THE EVALUATION OF HIGH-AND MODERATE-INTENSITY INTERVAL EXERCISE ON PERCEPTUAL RESPONSES, PHYSICAL HEALTH, QUALITY OF LIFE, MENTAL WELL-BEING AND EXERCISE MOTIVATION AMONG COLLEGE STUDENTS IN CHINA

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UNIVERSITI SAINS MALAYSIA
2025

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by

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Thesis submitted in fulfilment of the requirements
for the degree of
Doctor of Philosophy

February 2025

ACKNOWLEDGEMENT

Three years may not seem significant in a person's lifetime, but the three years spent pursuing a PhD have been incredibly meaningful to me.

First and foremost, I would like to thank my supervisor, Dr Adam Abdul Malik, for his tolerance and guidance over the past three years. It is his patient and unreserved teaching that has allowed me to gain a foothold in research and achieve academic results. His repeated encouragement and tireless efforts in helping me revise my papers have been invaluable. During the process of my dissertation, he patiently listened to my experimental progress reports, promptly addressed professional issues and unexpected situations, and provided continuous and patient guidance, offering professional feedback and revision suggestions. I extend my heartfelt thanks to Dr Adam Abdul Malik! As his first PhD student, I have always felt immense pressure to excel in everything I do. Although my efforts may still fall short, I hope to bring honour to my supervisor in the future and live up to the dedicated training he has provided. I would also like to thank my co-supervisor, Professor Hairul Anuar Hashim. His vast knowledge and meticulous attitude have deeply inspired me, and his exemplary conduct has taught me the principles of both life and scholarship.

I am grateful to my parents and family. During the arduous years of my PhD, they understood the hardships best, providing unconditional financial and emotional support. Without them, completing my studies would have been impossible. I hope to spend more time with them and care for them in the future, repaying them through dedicated work and a love for life.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of variance
BMI	Body mass index
DMT	Dual mode theory
ES	Effect size
FS	Feeling scale
HIIE	High-intensity interval exercise
HR	Heart rate
HRmax	Maximal heart rate
HRQOL	Health-related quality of life
IPAQ-C	International physical activity questionnaire-chinese
MAS	Maximal aerobic speed
MET	Metabolic equivalents
MIIE	Moderate-intensity interval exercise
MS	Maximal speed
PA	Physical activity
PACES	Physical activity enjoyment scale
PAR-Q	Physical activity readiness questionnaire
RPE	Rating of perceived exertion
SD	Standard deviation
20-mSRT	20-meter shuttle run test
VT	Ventilation threshold
$\dot{V}O_{2max}$	Maximal oxygen uptake
WHO	World health Organization
PA	Physical activity

LIST OF APPENDICES

PENILAIAN LATIHAN SELA BERINTENSITI TINGGI DAN SEDERHANA TERHADAP TINDAK BALAS PERSEPSI, KESIHATAN FIZIKAL, KUALITI HIDUP, KESEJAHTERAAN MENTAL, DAN MOTIVASI SENAMAN DALAM KALANGAN PELAJAR KOLEJ DI CHINA

