan, 2016; Wahlich et al., 2017), and systematic reviews (Kelly et al., 2016).

There are some underlying reasons why lack of time is a recurring barrier among adults. First, some researchers have argued that "lack of time" is a very broad notion and could serve as a pretext to hide their real barriers to being physically active (Kelly et al., 2016). Because time can be regarded as scarce resource, every daily life event such as work demands, childcare, and family responsibilities consumes time to a certain degree and might give rise to a perception of lack of time. In this study, when they were asked to explain why they lapsed, some fluctuators provided specific reasons for the lack of time (e.g., overwork, taking care of family members).

Second, rather than being regarded as a real barrier, lack of time is often considered an excuse for not being sufficiently motivated or not setting PA as a priority (Adachi-Mejia et al., 2010; Edmunds, Hurst, & Harvey, 2013; Graham, Dugdill, & Cable, 2005; Strazdins et al., 2010). Most often in daily life, fluctuators' lack of time or time constraints for implementing PA are simply related to priority setting and assessment. It has been argued that human beings in real-life contexts tend to prioritize engagements in urgent and pleasurable events (Cyders & Smith, 2008). It seems that doing PA in their leisure time is neither pleasurable nor urgent for fluctuators. Thus, fluctuators might instead choose to spend their leisure time on

things that are more pleasurable and urgent to them, such as playing video games, taking care of their family members and doing extra work to meet deadlines. In such cases, it is understandable that fluctuators set a low priority for PA and perceive that they do not have enough time to do it.

Third, a lack of time may reflect some fluctuators' negative experience sand time distortions in doing PA. It has been suggested that time perception is inseparable from emotions. Time can appear shorter during pleasurable events and can appear longer during boring chores (Droit-Volet & Meck, 2007; Droit-Volet & Gil, 2009). It might be hypothesized that some fluctuators' inability to derive joy and pleasure from PA leads them to perceive that PA participation requires large amounts of time. In retrospect, when they recall the time and experience in PA engagement, they might consider it an unpleasant and time-consuming event.

Lack of willpower is also a commonly reported barrier. Over half of the interviewed fluctuators selected it as one of their PA barriers and seven fluctuators selected it as the main PA barrier. These findings partially support Fuchs' (1999) original assumption on fluctuators' limited self-control and self-regulation regarding PA behavior. It has been summarized that coping with stress, regulating negative effects, and resisting temptation requires self-regulation (Muraven & Baumeister, 2000). According to this theoretical proposition, fluctuators' lack of willpower are related to stress in daily life events (stress from family and work), regulating the negative affect (during PA participation and outside PA participation), and resisting the temptations of sedentary leisure activities. Under favorable circumstances (low stress level, good mood, no temptation of sedentary leisure activities) requiring no self-regulatory resources, fluctuators might at times perform PA for a period of time. However, in unfavorable circumstances, and as soon as their self-control resources are depleted to a certain level, they easily substitute PA behavior for other behaviors that bring them immediate pleasure and comfort.

Another frequently reported barrier among fluctuators is lack of social support. The results from the current interview showed that only four fluctuators participate in

their PA behaviors alone. Fluctuators seem to have an inability to regularly participate PA behaviors by themselves. The interview questions regarding PA organization revealed that fluctuators are not likely to be initiators of sport or exercise activities. In most cases, they are passive participants. They need someone to lead or supervise them to engage in PA behaviors. If there is no leader or initiator, they might be in danger of a short lapse or a full-blown lapse. From the motivational perspective, fluctuators' aforementioned passive PA participation mode corresponds well to the behavioral pattern shown in people with introjected regulation in self-determination theory (Deci & Ryan, 2000; Ingledew & Markland, 2008). Specifically, PA participation of both fluctuators and people with introjected regulation are highly dependent on external sources such as others' initiation, supervision, and appreciation.

PA behavior and lapse

This study showed that half of the interviewed fluctuators were on average moderately active, and the other half were inactive. The 30 interviewed fluctuators' average weekly PA energy expenditure was a slightly above the threshold for moderately active (≥ 600 MET-minutes). Such findings are consistent with several previous studies that measured fluctuators' PA behavior using questionnaire surveys (Duan et al., 2013, 2015, 2016; Strobl et al., 2016) and pedometers (Conroy et al., 2007), which all showed that fluctuators are generally active rather than inactive.

Although fluctuators on average were physically active, great individual differences in their PA level were revealed. Their weekly energy expenditure ranged from almost no PA (80 MET-minutes) to more than 4 times as much as the moderately active criteria (2520 MET-minutes). This finding somewhat supports the previous hypothesis that fluctuators could be a group of people with heterogeneous PA behavior performance (Shang et al., 2018).

The current study revealed that exercise is main form of fluctuators' PA participation, and contributes to more than half of their PA behavior. In contrast, in their daily lives fluctuators do not engage in many sport activities. Fluctuators are mostly motivated by health-enhancing reasons (better fitness, disease prevention and

health preservation, weight control), so it fits that fluctuators participated in more exercise to pursue health-enhancing aims rather than for fun and competition (Caspersen, Powell, & Christenson, 1985; Loy, 1968).

Moreover, this study found that fluctuators' PA behavior appeared to be intermittent, with an average lapse lasting for about 18 days per each. More than half of the fluctuators (53.6%) accumulated more than 4 weeks of lapse. Studies of habit formation and relapse prevention have suggested that lapses can greatly disrupt habit formation of health behavior and can further lead to full-blown relapse (Armitage, 2005; Larimer et al., 1999). Therefore, in future PA interventions for fluctuators, attention should not merely be paid to fluctuators' overall PA level. It is also necessary to reduce the incidence of lapses and reduce their duration.

Regarding specific reasons for lapses, fluctuators tend to cite more external reasons (on holiday, on a trip, overwork) for their lapses. This tendency to use external reasons (excuses) to avoid regular PA has been indicated in previous literature (Cohen, 2003). This study confirms the previous evidence by showing that fluctuators provided nearly twice the amount of external reasons as internal ones for lapses.

The top three frequently cited reasons for lapse were "on holiday," "on trip," and "overwork" (working overtime). Holidays are the perfect time for Chinese adults to socialize, build Guanxi (social networks and relationships), and have family gatherings (Jim & Chen, 2009). Thus fluctuators' intended PA behaviors, especially when they are not clearly planned or not habitualized, are more likely to be postponed during holiday vacations (e.g., Spring Festival, National Day holidays).

For the second frequently cited contextual reasons for lapse, "being on trip" may bring about a series of environmental changes such as being away from the familiar PA locations and PA partners (Davis et al., 2011). The findings in the current study showed some fluctuators were very vulnerable to the trip-induced environmental changes and in the meantime stop engaging in any PA behaviors.

As to the third frequently cited reasons for lapse, working overtime may reduce their amount of disposable leisure time for intended physical activities. Previous studies revealed that busy work schedule and working overtime is an important factor contributing to exercise lapse (Conroy et al., 2007; Strazdins & Loughrey, 2008). However, some other anecdotal evidence also suggested that managers with high working load and prolonged working hours still were able to regularly perform PA behaviors by their time management skills and perfect execution (Roche, 2016; Wadhwa, 2016). Many of the senior managers regard sport and exercise as refreshment for their arduous work. Therefore, working overtime does not necessarily lead to reduced or fluctuating PA. The relationship between overworking and PA as well as the underlying mechanism involving mediation and moderation in between the relationships are worthwhile to be discovered.

In addition to the three contextual reasons for lapse (on holiday, working overtime, and being on trip), the other two frequently cited internal reasons for lapse were 1) feeling tired and 2) laziness. Feeling tired is an emotional or affective response to energy-draining activities (e.g., overwork, business trips, social activity engagements). Reviews have shown that work-induced fatigue and stress are a major impediment to regular PA and exercise participation (Shang et al., 2018; Stults-Kolehmainen & Sinha, 2014). According to the attribution theory (Kelley & Michela, 1980), in this study laziness can be considered as an internal cause of lapse. Research based on relapse prevention models has suggested that the internal attribution style to the failure of a health behavior maintenance (i.e., attributing internal and uncontrollable factors to the failure) can result in prolonged lapse or relapse (Larimer et al., 1999). This interview study has not shown the connection between attribution style and fluctuators' lapse duration. For future research, such relationship deserves more investigation.

Behind fluctuators' manifest irregular PA participation, they may hold ambivalent attitude towards PA participation. According to the definition of attitudinal ambivalence (Thompson, Zanna, & Griffin, 1995), it is defined as a state in which an

individual “is inclined to give it [an attitude object] equivalently strong positive or negative evaluations”. Some fluctuators on the one hand expect that doing PA may bring them positive outcomes (e.g. health-enhancing effects, pleasure); and on the other hand they anticipate similar amount potential negative outcomes (e.g. tiredness, time consumption) as well. Such ambivalent attitude towards PA participation may be the fundamental cause for their fluctuating behavior.

PA plan

This study found that fluctuators are generally planless for their PA behaviors. Half of the interviewees did not set any plan for their own PA participation. Of the half who set plan for their PA behavior, only four formulated a detailed plan. Research has shown that planning is a critical indicator that distinguishes between PA fluctuators and maintainers (Duan et al., 2013, 2015; Strobl et al., 2016). Planning has also been repetitively applied in intervention studies to facilitate PA behavior change and has achieved desirable results (Lippke et al., 2010; Reinwand et al., 2016; Sniehotta, Scholz & Schwarzer, 2006). For fluctuators, a particular group of people who are somewhat motivated but face barriers, helping them to formulate effective if-then plans (i.e., coping plans) involving specific responses to deal with temptation and obstacles could be an effective strategy (Gollwitzer, 1999).

Superstructure and sub-group comparison

In addition to examining fluctuators’ motivators, barriers, and behavior performances, the present study also took a more holistic approach to reveal many underlying interrelationships in fluctuators’ BL, outlined in Figure of 4.2. First, for the motivator-associated relationships, it is interesting that no significant positive associations were found between the five motivators. Instead, four pairs of significant negative relationships were found: 1) “better fitness” and “for fun” (M1 and M2); 2) “better fitness” and “health preservation and disease prevention” (M1 and M3); 3) “health preservation & disease prevention” and “for fun” (M3 and M5); 4) “for fun” and “weight control and good body shape” (M4 and M5).

The reason why there found no positive but only negative associations between fluctuators' motivators can be explained by the following two reasons:

- First, these findings could be partly caused by the interview design. The interview guide recommended that interviewees identify one to three PA motivators. Therefore, once interviewees selected a motivator, the possibility of choosing the other motivators was reduced, and this might increase the chance of finding more negative associations between motivators.
- Second, these negative associations also reveal that in the majority of fluctuators' ST, their health-enhancing motivators (improving fitness level, keeping weight, preventing diseases) and motivators for being socially connected and having fun cannot co-exist simultaneously.

This study revealed the distinctions between two types (physically related versus emotionally/socially related) of motivators. In short, fluctuators' physically-related motivators (M1: better fitness, M5 weight control) were associated with negative outcomes (unclear plans and prolonged lapses of more than 4 weeks), whereas their emotionally-related motivators were not associated with negative or positive outcomes. Subsequently, a distinction can be made between Type I fluctuators (physically motivated) and Type II fluctuators (mixed motivated). Type II fluctuators on average perceived greater willpower to engage in PA behavior, committed shorter lapses, and expended more energy in PA.

It has long been argued by scholars and philosophers that most of human behaviors in daily life tend to be driven by the hedonic elements such as "pleasure" (Annas, 1987; Freud, 2015), and "affect heuristic" (mental shortcut that allows people to make decisions quickly and efficiently based on emotions such as fear, pleasure, surprise, Slovic, Finucane, Peters, & MacGregor, 2007). In the recent two decades, there has been some literature addressing on the difference between instrumental (benefit and utility) and affective (pleasure and enjoyment) motivators and outcome expectancies in PA research (Courneya, Conner & Rhodes, 2006; Lowe, Eves & Carroll, 2002; McEachan et al., 2016; Rhodes, Fiala & Conner, 2009). The findings

from two meta-analyses showed that affective expectancies were more strongly related to PA behavior than instrumental expectancies (McEachan et al., 2016; Rhodes et al., 2009). As shown in the present study, fluctuators merely motivated by long-term health-enhancing reasons were associated with unfavorable outcomes. Thus, there is a need for future interventions targeting fluctuators to increase fun and create the feeling-better experience, rather than only stressing the long-term health benefits brought by PA.

Finally, special attention should be paid to a group of triadic relationships (relationships between M5: weight control & good body shape, doing exercise, and lack of willpower) in the superstructure in Figure 4.2. This triadic relational group represents some fluctuators' mindsets and behavioral characteristics. First, fluctuators motivated by weight control intend to use exercise to achieve their appearance-related goals (weight control and good body shape). However, changing one's physical appearance is a very demanding process that requires physical exercise, a healthy diet, and regular rests (Donnelly et al., 2009). A substantial proportion of fluctuators do not possess effective self-control and self-regulation skills to successfully implement their PA intention and endure the unpleasant process. As a result, their goal of an improved physical appearance is beyond reach. When exercise behaviors are implemented irregularly and fluctuators witness no obvious improvement in their physical appearance, they might start to doubt their willpower. If things continue in this vicious circle, their mindsets and irregular engagement could deteriorate into a status of fluctuating physical exercise behaviors. This explains why some fluctuators motivated by the possibility to change their physical appearance ultimately abandon their plan for regular exercise.

CHAPTER V: DISCUSSION AND CONCLUSION

This chapter mainly serves to summarize the main findings concerning the questions posited in Chapter I, and to discuss the theoretical and practical implications, methodological merits and limitations, as well as recommendations for further research.

5.1 Summary

The present thesis applied an exploratory systematic review and a sequential mixed-methods study design to investigate a series of questions regarding PA fluctuation. In this section, all of the findings from the present thesis were summarized to respond to the research questions presented in Chapter I.

Question 1: What are the definitions, measurements and empirical findings regarding PA fluctuation as a behavioral pattern in previous literature?

This question was addressed by the exploratory systematic review in the section literature review. Firstly, results showed that the fluctuation was mostly defined as a PA pattern or stage during the behavior change from the perspective of stage theory (e.g., Fuchs, 1999; Duan et al., 2013). Common features of the conceptual definitions can be summarized as: behavioral irregularity, high risk of drop-out, intention to PA, low automaticity or low habit level, and limited self-regulation or willpower. Fluctuation can be primarily measured or identified via stage algorithms within various stage theories (e.g., Duan, 2006; Lippke & Ziegelmann, 2006). Besides, fluctuation can also be identified by detecting lapse and readoption (Conroy et al., 2007; Kinnafick et al., 2014), and prospective within-person variation in meeting PA guideline (Dishman et al., 2010a). Previous literature focused mostly on demonstrating the empirical difference between fluctuation and other PA patterns such as preparation and maintenance. It was shown that fluctuation was behaviorally and psychosocially distinct from those in PA preparation and those in PA maintenance. Variables such as perceived barriers, intrinsic motivation, body concept, self-efficacy, planning, and affective attitude are effective variables to distinguish fluctuation from other PA patterns.

Question 2: Can we find distinct sub-categories that best summarize the complexity of PA fluctuators based on psychosocial factors? If yes, what are the particular characteristics that distinguish these sub-categories of fluctuators?

This question was particularly addressed by the quantitative study in Chapter III. Two sub-categories were separated as "uncommitted fluctuator (UC)" and "moderately committed fluctuator (MC)". The MC group possessed a more active mindset than the UC group. The MC profile was also found to be associated with more PA energy expenditure, a normal weight range, and a medium managerial position. It should also be noted that identifying sub-categories was also addressed by the qualitative study in Chapter IV. By firstly coding and summarizing the responses directly from the fluctuators, the qualitative study divided fluctuators into three distinct sub-categories of fluctuators: Type I (physically motivated + low PA level), Type II (mixed motivated + moderate PA level), and Type III (mixed motivated + low PA level). And these three types of fluctuators mainly vary in motivator configuration and PA level.

Question 3: What are the fluctuators' PA-related behavioral features (e.g., PA type, frequency, how they organize and implement their PA, etc.)?

The PA-related features were mainly addressed in the qualitative study by the interview. In brief, four features can be summarized as: 1) irregular and planless PA participation; 2) generally physically active; 3) preference for doing exercise; 4) occasional but long lapse. Specifically, the majority of fluctuators do not formulate clear PA and thus might further lead to their irregular PA participation. The fluctuators' average PA level is in the category of moderately active. The fluctuators prefer doing exercise (e.g., running, gym-based exercise, etc.) more than sports and daily life PA. Fluctuators tend to commit occasional but long lapse with a lapse averagely lasting for about 18 days per each. More than half of the fluctuators reported lapse longer than four weeks.

Question 4: In daily life context, what causes fluctuators' irregular PA participation? What are the motivators and barriers to their irregular PA participation?

What are the relationships among fluctuators' PA-related behavior, motivators, and barriers?

These questions were addressed in the qualitative study. Fluctuators' irregular participation is a behavioral consequence related to both motivators (motivating them to be physically active) and barriers (impeding them to be active). The main motivators for fluctuators to be active are: health preservation and disease prevention, weight control, tension release and mood regulation, better fitness, and fun. The main barriers are: lack of time, lack of willpower, physical discomfort and diseases, and lack of social support. The motivators and barriers interact with each other and jointly contribute to fluctuators' irregular PA participation. The relationships among fluctuators' behavior, motivators and barriers are reflected in the Figure 4.2. Briefly, no positive but four pairs of negative associations were found among fluctuators' motivators (e.g., for fun and better fitness were negatively associated, etc.), which might further suggest their ambivalent attitudes toward PA participation. Besides, two physically-related motivators (better fitness and weight control) were found associated with adverse outcomes such as an unclear plan and long duration of lapse.

5.2 Synthesis of findings from quantitative and qualitative study

In the present thesis, a quantitative study and a qualitative study were sequentially conducted for systematic understandings of PA fluctuation. The main aim of the quantitative study is to categorize PA fluctuators into sub-categories based on the psychosocial indicators from previous literature. In addition, the PA energy expenditure was involved as a behavioral predictor in predicting the sub-category membership in the quantitative study. On the other hand, the main aim of the qualitative study is to deeply and comprehensively investigate the behavioral and psychosocial characteristics of PA fluctuators. In addition, based on the results of behavioral and psychosocial characteristics, all commonalities (superstructure formation) and differences (sub-category identification) among sub-category fluctuators are subsequently addressed.

In particular, the two studies are closely connected with each other in the following aspects:

1) Shared aims. Both of the two studies specifically target PA fluctuators and aim to explore their behavioral and psychosocial characteristics from different perspectives.

2) Shared participants. The prior quantitative study offered a participant pool for selecting the interviewees in the later qualitative study. The interviewees were all selected from the participants in the previous quantitative survey.

3) Identifying sub-categories: Both of the two studies attempted to classify fluctuators into different sub-categories, though the two studies differed in the methods of classification.

Since both quantitative and qualitative study addressed fluctuators' behavioral features and the identification of sub-categories, a brief synthesized discussion is deserved particularly regarding the findings from each study.

Findings regarding behavioral features

First of all, in terms of behavioral findings, the two studies corroborate with each other in finding that fluctuators are generally physically active. In the quantitative survey study, the results revealed that the average MVPA energy expenditure of the sampled fluctuators was above the standard of being physically active (Amireault & Godin, 2015). In the subsequent qualitative study by interview, the average MVPA energy expenditure calculated upon their verbal report fell into the category of moderately active according to the criteria from the IPAQ Research Committee (2005). Findings from both studies support previous research regarding fluctuators' PA energy expenditure (Duan et al., 2013, 2015; Strobl et al., 2016).

In addition, the qualitative study explored more detailed information regarding the behavior features of fluctuators. It was found that fluctuators' preference PA type is exercise (e.g., running, gym-based exercise, and cycling) rather than sports. Besides, information regarding PA lapse revealed that each fluctuator committed 1.6 lapses in the recent half a year with every lapse averagely lasting for 18.4 days.

Findings regarding categorization

In the present thesis, the findings of the quantitative survey identified two sub-categories of fluctuators (uncommitted and moderately committed) based on the score distribution of six psychosocial indicators. Whereas, the findings of the qualitative study found three types of fluctuators (Type I: physically motivated + low PA level; Type II: mixed motivated + moderate PA level; and Type III: mixed motivated + low PA level) based on the combination of motivator configuration and PA levels. If only considering the difference of motivator configuration, Type II and Type III can be merged together. Thus, two sub-categories of fluctuators emerged in the qualitative study including the physically motivated and mixed motivated. Thus, the two studies complement each other and jointly facilitate the understandings of the variability and heterogeneity in fluctuators' psychosocial profiles.

To further demonstrate the relationship between the categorizations in both studies, a two by two contingency table is presented (see Table 5.1). It can be found that the uncommitted fluctuators in the quantitative study are more likely to be physically motivated fluctuators than mixed motivated fluctuators in the qualitative study, and moderately committed fluctuators are more likely to be mixed motivated fluctuators than physically motivated fluctuators, Phi= .418, $p< .05$. (Table 5.1). These findings are consistent with previous research that affective motivators (e.g., for fun, etc.) were more strongly related to PA commitment than instrumental motivators (e.g., improving health, body appearance, etc.) (McEachan et al., 2016).

Table 5.1

Two by two contingency table by sub-categories from two studies

Sub-categories in quantitative study	Motivator configuration in qualitative study				
	Physically motivated	Mixed motivated	Total	*phi*	*p*
Uncommitted	9	6	15	.418	.033
Moderately committed	2	9	11		
Total	11	15	26		

5.3 Theoretical implications

Based on the findings from the present thesis, the author developed a tentative model to highlight the features of PA participation among fluctuators and to describe their behavioral change process. As shown in Figure 5.1, the model incorporates: 1) two types of fluctuators; 2) two common features (insufficient action control and medium level of barriers) of fluctuators; 3) affect as one main thread throughout the PA behavior change process; 4) and three intervention approaches (improving action control and affect, reduce barrier) facilitating the behavior change. The aforementioned aspects are introduced in detail as follows.