ABSTRAK

Kelaziman ketidakaktifan fizikal dalam kalangan pelajar kolej menjadi cabaran serius bagi pihak berkuasa pendidikan dan kesihatan di banyak kawasan di dunia termasuk China. Akibatnya, penyelidik dan pengamal perkhidmatan kesihatan telah mengalihkan perhatian mereka kepada jenis senaman sela sebagai strategi kesihatan untuk menggalakkan aktiviti fizikal. Walau bagaimanapun, tidak jelas sama ada intensiti senaman sela yang berbeza boleh menggalakkan kepatuhan senaman dan kesihatan yang menyeluruh dalam kalangan pelajar kolej. Kajian ini mengkaji kesan intensiti kerja yang berbeza semasa latihan senaman bersela terhadap tindak balas persepsi, parameter kesihatan, motivasi senaman, kesihatan mental dan kualiti hidup berkaitan kesihatan (HRQOL) dalam pelajar kolej yang tidak aktif secara fizikal. Dua puluh empat pelajar kolej yang tidak aktif (berumur 20.8 ± 1.2 tahun; tahap PA = 448 ± 80 MET-min/minggu) telah dibahagikan secara rawak kepada dua kumpulan: Senaman Selang Intensiti Tinggi (High-Intensity Interval Exercise (HIIE); n = 12; 6 - 10 × 1-min selang kerja pada 90% MAS) atau Senaman Selang Intensiti Sederhana (Moderate-Intensity Interval Exercise (MIIE); n = 12; 6 - 10 × 1-min selang kerja pada 60% MAS). Kedua-dua kumpulan menjalani latihan selama tiga hari seminggu (36 sesi). Parameter kesihatan (kecergasan kardiorespiratori dan komposisi badan), motivasi senaman, kesihatan mental (tekanan, kemurungan, dan kebimbangan), dan HRQOL diukur sebelum dan selepas intervensi senaman selama 12 minggu. Hasil

Analisi Faktor Bercampuran Perubahan menunjukkan interaksi yang signifikan antara kumpulan eksperimen sepanjang sesi pengukuran dibandingkan dengan kumpulan kawalan untuk skala perasaan (FS), keseronokan, respons kardiospiratori, kecemasan, depresi, HRQOL, dan motivasi latihan. Hasil analisis post-hoc menunjukkan bahawa kumpulan HIIE menghasilkan respons afektif yang lebih rendah pada selatan kerja 4 dan selatan kerja akhir dalam sesi 1 dan sesi 18 dibandingkan dengan kumpulan MIIE (semua $P < 0.05$). Saiz efek digunakan untuk menunjukkan magnitud perbezaan antara kumpulan.. Walau bagaimanapun, HIIE memperoleh skor yang lebih besar dalam skala perasaan (FS) pada akhir sela kerja semasa sesi 18 dan 36 berbanding sesi 1 ($P < 0.05$). Kedua-dua kumpulan menjana lebih banyak keseronokan selepas sesi 36 berbanding sesi 1 (semua $P < 0.05$). Peningkatan ketara dalam tindak balas kardiorespiratori dan komposisi badan dapat diperhatikan dalam kumpulan HIIE berbanding kumpulan MIIE selepas 12 minggu ($P < 0.05$). Kumpulan HIIE juga menghasilkan peningkatan ketara dalam skor kebimbangan dan kemurungan berikutan selepas 12 minggu berbanding kumpulan MIIE (semua $P < 0.05$). HIIE menunjukan peningkatan dalam keseluruhan pembolehubah HRQOL (semua $P < 0.05$) berbanding hanya dua pembolehubah HRQOL dalam kumpulan MIIE (semua $P < 0.05$) selepas 12 minggu latihan intervensi. Peningkatan ketara dalam skor faktor motivasi intrinsik dan faktor motivasi identifikasi juga diperhatikan (semua $P < 0.05$) selepas latihan intervensi HIIE. Sebaliknya, kumpulan MIIE memperoleh skor yang lebih besar bagi faktor motivasi luaran dan faktor tidak bermotivasi selepas intervensi senaman. (semua $P < 0.05$). HIIE merupakan strategi yang cekap dalam masa dan berdaya maju untuk memudahkan pematuhan senaman pada masa hadapan sambil menghasilkan keseluruhan kesihatan fizikal dan mental dalam kalangan pelajar kolej yang tidak aktif secara fizikal apabila mempertimbangkan kesan tindak balas persepsi, kesihatan

keseluruhan, dan faktor motivasi senaman .