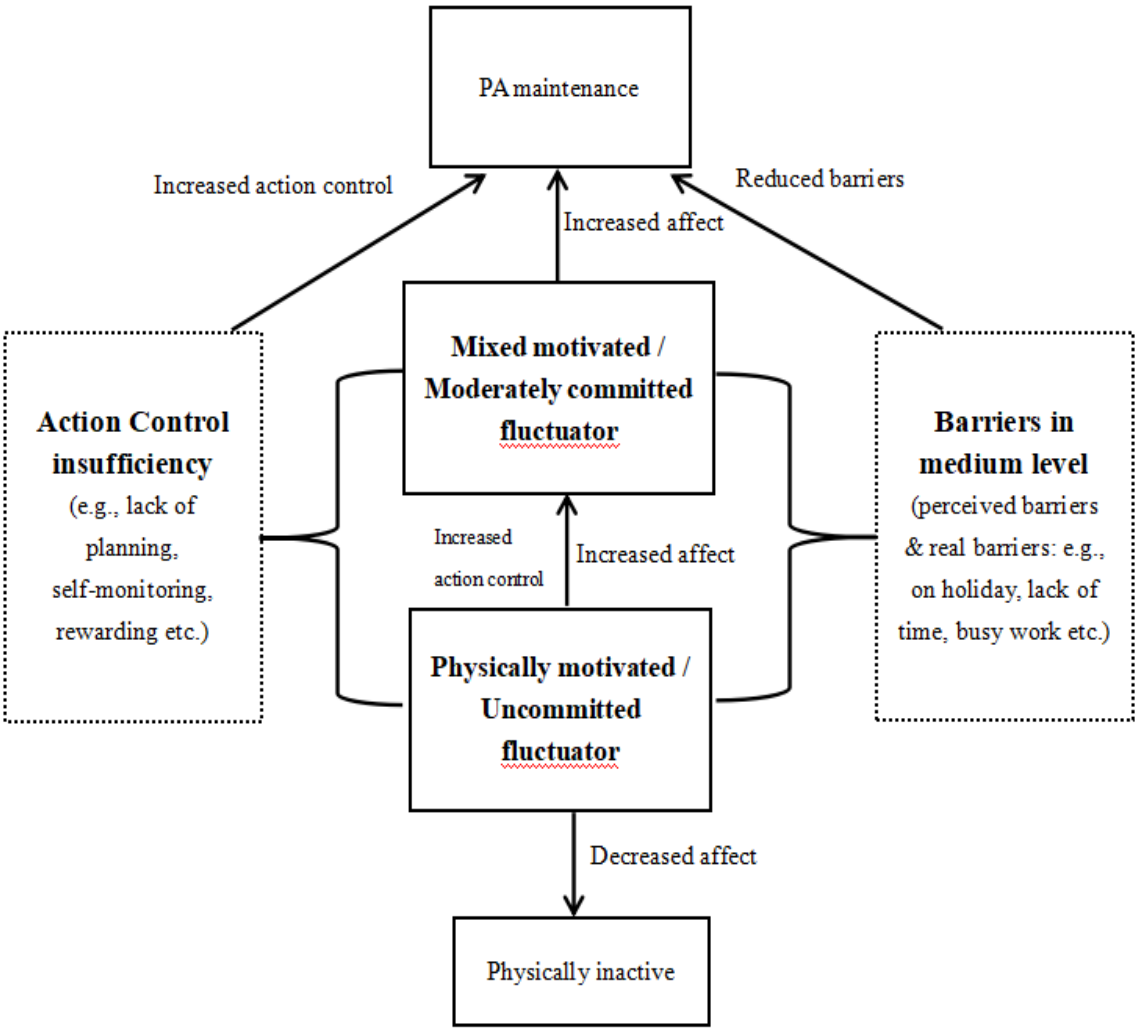


Figure 5.1. Tentative model highlighting the features of PA fluctuators

1) Two types of fluctuators

The two types of fluctuators (physically motivated/uncommitted, mixed motivated/moderately committed) are from the categorization of both quantitative study and qualitative study. The physically motivated/uncommitted fluctuators are those who mainly motivated by physically related reasons and show low level of commitment to PA participation. The mixed motivated/moderately committed fluctuators are those motivated by both physically related and emotionally related reasons and show moderate level of commitment to PA participation. These two main types of fluctuators (physically motivated and mixed motivated) are situated between people who are in PA maintenance and people who in physical inactivity.

2) Two main common features

Fluctuators, no matter in what types, are featured by insufficient action control and medium level of barriers. Fluctuators' insufficient action control was mainly reflected as "lack of willpower" (B4) and "lack of clear plan" in the findings of qualitative study. The medium level of barriers and are shown as a psychosocial feature for fluctuators in the quantitative study. Besides, all fluctuators in the qualitative study reported barriers to their PA participation.

For all fluctuators, doing PA is not naturally easy. Even though they embrace the intention to do PA, some real and perceived barriers impede the process of transforming the intention into real action. In order to make this transformation, action control is thus required. However, fluctuators' insufficient action control may not be effective enough to facilitate the intention of behavior. Thus, the two features of insufficient action control and medium level of barriers jointly contribute to fluctuators' irregular PA participation.

3) One main thread

Affect plays the critical role throughout the PA behavior change process. The construct of affect is from the affective attitude in the quantitative study, as well as from the motivators of "for fun" (M2) and "tension release and mood regulation" (M4) in the qualitative study. Within the framework, affect mainly refers to the extent to

which an individual subjectively experiences positive moods such as joy, interest, and relaxation (Miller, 2011).

The physically motivated fluctuators experience less affect than mixed motivated fluctuators. If affect decreases to a certain level, they would fall back to totally physically inactive. Since the mixed motivated fluctuators have accumulated a certain level of positive affect by previous PA participation, if they continue their PA participation and derive more affect from it, they are very likely to form a habit of doing regular PA.

4) Three intervention approaches facilitating PA behavior change

According to the tentative framework, to promote fluctuators' regular PA participation, theoretically, we should improve affect, reduce barriers and cultivate fluctuators' action control. The first two intervention approaches including affect improvement and barrier reduction can cater to individuals' spontaneity for easy and fun events. For fluctuators, it could be a natural and effortless way to change if the easy, fun and attractive PA programs can be designed.

On the other side, it is also critical to cultivate fluctuators' action control over their PA behavior, given that the PA is not easy and fun for them. Many of the PA fluctuators engage in exercise. In order to achieve the benefits of exercise (weight control, health benefits), fluctuators should at least regularly adhere for a prolonged period. During the process, a series of strategies involving goal-setting, planning, self-monitoring, reminding the standard, rewarding are critical to prolonging the period of adherence (Sniehotta et al., 2006; Shahin & Mahbod, 2007).

5.4 Practical implication

To the best of our knowledge, the present research is the first-ever exploration of the psychosocial and behavior features among PA fluctuators. The findings from the present thesis may bear implications for PA practitioners as well as for decision-makers in relevant organizations and policy-makers in the government.

The findings regarding categorization have important implications for developing tailored intervention programs for different sub-categories of fluctuators.

Practitioners should firstly distinguish between physically motivated fluctuators and mixed motivated fluctuators by asking their primary motivators. For physically motivated fluctuators, informing them of the psychological benefits of PA and helping them to experience the pleasure and joy during PA should be prioritized. After they substantially experience and value the pleasure derived from PA, they are more likely to shift to the mixed motivated fluctuators. Then a more comprehensive intervention improving their action control skills (e.g., action planning, coping planning, self-monitoring, etc.) is needed.

Besides, findings from the present thesis showed fluctuators' common barriers such as lack of time, lack of willpower, and physical discomfort or diseases. These findings highlight the needs of tailored intervention design from the aspect of improving time management skills (Boniwell & Zimbardo, 2004), building willpower (Oettingen et al., 2015), and preventing sport and exercise injuries (Van Mechelen et al., 1993).

The findings from the present thesis also suggest several calls for action for decision makers in relevant organizations and policy-makers in government. Given that lack of time, busy work schedule are the main reasons for irregular PA participation, it leaves the necessity for decision makers to consider the balance of work and PA for their employees. It would be meaningful for company's sustainable development to promote employees' regular PA participation. Hence, arranging mandatory "broadcast gymnastics" and organizing sports campaigns on a regular basis is suggested (Li, 2013). Besides, efficiency rather than working overtime should be emphasized.

Moreover, the findings showed a certain number of fluctuators are physically motivated. This implies that at least the previous propaganda of "exercise is medicine" and "exercise improves health" is preliminarily effective (Sallis, 2009). However, for the government, only informing folks about the health benefits of PA is not enough. In the future, combining health benefits and pleasant emotional experiences (e.g., informing the benefits of improving mental well-being, adding

affective elements in posters, Brown et al., 2012) may be a more effective way. Maybe, it would be more comprehensive and appealing to slightly adjust the popular slogan from its original version "Exercise is medicine" to "Exercise (or PA) is medicine, with delicious taste".

5.5 Reflection on research methodology and limitations

The present thesis is by nature exploratory due to the scarcity of the research topic. Prior to the present thesis, some fundamental issues regarding the definitions and measurements of PA fluctuation were not well addressed and synthesized and let alone sound theoretical frameworks to systematically explain this issue. Therefore, the present thesis started with an exploratory systematic review to synthesize definitions, measurements and empirical findings related to PA fluctuation from previous literature.

The exploratory systematic review is flexible in application, which may bear two-fold effects in its implementation. On the positive side, it allows researchers to aggregate and consolidate data in both qualitative and quantitative form to provide an overview of a specific topic (Henrie & D'Antonio, 2016) following relatively systematic procedures, which is particularly helpful for PA fluctuation - an emerging field or topic where consistent definitions and findings have not been reached. However, unlike standard systematic review or meta-analysis with a very rigorous protocol (e.g., PRISMA; Preferred Reporting Items for Systematic Reviews and Meta-Analyses; Moher et al., 2009), there has not been such official protocols to guide the implementation of exploratory systematic reviews. In the present review, literature search, article inclusion and exclusion were primarily based on the PRISMA. For the summary and syntheses of results (definitions, measurements, and empirical findings), there was inevitably some subjectivity during the procedures of results syntheses and presentation due to the heterogeneity of the articles (i.e., both qualitative and quantitative articles were included) and lacking protocols.

In addition to the aforementioned methodological limitations, three limitations in the review section also need to be noted. First, the risk of bias was not comprehensively assessed in the review. Due to the heterogeneity of the research type,

no suitable assessment tool is available to evaluate two commentary articles (Kahlert, 2015; Seymour et al., 2010) and one theory proposition article (Fuchs, 1999). Secondly, among the 15 eligible articles in the exploratory systematic review, three pertained to gray literature lacking peer review process (Cohen, 2003; Duan, 2006; Fuchs, 1999), which bears the potential risk of results contamination. Finally, despite our best efforts to conduct a thorough literature search, it may still have resulted in the omission of suitable or topic-related studies due to key terms not having been included, or articles in language other than English, or research outside the searching time span.

Based on the findings of the exploratory review, the author applied a mixed-methods approach (including quantitative survey and qualitative interview) to conduct empirical studies in order to explore the characteristics of PA fluctuation further. The mixed-methods paradigm bears a series of merits as 1) providing a holistic view of the research topic of PA fluctuation; 2) avoiding potentially misleading results caused by using a single method (Johnson et al., 2007); 3) offsetting the weaknesses inherent to using each approach (quantitative and qualitative) by itself (Greene, 2008).

Regarding the sequence of the two studies, the quantitative study was arranged prior to the qualitative study due to two main reasons. First, this sequence helped the data collection. The previous quantitative survey can provide a participant pool for the following qualitative survey. Secondly, the arrangement suits our study purpose. The exploratory nature of the present thesis favors the sequence of firstly taking a broad perspective exploring the sub-categories of PA fluctuators, and then deeply exploring their behavioral and psychosocial characteristics.

It should be noted that the design in the present thesis is less common to see in previous mixed-methods research (Camerino, Castañer, & Anguera, 2014), which might be a potential limitation of the thesis. Conventionally, a mixed-methods study design with quantitative study prior to the qualitative study (named “explanatory sequential design”) is believed to explain the results from the quantitative study by a

subsequent qualitative interview (Creswell & Clark, 2017). Yet, in the present thesis, the qualitative study not only serves to explain the results from the quantitative study but also further explore more detailed characteristics of PA fluctuators. Thus, the present thesis also leaves some debatable methodological issues regarding mixed-methods design such as the mixed-methods design including a quantitative study first must be by nature explanatory? Can the subsequent qualitative study bear more functions other than explanations of the results from the quantitative study? As mixed methods research is a relatively young field, more discussion and explication of these issues remain critical to advance mixed methods research methodology (Tashakkori & Creswell, 2007).

In terms of each empirical study, the quantitative study explored the complexity of PA fluctuator's psychosocial profile by questionnaire survey. The entire study first identified PA fluctuators among office-based employees and then classified them according to their psychosocial characteristics. Latent profile analysis (LPA) as a statistical method was employed to facilitate the classification. An advantage for using LPA is that there is no need to specify beforehand what constitutes a correct answer. It helps to reduce the subjectivity in the categorization to the utmost extent (Rijmen, 2011).

However, methodologically, the design of cross-sectional survey in the quantitative study bears some inherent limitations. First, it only takes a snapshot of a sample at a particular time, and thus longitudinal changes cannot be tracked. Therefore, the present survey did not focus on the dynamic development of PA behavior among fluctuators but aimed to investigate their relatively stable psychosocial profile at a one-time section. Secondly, results in questionnaire survey may be biased by social desirability and recall errors (Althubaiti, 2016).

Besides, the quantitative study was also limited in sampling strategy and inclusion of psychosocial indicators. The survey recruited participants by convenience sampling which may not lead to a representative sample for PA fluctuators, which might negatively influence the generalizability of this study among PA fluctuators.

Secondly, the questionnaire survey may not comprehensively include all the potential psychosocial indicators associated fluctuators' PA behavior. For example, some critical indicators such as intrinsic motivations and outcome expectancies were not included in the present survey (Duan et al., 2013; Strobl et al., 2016). Thirdly, fluctuators' PA behavior was not objectively measured by pedometer or accelerometer, which might cause low accuracy of the measurement. Future studies are recommended using stratified sampling and objective measurement and considering a broader inclusion of psychosocial indicators to improve study validity.

In terms of the qualitative study, by using the "Research Program Subjective Theories (RPST)" consisting of semi-structured interview and structure laying technique, fluctuators' verbal data concerning complex cognition toward PA participation were step by step converted into graphical representations. The semi-structured interview allowed the fluctuators to freely express their experiences and feelings regarding PA participation in their daily life, such greatly enhance the richness of the study. By using the structure laying technique, the structure of fluctuators' subjective theories can be visualized. All the psychosocial characteristics and the relationships between the psychosocial characteristics and their PA and lapse behavior provided insight into PA fluctuation.

A main characteristic of the present qualitative study is the quantification of qualitative data. Through procedures of coding, synthesizing, and statistical analyzing (correlation analyses and independent t-tests), commonalities and differences of fluctuators' subjective theories emerged. The quantification of qualitative data was commonly adopted in previous qualitative studies using RPST (Gastager, Patry & Wiedemair, 2010; Rita, 2011). The quantification allowed the numeric representation and manipulation of qualitative data for a more detailed description and explanation of PA fluctuation.

In addition, several specific approaches were adopted to ensure the reliability and validity of this qualitative study. Specifically, two researchers were involved in the coding and analytic process to enhance the inter-rater reliability. The confirmational

questions were asked in the interview to ensure the communicative validation. However, it should be particularly noted that, due to the practical issues (time constraints and unwillingness of participants' cooperation), the author adopted a simplified RPST design (Scheele, 1992) which combined the interview and the individual picture presentation in one phase. This might somewhat negatively affect the interpretative rigor. Another limitation of the qualitative study is lacking subsequent observational data or objective measures of real PA behavior as a falsifiable criterion to corroborate the explanatory validation (Groeben & Scheele, 2000). Thus, the mechanism of fluctuation was only revealed in a correlational way instead of a causal way.

5.6 Suggestions for future research

The investigation into fluctuation is in its infancy. This present thesis only provided preliminary findings regarding fluctuators' behavioral and psychosocial characteristics. To advance studies on PA fluctuation, the following suggestions are proposed for future research.

1. Objective fluctuation identification

Considering the fluctuation identification was highly subjective and retrospective, objective fluctuation identifications are suggested. A standardized identification for future research might go through the following procedures: 1) selecting a commonly accepted PA recommendation as a benchmark (e.g., 150 minutes MVPA per week, WHO, 2017); 2) assess individuals' PA behavior by using objective measures (e.g., pedometer, accelerometer); 3) tracking individuals' natural PA change over time (e.g., 12 weeks, Seelig & Fuchs, 2011); 4) setting cutoff point of adherence rate to demarcate fluctuators (e.g., the adherence rate between 25% and 75%, three to nine weeks out of 12 successfully meet the recommendation, Shang et al., 2018).

2. Theory development

The present thesis proposed a tentative descriptive model (see Figure 5.1) based on the key findings. However, this model cannot explicitly reveal the psychological mechanism of PA fluctuator's behavior change process. Future research is needed to

further develop a sound theory, including mediation and moderation variables of behavior change among PA fluctuators.

3. Investigating fluctuators' attributional style

The present thesis found that fluctuators tend to report life-induced reasons for PA lapse (e.g., working overtime, on trip, etc.). It might be interesting to further explore their attributional style and its linkage to the frequency and duration of their lapse behavior.

4. More prospective studies

Since PA fluctuation literally indicates PA variation as time proceeds, it is by nature a longitudinal concept related to the temporal constructs. Therefore, to elucidate the PA fluctuation feature, longitudinal designs tracking the natural changes of fluctuators' PA behavior and their changes in psychosocial variables should be prioritized. The advanced statistical methods such as latent growth curve modeling are recommended to estimate behavior changes and their related psychosocial variables over a certain period (examples elsewhere, Seelig & Fuchs, 2011; Stenling, Ivarsson, & Lindwall, 2017).

5. Intervention design

All in all, the ultimate purpose is to promote fluctuators to engage in PA as regularly as possible. Based on the findings from the current thesis, future interventions targeting fluctuators should aim to improve their affect, help developing action control skills and reduce barriers. Tailored intervention should also be designed for different sub-categories of fluctuators. For physically motivated fluctuators, implementing on-site interventions to help them substantially experience the pleasure and joy of PA should be a priority. For mixed motivated fluctuators, improving action control skills (e.g., goal setting, setting action and coping plan, self-monitoring and rewarding) should be incorporated in the intervention program (Rhodes & de Bruijn, 2013). Since PA lapses often occur among fluctuators, future intervention should also target on reducing the frequency and duration of lapses in order to prevent them from becoming full-blown relapse (Larimer et al., 1999).

5.7 Conclusion

The present thesis took a person-centered perspective and conducted a series of exploratory studies to summarize findings in previous literature, make further classifications, and investigate fluctuators' characteristics. Main characteristics found from the current thesis are: PA fluctuators are common in daily life context, they are planless, motivationally and behaviorally heterogeneous, limited in self-regulation, and impeded by unfavorable circumstances in doing PA. Since fluctuation study is in its infancy, the current thesis has provided an important opportunity to advance the knowledge development regarding the topic. Based on this thesis, it is expected that further investigation will focus more on this common but neglected PA phenomenon from various angles.

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APPENDICES

Appendix 1. Questionnaire package in Chapter III (English and Chinese version)

Questionnaire Package

Dear participants:

Thank you for attending this survey. The aim of this survey is to know about your physical activity behavior and psychosocial factors related to your physical activity behavior. Please read the items carefully and tick (√) the options which best describe you. There are no right or wrong in your answers, so please answer truthfully. You need about **6 minutes** to finish the survey.

This study guarantees the anonymity of participants. Your personal information and data in this survey will be kept strictly confidential and only the results of analyses will be reported for the purpose of academic research. The questionnaire will be destroyed or deleted within one year upon the completion of this study.

If you have questions or concerns about this study, please contact: Mr. Shang Borui, at Hong Kong Baptist University, QQ: 770567338; Email: 15484653@life.hkbu.edu.hk. Thank you!

Demographics

1. Age _____
2. Gender:
   - ●male
   - ●female
3. Height: _____ cm; Weight: _____ kg
4. Education level:
   - ●High school or below
   - ●Bachelor degree or equivalent
   - ●Postgraduate or above
5. Occupational type:
   - ●Marketing / Salesperson
   - ●Customer service
   - ●Logistics
   - ●Human resources
   - ●Financing / Auditing
   - ●Technology research or development
   - ●Teacher / Lecturer
   - ●Consulting
   - ●Civil servant
   - ●Lawyer / Judge
   - ●Others, please indicate_____

6. Job position:

- ●Senior manager or executive
- ●Middle-level manager or cadre
- ●Ordinary employee

7. How many hours do you stay in your office during a typical working day? ___hours

8. Please describe your race/ethnicity

- ●Han ethnicity
- ●Minority (please provide): _____

9. Do you have any diseases or mobility restrictions (e.g. poliomyelitis, epilepsy, and myocarditis) which may hinder you to engage in PA?

- ●Yes, please specify _____
- ●No

10. Marital status:

- ●Single
- ●Married

11. Please indicate if you have children

- ●Yes, please indicate how many _____
- ●No

Physical activity assessment & Fluctuation identification

"PA" is short physical activity, indicating the physical activities you participate in non-working time. It may include 3 levels of intensity:"high intensity" (sweat a lot, exhausted), "moderate intensity" (sweat some, a little breathless), "low intensity" (sweat little, heartbeat changes little). The examples of PA can be: brisk walking, hiking, housework (car washing, carry loads), cycling, jogging, swimming, playing ball games etc.

☆ In the questions of 12-15 asking you the PA you do in non-working time. (Only including **PA of HIGH AND MODERATE intensity**).

12. In a typical or usual month, on how many weeks per month on average do you accumulate PA (HIGH AND MODERATE intensity) at least 150 minutes?

- 0 week
- 1 week
- 2 weeks
- 3 weeks
- 4 weeks or every week

13. How easy is it for you to regularly engage PA (HIGH AND MODERATE intensity) at least 150 minutes per week?

- Very hard
- Somewhat hard

- Somewhat easy
- Very easy

14. To what degree has it become habitual for you to do PA (HIGH AND MODERATE intensity) at least 150 minutes per week?

- Totally not a habit
- Somewhat cannot be a habit
- Somewhat can be a habit
- Absolutely a habit

15. Please first carefully read the 6 following statements, choose the statement which best describes you (here "physically active" indicates doing moderate or high intensity PA for at least 150 minutes per week).

- I am not physically active, and I am not thinking about being physically active in the future
- I am not physically active, but I am thinking about being physically active soon.
- I am not physically active, but I am just making decisions and building up plans to start physical activity
- I am physically active every week, and have accumulated at least 150 minutes, but for less than twelve months
- I am physically active, but not regular every week, or have not accumulated at least 150 minutes every week
- Yes, I am physically active every week and have accumulated at least 150 minutes, and I have done this for twelve months or more

☆ The Question 16 asks you the frequencies of your PA at 3 different intensities (high, moderate, low) in a **typical week** in your leisure time (at least 15 minutes can be counted as one time).

16. a) PA of high intensity (sweat a lot, exhausted, e.g. running, basketball, football etc.)
0 time (none) ; 1 time; 2 times; 3 times; 4 times; 5 times; 6 times; 7 times or more

b) PA of moderate intensity (sweat some, a little breathless, e.g. brisk walking, housework etc.)
0 time (none) ; 1 time; 2 times; 3 times; 4 times; 5 times; 6 times; 7 times or more

c) PA of low intensity (sweat a little, breathe normally, e.g. walking, fishing etc.)
0 time (none) ; 1 time; 2 times; 3 times; 4 times; 5 times; 6 times; 7 times or more

Psychosocial Indicators of PA

17. Self-Efficacy

The following questions ask you how confident you can participate PA under unfavorable circumstances. I am confident I can participate in regular PA (150 minutes HIGH or MODERATE intensity per week) even when…

		Not at all true				Exactly true
1.	… I am tired.	❑1	❑2	❑3	❑4	❑5
2.	… I am in a bad mood.	❑1	❑2	❑3	❑4	❑5
3.	… I have much work to do.	❑1	❑2	❑3	❑4	❑5
4.	… No one accompany me doing PA.	❑1	❑2	❑3	❑4	❑5
5.	… The weather is not good.	❑1	❑2	❑3	❑4	❑5

18. Plan

The following questions ask how specific you have planned your PA behaviors. I have planned…

		Not at all true				Exactly true
1.	… which concrete physical activity I will pursue	❑1	❑2	❑3	❑4	❑5
2.	… where I will do physical activity	❑1	❑2	❑3	❑4	❑5
3.	… when I will do physical activity.	❑1	❑2	❑3	❑4	❑5
4.	… with whom I will do physical activity.	❑1	❑2	❑3	❑4	❑5
5.	… how often I will do physical activity.	❑1	❑2	❑3	❑4	❑5

19. Action Control

Please read through the following 6 statements, select the option which best describe you. Usually for my physical activity behavior, I have . . .

	Not at all true				Exactly true

1.	…constantly monitored myself whether I exercise frequently enough.	❑1	❑2	❑3	❑4
2.	…watched carefully that I trained for at least 30 minutes with the recommended unit.	❑1	❑2	❑3	❑4
3.	…had my exercise intention often on my mind.	❑1	❑2	❑3	❑4
4.	…always been aware of my prescribed training programme.	❑1	❑2	❑3	❑4
5.	…really tried to exercise regularly.	❑1	❑2	❑3	❑4
6.	…tried my best to act in accordance to the physical activity standards.	❑1	❑2	❑3	❑4

20. Affective Attitude

When I am thinking of participating in physical activity, I will feel…

		Not at all true						Exactly true
1.	pleased	❑1	❑2	❑3	❑4	❑5	❑6	❑7
2.	satisfied	❑1	❑2	❑3	❑4	❑5	❑6	❑7
3.	happy	❑1	❑2	❑3	❑4	❑5	❑6	❑7
4.	comfortable	❑1	❑2	❑3	❑4	❑5	❑6	❑7

21. Social support

The following questions ask you how much support you get from others for being physically active (at least 150 minutes moderate or high intensity PA per week).

		Not at all true				Exactly true
1.	My Partner (spouse or girl/boyfriend) helps me stay physically active.	❑1	❑2	❑3	❑4	❑5
2.	My family members (parents or children) help me stay physically active.	❑1	❑2	❑3	❑4	❑5

3. My colleagues and friends help me stay physically active.	❑1	❑2	❑3	❑4	❑5

22. Perceived barriers

These questions ask you to what degree the following situations keep you from doing physical activity.

	Never	Sometimes	Very often
1. Tight work schedule	❑1	❑2	❑3
2. Lack block of time	❑1	❑2	❑3
3. Lack of facilities	❑1	❑2	❑3
4. Inconvenience of transportation to the place I exercise	❑1	❑2	❑3
5. Bad weather	❑1	❑2	❑3
6. Too cold or hot temperature	❑1	❑2	❑3

Recruitment for the follow-up interview

There will be a follow-up face-to-face interview lasting about **15 minutes** on factors affecting physical activity behavior. Each eligible interviewee will receive **RMB 100** in cash for reward. If you are interested in joining us, please leave your contact information (you may leave any one of the following contacts) so that we can keep you informed. If you are not interested, please ignore this question.

Mobile phone number：_____;

QQ number_____ ;

Wechat number：_____;

Email：_____

This is the end of survey, thank you for your participation and support!

身体活动行为及其社会心理学影响因素调查

感谢您参与本项研究。本研究旨在了解您的身体活动行为及其社会心理学影响因素，请填写下面的问题并在符合您情况的选项上打勾√。答案并无正确与错误之分。您大概需要**六分钟**左右的时间 即可完成调查。

本研究采取匿名方式。您的一切信息都将只用于学术研究，研究结束后您的数据将会被销毁。如有任何疑问，请联系香港浸会大学社会科学学院博士研究生尚博睿先生，QQ 号：770567338，邮箱:15484653@life.hkbu.edu.hk 谢谢！

一、基本信息

1. 年龄_____岁
2. 性别： 男 女
3. 身高：_____ 厘米； 体重：_____公斤
4. 教育程度： 高中及以下； 大学或同等学历； 研究生及以上
5. 职业： 市场、销售； 客服； 后勤； 人力资源； 财务、审计； 技术研发 教师； 咨询顾问； 公务员； 律师、法官； 其他，请指出____
6. 职位： 高层管理人员； 中层管理人员； 普通员工
7. 您在上班期间，通常每日在办公室的工作时间是_____小时
8. 民族： 汉族； 少数民族，请指出 _____
9. 您是否患有妨碍身体活动或锻炼的慢性疾病 （如小儿麻痹症，癫痫，心肌炎等）？ 有，请指出 _____ ； 无
10. 婚姻状况: 单身 已婚
11. 请指出您是否有子女： 有，请指出几个 _____ ； 无

二、身体活动行为评价

“**身体活动**”是指您在上班时间之外参与的体力活动，包括“**高强度**”（大量流汗、气喘吁吁）、 “**中等强度**”（轻微流汗、气喘）、和“**低强度**”（几乎不流汗，心跳几乎不加快）三类。这些活动 可以是：健步走、爬山、一定强度的家务劳动（洗车、搬运重物）、骑自行车、慢跑、游泳、打球等。

☆ 下面12-15 题将询问您在闲暇时间里进行的**高强度和中等强度的身体活动。**

12. 通常情况下， 在一个月（4 周）内，您有几周能达到每周至少150 分钟的身体活动量（仅指中、 高强度）？

0 一周都没
1 只有一周
2 有两周达到
3 有三周达到
4 四周全能达到

13. 您认为坚持每周至少150 分钟的身体活动（仅指中、高强度）对您来说难度如何？

非常困难
比较困难
有点困难
一点都不难

14. 对您而言坚持每周至少150 分钟的身体活动（仅指中、高强度）是否已经是一种习惯？

完全不能算习惯
还不能称为习惯
某种程度而言算是
绝对可以称之为习惯

15. 请先仔细阅读以下六个陈述，选择最能代表您身体活动状况的选项。（本问题中**身体活动**指的是
每周至少150 分钟的中、高强度的身体活动）。

1. 我没在进行身体活动，也不打算接下去要参加身体活动。
2. 我没在进行身体活动，但我考虑接下去要参加身体活动。
3. 我没在进行身体活动，但我正决定要去参加并且正在制定身体活动计划。
4. 我最近有在进行身体活动，但并不是每周都参加也不是每周累计时间都达到至少150 分钟。
5. 我通常每周都会进行身体活动并且累计时间至少达到150 分钟，但此状况持续时间不到一年。
6. 我通常每周都进行超过150 分钟的身体活动并且这种情况已经超过一年。

☆ 下面第16 题询问您在通常情况下的一周里，您在闲暇时间进行不同强度的身体活动的运动频率。

16. a) 高强度身体活动（大量流汗、气喘吁吁；如跑步、篮球、足球等）
0 次(没做过); 1 次; 2 次; 3 次; 4 次; 5 次; 6 次; 7 次或以上
b) 中等强度身体活动 （轻微流汗，气喘；如快步走、 一定强度的家务劳动等）
0 次(没做过); 1 次; 2 次; 3 次; 4 次; 5 次; 6 次; 7 次或以上
c) 低强度身体活动 （几乎不流汗、不气喘；如散步、钓鱼、低强度家务劳动等）
0 次(没做过); 1 次; 2 次; 3 次; 4 次; 5 次; 6 次; 7 次或以上

三、 身体活动行为的心理特征调查

17. 下面问题是询问您面对困难情况下参与身体活动的自信程度。 我确信自己能够有规律的参加身 体活动，即使...

	非常不确定				非常确定
1. … 当我感觉很累时	1	2	3	4	5
2. … 当我感到沮丧时	1	2	3	4	5
3. … 当我还有很多工作要去做时	1	2	3	4	5
4. … 没有人和我一起参加身体活动时	1	2	3	4	5
5. … 天气不好时	1	2	3	4	5

18. 我在以下方面制定了详细的身体活动计划。包括...

	完全不符合				完全符合
1. ...进行哪些身体活动	1	2	3	4	5
2. ...何时进行身体活动	1	2	3	4	5
3. ...在哪里进行身体活动	1	2	3	4	5
4. ...和谁在一起进行身体活动	1	2	3	4	5
5. ...多久进行一次身体活动	1	2	3	4	5

19. 请您仔细阅读以下六个描述，选出符合自己实际情况的选项。

	非常不符合			完全符合
1. 我会时常检查自己是否经常做身体活动	1	2	3	4
2. 我会留意自己每次是否进行了至少30 分钟的身体活动	1	2	3	4
3. 我会经常有想去进行身体活动的想法	1	2	3	4
4. 我总是会想到自己制定的身体活动计划	1	2	3	4
5. 我确实有在尝试进行规律的身体活动	1	2	3	4
6. 我已经尽最大努力去完成自己定下的身体活动目 标	1	2	3	4

20. 下列问题是询问您对身体活动行为的情感态度。当我想到要进行身体活动的时候，就会感到：

	完全不符合						完全符合
1. 十分惬意	1	2	3	4	5	6	7
2. 十分满意	1	2	3	4	5	6	7
3. 十分快乐	1	2	3	4	5	6	7
4. 十分舒服	1	2	3	4	5	6	7

21. 下列问题询问您在身体活动方面得到怎样的支持。

	完全不符合				完全符合
1. 我的伴侣（如配偶或男/女朋友）帮助 我坚持身体活动	1	2	3	4	5
2. 我的家人(父母、子女)帮助我坚持身体活动	1	2	3	4	5
3. 我的同事及朋友帮助我坚持身体活	1	2	3	4	5

22. 下列情况在多大程度上阻碍了您参加身体活动？

	从不	有时	经常
1. 工作日程紧	1	2	3
2. 缺乏整段时间	1	2	3
3. 缺少设备	1	2	3
4. 到达锻炼地的交通不便	1	2	3
5. 天气不好	1	2	3
6. 天气太冷或太热	1	2	3

23. 本研究后续还将进行 **15 分钟左右**的有关身体活动行为影响因素的面对面访谈调查,每位符合条件 的受访者将获得 **100 元现金报酬**如果您有兴趣参加请留下您的联系方式 (选择以下其中一种即可)， 以方便我们联系您。如果您没有兴趣参加，请忽略此题。

手机号：_____ QQ 号：_____ 微信号：_____ 邮箱：_____

Appendix 2: Organizations for the survey study

Organization	Type
1. China Electronic Technology Group Corporation 54th Research Institute	State-owned enterprise
2. Dawu County Government	Government sector
3. Hangzhou Minsheng Pharmaceutical Co., Ltd.	Private enterprise
4. North China Geological Exploration Institute	State-owned enterprise
5. Tianjin University of Science and Technology	Educational organization
6. Shenzhen Nanshan Police Station	Government sector
7. Shijiazhuang Junlebao Dairy Co., Ltd.	Private enterprise
8. Wuhan Sports University	Educational organization

Appendix 3: Mplus Syntaxes for doing LPA in Chapter III:

```
Title:
    LPA with 434 fluctuators.
Data:
    File is "C:/Users/15484/Desktop/Mplus/MplusLPA434.csv";
Variable:
    names = SE Planning AC AA SS PB;
    classes = c(2);
Analysis:
    Type=mixture;
Plot:
    type is plot3;
    series is SE(1) Planning(2) AC(3) AA(4) SS(5) PB(6);
Savedata:
    file is LPA2_save.txt ;
    save is cprob;
    format is free;
Output:
    tech1 tech11
```

Appendix 4: Interview guide (English and Chinese version) in Chapter IV

Semi-structure interview guide

Introduction

Hello! Please sit down. Thank you very much for sparing your time to participate this interview about your physical activity.

First let me briefly introduce myself. I am currently a PhD. student majored in physical education in Hong Kong Baptist University. This interview is a part of my dissertation. At the same time, it is also a project supported by Hong Kong Baptist University.

The purpose of this interview is to know about your daily life physical activity and your thoughts and perceptions about your PA. This interview will normally last no more than 30 minutes.

The interview is conducted anonymously and the results will remain confidential. All of your information will be only used for the sake of research. The interview content will be destroyed 6 months later after the research ends.

Besides, if you finish this interview you will be rewarded with 100 RMB. Do you have any other questions? If not, please sign this "participation agreement". Thanks.

1. **Physical Activity -Related**
   Let's first talk about how you do physical activity in your daily life in recent half a year.
   1.1 PA-participation-related

   - You can think about the physical activities you normally engage in, can you tell me which physical activities you are performing? I am interested in your daily life activities as well as in your sport and exercise activities (like fitness training or competitive sports).
   - Where do you normally implement them?
   - Normally are you doing each of your PA (a) By yourself? (b)With friends? (c) In a group with professional instructions?
   - Which of these activities are you performing in a way that you are sweating at least a bit, or you are breathing at least a bit faster? Which of these activities make you sweating a lot and even exhausted or breathless? (This question used to confirm all the activities are at least in moderate intensity)

Only the cards with at least moderate intensity are remained. And the normal walking behavior and normal housework with low intensity are removed.

- Which of these activities are you performing most often and how long is the duration of each session? What about the second most often activity and how long? On average, how often do you perform them, and how long do you do for each session?

  The interviewer is writing the frequencies and duration on the cards. Then he ranks the cards with PA by frequency from most frequent PA on top to least frequent PA in the bottom.

1.2 Plan & regularity-related

- How regular is your PA participation? a) Do you have fixed dates or time for your activities or b) Are you just randomly performing PA when you have time, or performing PA following plans? If having a plan, could you tell me more about it?

  The interviewer makes a note about the information regarding, plan and regularity on the cards of each type of PA.

2. Motivators

- Please think about why you do the physical activities above. Here I have 7 cards with reasons why people are physically active. The 7 prepared motivators are: 1) Better fitness; 2) For fun; 3) Health & Preventing disease; 4) Tension release & mood regulation; 5) Weight control & good body shape; 6) Improving skills; 7) For social interaction. Please take now 1-3 cards out of these with the motivators which are important for you and specify them.
- Do you have the motivators other than these seven? Could you tell me what are they?
- Here are all your motivators. Please rank the motivators by importance, that is, which is the most important, second and third. Could you provide brief justifications?

  The interviewer writes 1-3 on the cards and is lying these cards on the left side of the PA cards with the most important on the top.

3. Barriers

- Please think about your own barriers for being active. Here I have seven cards with reasons why people want to be physical active but not. The 7 prepared barriers are: 1) Lack of time; 2) Lack of interest; 3) Lack of facilities; 4) Lack of willpower; 5) Physical reasons; 6) Much economic cost; 7) Lack of social support or organization. Please take now 1-3 cards with the barriers most impeding you from being regularly active.
- Do you have the barriers other than these seven? Could you tell me what are they?

- Here are all your barriers. Please rank them by importance and provide brief justifications.

  The interviewer writes 1-3 on the cards and is lying these cards on the right side of the PA cards with the most important on the top.

4. Lapses and reasons

- Please think again about your physical activities in the **recent half a year**. Did you have a long period (at least one week or more) when you not at all implement your aforementioned physical activities (only moderate to vigorous)? How many of these interruptions did you have? How long was each interruption lasting? Could you tell me more about that?

  The interviewer writes the answers on a card and lays this card under the PA cards.

- Could you tell me about the specific reasons causing these interruptions?

  The interviewer makes remarks on the card according to the answers from the participant.

Final Confirmation

- Now it is the time to look again on the whole content you were just providing. Are you fine with the picture and whether it reflects your real thoughts? Or do you want to add, change or delete something?

If the interviewee permits, this is the final confirmation of the answers (communicative validation). If not permitted, revisions should be according made.

5. Socio-demographic information

I would like to end this interview with some questions about your basic information

1) How old are you? 2) What kind of job do you have? 3) How long are you working in a normal week? 4) Are you living alone or together with others? In relationship or not? Having children or not?

In the end, the researcher writes down these information as well as the interview time and location at the bottom of the card.

中文访谈提纲

简要介绍：

您好！ 请坐！ 谢谢您百忙之中抽时间参加我们这个关于身体锻炼的访谈。

首先我先介绍一下自己。我现在是浸会大学体育系一名在读博士生。这个访谈是我论文的其中一部分，同时也是浸会大学科研项目之一。

此次访谈的主要目的是了解您日常生活中锻炼身体的情况，以及关于锻炼身体的一些想法。 访谈时间一般不会超过 30 分钟。

您的所有的私人信息将完全保密，访谈内容仅用于研究，所有访谈信息将在研究 6 个月后被销毁。

此外，访谈结束后您将有 100 人民币的奖励，您对此次访谈还有什么不清楚的吗？如果没有的话，您可以在这份访谈者同意书上签字，姓名简称和日期即可！谢谢。

1. 身体活动相关问题

首先我们谈一下你平时是如何锻炼身体的。（拿出准备的黄颜色卡片）

1.1 身体活动行为方面：

- 您可以想一下平常都进行哪些身体活动？这些身体活动可以是一些日常体力活动，也可以是进行有计划的锻炼的体育项目。

- 您在哪做这样的活动？
- 您的这些身体活动都是 a) 自己一个人做? b) 还是同别人一起？亦或是 c) 在专业人员的指导下进行的？
- 您参加的这些活动哪些是让您不怎累的？哪些让您有点累，心跳加快了，并且出汗了？哪些又是特别累，出很多汗的？（此问题是帮助研究者筛选出那些中等强度及以上的活动）
  删除那些不累的低强度运动，区分并保留中高强度运动

- 这些身体活动您大概多久参加一次，哪项参加的最多，哪项第二多？平均来看您一星期参加多少次上述的活动，大概每次做多久？
  研究者记录频率以及时长

1.2 计划和规律性

- 您觉得您参加身体活动算有规律吗？您是每次都有固定时间参加还只是有空参加没空算了？您锻炼有计划吗？请您针对这些问题结合自己经验，具体谈一谈。
  研究者记录关于锻炼规律性和计划的信息

2. 锻炼动机

- 请您想一下您参与锻炼的动机有哪些。我这里有七张卡片，分别写着为什么锻炼的理由。如果您有除卡片之外的理由也可以告诉我们。
  7 张卡片分别写有：
  1）为了拥有更好的身体素质
  2）有乐趣
  3）为了身体健康，不生病
  4）缓解压力，调节情绪
  5）控制体重拥有好身材
  6）提高运动技能技巧
  7）社交原因
  8）空白卡片 其他：访谈者自填

- 请您结合自身的锻炼动机，选取 1-3 张卡片

- 将其按重要性排序，并给出理由，举例具体说明
  研究者将锻炼动机信息记录下来并将其放在身体活动卡片的左边。

3. 锻炼阻碍因素

- 请您结合自身情况想一想哪些因素阻碍你，让你没法坚持锻炼。
  我这里同样有 7 个阻碍人们参与锻炼的原因。如果您有自己的原因也可以告诉我们。
  7 张卡片写有：
  1）没时间
  2）没兴趣
  3）没器材
  4）意志力差
  5）身体原因
  6）花销太大
  7）没人组织或缺乏他人支持
  8）空白卡片 其他：访谈者自填
- 请您结合自身的情况，选取 1-3 张卡片
- 将其按重要程度排序，哪一个是对自己锻炼最大、其次、再次的阻碍因素，并给出理由，或举例具体说明
  研究者将锻炼动机记录下来并将其放在身体活动卡片的右边。

4. 锻炼中断情况和具体原因 （可以分为直接原因、根本原因）

- 请您想一下，在最近半年中，您有没有长时间中断过（至少超过一个星期）上述身体活动？有几次中断过？每次中断大概多久？
- 您能回想一下，并描述一下为什么锻炼会中断，有什么具体原因吗，中断的直接原因（外界）是什么？ 根本原因是什么（内部原因）？

研究者将这些信息记录在空白卡片上，置于锻炼项目之下

确认总结

- 将上述所有信息贴到一张空白纸上面。我们问了您关于锻炼项目，动机，阻碍因素，锻炼中断及原因的问题。 您可以回顾一下这张纸上的信息，您觉得这些信息是否能反映您在日常生活中参与身体活动的真实情况？您还有什么要补充的或者要更改的吗？
  如果还有补充就写在大纸空白部分，如果没有下一环节。

5. 访谈者基本信息

最后想对您的基本信息有个大致了解：

您今年年龄？

您的日常工作性质（职业）？

每天在办公室的时间？

婚否？

您是自己住还是和家人住一起？

研究者将这些基本信息连同访谈时间填在纸张空白处。最后表示感谢，给被试访谈费用。

Appendix 5: Detailed records of eligible studies in exploratory systematic review in Chapter II

First author (year)	Study characteristics				Definition-related findings		Empirical findings		
	Study design	Study context/participant	Theoretical framework	Data analysis	Descriptive definition	Operational definition/fluctuation identification	Distribution	Behavior performance	Psychosocial
Cohen (2003)	Cross-sectional	US *N*=931 (62.4%) M_{age}=37.4yr, SD_{age}=12.9yr	Adapted version of TTM	MANOVA with post hoc test	Naming: Excuserciser ("Relapse stage") Description: Individuals who tend to employ psychological, sociological, physiological, environmental, or spiritual barriers/reasons/excuses to avoid regular participation in unstructured physical activity or structured exercise.	Self-report stage algorithm: 1) I was exercising regularly at times over the past 12 months; 2) I am not currently exercising regularly; 3) I intend to resume exercising regularly in the future.	9.9% in "Exercusercise" 51.7% in Maintenance 16.2% in Action 11.8% in Preparation	N/A	5 psychosocial variables: 1. Decisional balance (pros and cons): P< Excuserciser=A<M; 2. Barriers: M< Excuserciser=A=P; 3. Self-efficacy: P< Excuserciser=A<M 4. Intrinsic motivation: P< Excuserciser =A<M
Conroy (2007)	Cross-sectional	US *N*=497 (100%) M_{age}=56.9yr SD_{age}=2.9yr	RPM	Univariate analyses	Category: regular exercise with lapse	Self-report: 1) had engaged in regular exercise (three or more times per week) during the past 6 months; 2) with exercise *lapses* (not enough PA longer than two weeks) during the past 6 months.	25.6% in "Regular with lapse" 35% in "occasional with lapse" 18.7% in "regular without lapse"	PA level (MET-hour/week): Regular with lapse=16.6; Occasional with lapse=9.8; Regular without lapse=19.7.	5 psychosocial variables: Regular with lapse VS Regular PA without lapse: 1. More perceived barriers; 2. Lower self-efficacy; 3. Less coping strategies 4. Decisional balance (less pros and more cons); 5. Higher level of stress and depressive

First author (year)	Study characteristics				Definition-related findings		Empirical findings		
	Study design	Study context/participant	Theoretical framework	Data analysis	Descriptive definition	Operational definition/fluctuation identification	Distribution	Behavior performance	Psychosocial
									symptoms.
								Steps/day: Regular with lapse=7176; Occasional with lapse=5906; Regular without lapse=7771.	
Dishman (2010a,b)	Prospective cohort study	US *N*=497 (63.6%) M_{age}=49.7yr SD_{age}=16.7yr	TTM	Latent Transition analysis	Category: Occasionally meeting PA recommendation	Self-report: 1) report weekly PA by IPAQ and GLTEQ five times; 2) meet the PA recommendation for at least once but not each time.	Partially meeting the guideline (52%); Never meeting the guideline (7%); Always meeting the guideline (41%)	N/A	2 psychosocial variables Partially meeting guideline VS Always meeting guideline: 1.Lower self-efficacy; 2. No difference in decisional balance.

First author (year)	Study characteristics				Definition-related findings		Empirical findings		
	Study design	Study context/participant	Theoretical framework	Data analysis	Descriptive definition	Operational definition/fluctuation identification	Distribution	Behavior performance	Psychosocial
Duan (2006)	Cross-sectional	China *N*=856 (61.2%) M_{age}=29.6yr SD_{age}=10.8yr	BSM	ANOVA with post hoc test	Naming: Fluctuation stage Description: Sporadic, unstable, irregular, occasional, unhabituated participation in physical activity behavior.	Self-report stage algorithm: 1) I have usually engaged in PA regularly (meeting the PA guideline); 2) I was doing sufficient PA at least once but not for every week during the past 4 weeks; 3) I did not start regular PA just from the last week.	27.2% in Fluctuation; 11.3% in Implementation; 30.7% in Habituation.	N/A	2 psychosocial variables: 1. Self-efficacy: I<F<H 2. Social support: I=F<H
Duan (2013)	Cross-sectional	China & Germany *N*=2071 (56.9%) M_{age}=38.7yr SD_{age}=8.7yr	FIT	ANOVA with post hoc test	Naming: Fluctuating stage	Self-report stage algorithm: I am physically active, but not regular every week, or have not accumulated at least 120 minutes every week.	17.6% in Fluctuating; 10.3% in Preparing; 10.4% in Exploring; 33.3% in Maintaining.	PA energy expenditure (kcal/week): P (479) < PA guideline (800) < F(1197)< E (1620) < M (2048).	10 psychosocial variables: 1. Perceived barriers: M<E<F<P; 2. Self-efficacy: P<E=F<M; 3 Affective attitude: P<E=F<M; 4. Body concept: P<E=F<M; 5. Plans: F<P=E<M; 6. Intrinsic motivation: P<E=F<M;

First author (year)	Study characteristics				Definition-related findings		Empirical findings		
	Study design	Study context/participant	Theoretical framework	Data analysis	Descriptive definition	Operational definition/fluctuation identification	Distribution	Behavior performance	Psychosocial
									7. Activity emotions: E=F<M; 8. Social support: P<E=F<M 9. Outcome expectancies: P=E=F=M 10. Assessment of activity situation: P=E=F=M
Duan (2015)	Cross-sectional	Hong Kong & Germany *N*=770 (53.1%) M_{age}=20.7yr SD_{age}=2.2yr	FIT	Univariate F tests with multiple contrasts (Bonferroni)	Naming: Fluctuating stage	Self-report stage algorithm: I am physically active, but not regular every week, or have not accumulated at least 120 minutes every week.	19.2% in Fluctuating; 12.2% (n=94) in Preparing; 10.9% (n = 84) in Exploring; 28.8% (n=222) in Maintaining.	PA energy expenditure (kcal/ week): P (659) < PA guideline (1560) < F (1691)< E (2141) < M (2566).	10 psychosocial variables: 1. Perceived barriers: M<E=F<P; 2. Self-efficacy: P=E=F<M; 3 Affective attitude: P=E=F<M; 4. Body concept: P<E=F<M; 5. Plans: F=P=E<M; 6. Intrinsic motivation: P<E=F<M; 7. Activity emotions: P=E=F<M; 8. Social support: P<E=F=M 9. Outcome expectancies: P<E=F=M 10. Assessment of activity situation: P=E=F=M

First author (year)	Study characteristics				Definition-related findings		Empirical findings		
	Study design	Study context/participant	Theoretical framework	Data analysis	Descriptive definition	Operational definition/fluctuation identification	Distribution	Behavior performance	Psychosocial
Duan (2016)	Cross-sectional	Hong Kong *N*=1012 (70.0%) M_{age}=19.0yr SD_{age}=1.3yr	FIT	ANOVA with post hoc test	Naming: Fluctuating stage	Self-report stage algorithm: I am physically active, but not regular every week, or have not accumulated at least 120 minutes every week.	16.5% in Fluctuating; 16.6% in Preparing; 11.7% in Exploring; 7.2% in Maintaining.	N/A	3 psychosocial variables: 1. Perceived barriers: M<E<F<P; 2. Intrinsic motivation: P<F=E<M 3. Plans: P=F=E=M
Fuchs (1999)	Theoretical model proposition	N/A	BSM		Naming: Fluctuation stage Description: Sporadic, unstable, irregular, occasional, not habituated participation in physical activity behavior.	N/A	N/A	N/A	N/A
Kinnafick (2014)	Qualitative longitudinal	UK *N*=15 (100%) M_{age}=49.4yr SD_{age}=8.0yr	SDT	Thematic analysis	Category: lapse and readoption Description: adhere to a PA program from beginning to the end, yet experiencing lapse (for approximately 2 to 3 months) and readoption.	N/A	26.7% in lapse and readoption; 46.7% in adherence.	N/A	3 component from SDT perspective: 1. Competence: in increasing process, doubt their ability at the beginning, but this increases as the process proceeds; 2. Relatedness: social support (accompany) was very important at the beginning phase. 3. Autonomy: sense of guilt and obligation (introjected motivation) is linked with

First author (year)	Study characteristics				Definition-related findings		Empirical findings		
	Study design	Study context/participant	Theoretical framework	Data analysis	Descriptive definition	Operational definition/fluctuation identification	Distribution	Behavior performance	Psychosocial
									readoption. The lapse-readoption individuals are undergoing a process of motivation internalization.
Lippke (2006)	Cross-sectional	Germany *N*=835 (59%) M_{age}=46yr SD_{age}=11.7yr	MSM	ANOVA with post hoc test	Naming: Fluctuation stage Performing PA behavior without ease over half a year or longer	Self-report stage algorithm: 1) I started to engage in PA regularly (meeting the PA guideline) within last one year; 2) How easy is it for you to exercise regularly? 3) How much has it become your habit to exercise regularly Questions 2 and 3 are in 4-point Likert scale, options of question 2 are from "very hard" to "very easy", options of question 3 are from "not at all" to "absolutely." The individuals were assigned to fluctuation stage if neither ratings were the highest (very easy and absolutely	24% in Fluctuation; 17% in Implementation; 2% in Habituation.	N/A	5 psychosocial variables: 1. Intention: I<F=H; 2. Self-efficacy: I=F<H; 3. Outcome expectancies: I<F<H; 4. Social support: I=F=H 5. Risk perception: I=F=H

	Study characteristics				Definition-related findings		Empirical findings		
First author (year)	Study design	Study context/participant	Theoretical framework	Data analysis	Descriptive definition	Operational definition/fluctuation identification	Distribution	Behavior performance	Psychosocial
						a habit).			
Stetson (2005)	Cross-sectional	US *N*=65 (56.9%) M_{age}=35.4yr SD_{age}=11.5yr	RPM	Logistic regression	Naming: Intermittent exerciser	Self-report perceived exercise status: either regular exerciser or intermittent exerciser.	61.8% in "regular exerciser"; 38.2% in intermittent exerciser"	N/A	2 psychosocial indicators: 1. Self-efficacy: no difference between regular exercisers and intermittent exercisers 2. Coping strategies: regular exercisers have more coping strategies than the intermittent exercisers.
Seymour (2010)	Focus group	N/A	N/A		Related definitions clarification: Maintenance: sustained behavior during the period of observation and after the intervention has stopped that meets a threshold believed to be necessary to improve health or well-being within a given population; Adherence: protocol-related behaviors, such as attendance and participation in PA behavior in	N/A	N/A	N/A	N/A

First author (year)	Study characteristics				Definition-related findings		Empirical findings		
	Study design	Study context/participant	Theoretical framework	Data analysis	Descriptive definition	Operational definition/fluctuation identification	Distribution	Behavior performance	Psychosocial
					accordance with relevant PA recommendations; Grace Period: a window of time during which lack of adoption of the behavior was not counted as a failure; Relapse: a period of interruption of regular sustained behavior after its initiation and maintenance; Reactivation: the resumption of the sustained behavior following a period of relapse.				
Kahlert (2015)	Commentary	N/A	N/A		Category: PA pattern of lapse Description: Individuals who drop back to their former behavior for some days or weeks but subsequently resume a higher activity level again	N/A	N/A	N/A	N/A
Strobl(2016)	Cross-sectional	China & Germany	FIT	ANOVA with post hoc	Naming: Fluctuating stage	Self-report stage algorithm:	17.6% in Fluctuating;	PA energy expenditure (kcal/week): P (479) < PA guideline (800) < F	6 psychosocial indicators:

First author (year)	Study characteristics				Definition-related findings		Empirical findings		
	Study design	Study context/participant	Theoretical framework	Data analysis	Descriptive definition	Operational definition/fluctuation identification	Distribution	Behavior performance	Psychosocial
		N=2071 (56.9%) M_{age}=38.7yr SD_{age}=8.7yr		test		I am physically active, but not regular every week, or have not accumulated at least 120 minutes every week.	10.3% in Preparing; 10.4% in Exploring; 33.3% in Maintaining.	(1197)< E (1620) < M (2048).	1. Outcome expectations: P=F=E=M; 2. Barriers: P<F=E<M; 3. Social support: P=F=E<M; 4. Maintenance self-efficacy: P<F=E<M; 5. Intrinsic motivation: P<F=E<M; 6. Affective attitude: P<F=E<M;

Note. TTM= Transtheoretical model; MANOVA= Multivariate analysis of variance; N/A= Not applicable; P= Preparation stage; A= Action stage; E= Exploration stage; M=Maintenance stage; RPM= Relapse prevention model; MET=Metabolic equivalent of task; VS=Versus; PA= Physical activity; IPAQ= International physical activity questionnaire; GLTEQ= Godin leisure-time exercise questionnaire; BSM= Berlin exercise stage model; ANOVA= Analysis of variance; I= Implementation stage; F= Fluctuation stage; H= Habituation stage; FIT= Four steps from inactivity to health-enhancing physical activity model; SDT= Self-determination theory; MSM= Multi-stage model

Appendix 6: Informed consent (English and Chinese version)

[Fluctuation – A Common but Neglected Phenomenon of Physical Activity Behavior]

You are invited to participate in a research study. The purpose of this study is to understand the psychosocial and behavioral features of those who engage in physical activity (PA) behavior irregularly. The outcomes of this research project will mainly provide knowledge relative to:

1. Determining the number and prevalence of sub-categories that best summarize the complexity of fluctuators based on psychosocial indicators.
2. Discovering fluctuators' PA behavioral features such as PA type, frequency, intensity.
3. Exploring the perception and cognition of PA fluctuators towards their irregular PA participation.

INFORMATION

This project adopts mixed-methods design incorporating a quantitative survey and a qualitative interview. Participants in survey will complete a questionnaire package. Personal demographic information, PA behavior feature and several psychosocial factors related to physical activity participation need to be provided. Each questionnaire survey will take **approximately 6 minutes**. Participants are suggested to indicate their true perception or feeling about issues described in the questionnaire. Participants in interview will be asked to elaborate a series of questions relative to their physical activity behavior including motivations, beliefs, barriers etc. The interview will last **around 30 minutes**. The interview content will be audio recorded for further data analyses.

BENEFITS

By participating in this project, you will contribute to advance the understandings of the psychosocial characteristics of fluctuators. Based on this knowledge, the tailored intervention can be designed for physical activity behavior promotion among fluctuators. Additionally, you will also receive monetary reward after the completion of interview.

CONFIDENTIALITY

This study guarantees the anonymity of participants. For the questionnaire survey and the interview, all the information you provide will be kept strictly confidential and only the results of analyses will be reported for the purpose of academic research. In addition, the questionnaire and audio record will be destroyed within 1 year upon the completion of this study.

COMPENSATION AND INSURANCE

For participants attending the interview, RMB 100 in cash will be offered upon the completion of interview. No monetary reward will be paid if participants withdraw from the interview prior to its completion.

CONTACT

If you have questions or concerns about the study or the procedures, you may contact the researcher, Mr. Shang Borui at telephone 852-34112722 or 15484653@life.hkbu.edu.hk by email. If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact the Committee on the Use of Human and Animal Subjects in Teaching and Research by email at hasc@hkbu.edu.hk or by mail to Graduate School, Hong Kong Baptist University, Kowloon Tong, Hong Kong.

PARTICIPATION

Your participation in this study is voluntary; you may decline to participate without penalty. If you decide to participate, you may withdraw from the study at any time without penalty and without loss of benefits to which you are otherwise entitled. If you withdraw from the study before data collection is completed your data will be returned to you or destroyed.

CONSENT

I have read and understand the above information. I have received a copy of this form. I agree to participate in this study.

Signature of the Subject _____ Date _____

Signature of the Investigator _____ Date _____

同意書

【身体活动行为波动现象的研究】

您受邀参加这项研究。该研究旨在了解身体活动波动者（不规律锻炼者）的社会心理及身体活动行为特征。具体研究目的包括以下三个方面：

1. 基于社会心理变量，探究身体活动波动者的类别以及每个类别的人数。
2. 探究波动者的身体活动行为特征（例如运动的类型、频率和强度）。
3. 探究身体活动波动者对参与身体活动行为的主观想法。

背景资料

本研究采用量化调查与质性访谈的混合研究设计。对于量化调查参与者，您须填写一份问卷包。问卷包的内容包括个人信息、身体活动行为调查以及与身体活动行为相关的社会心理学因素。希望您依照您的真实感受如实作答。填写一份问卷大约占用您 6 分钟时间。对于质性访谈参与者，您需要详述对于一系列有关您对身体活动参与问题（包括动机、信念、障碍等）的看法。访谈时长约 30 分钟，访谈内容将被录音以供后续分析。

研究效益

通过参与此项研究，您将会帮助我们了解身体活动波动者的社会心理特征。基于这些知识，今后可以设计匹配性的干预项目，以期促进身体活动波动者们进行有规律的身体活动。此外，如果您参与了本研究中的访谈，您个人还会有机会获得一定的资金奖励。

隐私保障

本研究采取匿名方式。无论您是参与问卷调查还是质性访谈，您的一切信息将会完全保密，只是最终数据统计结果会被用于学术研究及汇报。此外，所有收集到的信息将会在研究结束后的一年内全部销毁。

补偿方式

本研究中质性的访谈参与者将在研究结束后立即获得 100 元的现金奖励。如果中途退出，将无法获得现金奖励。

联络资料

如果您对本研究有任何疑问和困惑，请联系本研究负责人：尚博睿 先生，电话：+852 3411 2722，邮箱：15484653@life.hkbu.edu.hk。如果您在参与研究的过程中发现实际情况与本文件所述内容不相符，或者感到自己作为参与者的权益受到侵犯，请您以网络邮件的方式(hasc@hkbu.edu.hk)与教研所用人畜实验监管委员会联系，或者写信给香港浸会大学研究生院。

参与条款

您是否参与本研究是完全自愿的，拒绝参与不会受到任何惩罚。中途退出不会受到惩罚，所享有的权益也不会受到损害。如果您在数据收集结束之前决定退出本研究，那您的数据将会被退还或者销毁。

同意书

我已经阅读了上述研究信息。我同意参加该项研究。

参与者：_____ 日期：_____

调查者：_____ 日期：_____

Appendix 7: Main academic output:

Journal articles:

1) **Shang, B**., Duan, Y., Huang, W. Y., & Brehm, W. (2018). Fluctuation–a common but neglected pattern of physical activity behaviour: An exploratory review of studies in recent 20 years. *European journal of sport science, 18*(2), 266-278.

2) Niemeier, B. S., Duan, Y. P., **Shang, B. R.**, & Yang, J. (2017). Parental influences on weight-related health behaviors in western and eastern cultures. *Child: care, health and development, 43*(2), 259-266.

3) Yang, M., **Shang, B.**, Sun, C., & Duan, Y. (Under review). Association between Stages of Change for Physical Activity and Psychosocial Correlates among Chinese Mongolian adults. *Journal of Wuhan Institute of Physical Education.* (In Chinese)

4) Liang, W., Duan Y., **Shang, B.**, & Wang, Y. (Under review). Evaluation of web-based interventions on physical activity and fruit-vegetable consumption in Chinese college students: study protocol and enrollment results. *International Journal of Public Health*

Main conference presentations:

1) Oral Presentation: "Testing the Hybrid feature of the health action process approach (HAPA) for physical activity among Chinese adults", 14th World ISSP Congress of Sport Psychology, Sevilla, Spain, 2017. July.10-14.

2) Poster Presentation: "Fluctuation – A Common but Neglected Pattern of Physical Activity Behaviour: An Exploratory Systematic Review", 2017 FISU World Conference, Taipei, 2017. August 27-30.

Award:

1) BEST 3-MINUTES PRESENTATATION AWARD, issued by Hong Kong Baptist University Faculty of Social Science, 2016. Presentation title: "Fluctuation – a common but neglected phenomenon in the context of exercise participation"

CURRICULUM VITAE

Academic qualifications of the thesis author, Mr. SHANG Borui:

- Received the degree of Bachelor of Economics from China University of Geoscience Great Wall College, July 2011.

- Received the degree of Master of Education from Wuhan Institute of Physical Education, June 2015.

March 2019