THE EVALUATION OF HIGH-AND MODERATE-INTENSITY INTERVAL EXERCISE ON PERCEPTUAL RESPONSES, PHYSICAL HEALTH, QUALITY OF LIFE, MENTAL WELL-BEING AND EXERCISE MOTIVATION AMONG COLLEGE STUDENTS IN CHINA

ABSTRACT

The prevalence of physical inactivity among college students has become a serious challenge for the education and health authorities across many regions in the world, including China. Consequently, researchers and health providers have shifted their attention to interval-type of exercise as a potentially effective strategy to promote physical activity. However, it is unclear whether different intensities of interval exercise could promote exercise adherence and overall wellness among college students. The present study examined the effects of different work intensities during interval exercise training on the perceptual responses, physical health parameters, exercise motivation, mental well-being and health-related quality of life (HRQOL) in physically inactive college students. Twenty-four inactive college students (aged 20.8 ± 1.2 years; PA levels = 448 ± 80 MET-min/week) were randomly assigned to two groups: High-Intensity Interval Exercise (HIIE) or Moderate-Intensity Interval Exercise (MIIE). Both groups underwent 12 weeks of exercise intervention, with 6–10 × 1-minute work intervals at 90% of Maximal Aerobic Speed (MAS) for HIIE and 6–10 × 1-minute work intervals at 60% of MAS for MIIE. The exercise sessions were conducted three times per week, for a total of 36 sessions. Perceptual responses (affective, enjoyment, and perceived exertion) observed in sessions 1, 18, and 36 were measured. Whereas physical health parameters (cardiorespiratory fitness and body composition), exercise motivation, mental well-being (stress, depression, and anxiety)

and HRQOL were measured before and after 12-week exercise intervention. The results of the Mixed Factorial Analysis of Variance displayed significant interactions between experimental groups across the measurement sessions compared to the control group for feeling scale (FS), enjoyment, cardiorespiratory responses, anxiety, depression, HRQOL, and exercise motivation. The results of post–hoc analysis displayed that HIIE group generated lower affective responses at work interval 4 and end work interval in session 1 and session 18 compared to MIIE group (all $P < 0.05$). However, HIIE elicited greater score in FS at the end of the work interval during sessions 18 and 36 compared to session 1 ($P < 0.05$). Both groups generated greater post-enjoyment in session 36 compared to session 1 (all $P < 0.05$). A significant improvement in cardiorespiratory responses and body composition was observed in HIIE group compared to MIIE group following a 12-week intervention ($P < 0.05$). Also, HIIE group produced a significant improvement in anxiety and depression scores following a 12-week intervention compared to MIIE group (all $P < 0.05$). HIIE elicited an improvement from baseline in overall HRQOL variables (all $P < 0.05$) compared to only two HRQOL variables in MIIE group (all $P < 0.05$). A significant improvement in intrinsic and identified scores were also observed (all $P < 0.05$) after HIIE intervention. In contrast, MIIE group elicited greater scores in external and amotivation following exercise intervention (all $P < 0.05$). HIIE appears to be a time-efficient and viable strategy to facilitate future exercise adherence while producing overall physical and mental well-being among physically inactive college students when considering the impact of perceptual responses, overall physical health parameters, and exercise motivation factors.

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Health related quality of life (HRQOL) is a multidimensional concept that encompasses various aspects such as physical health, mental health, social functioning, and personal subjective satisfaction with life. For college students, a good quality of life is not only the foundation of academic success, but also an important guarantee for their physical and mental health development (Snedden et al., 2019). Despite the substantial number of evidence available to indicate the impact of regular physical activity (PA) on the physical and mental well-being of individuals, the issues of physical inactivity becoming increasingly severe among various populations including college or university-age groups (age 17-24 years old) (DiPietro et al., 2020). Recent evidence indicates college students are often exposed to unhealthy behaviour changes such as increased sedentary behaviour while decreasing PA (Anuar et al., 2021). Indeed, previous findings have reported that almost 40% to 50%) the college students are physically inactive regardless of gender across the world, including in China (Chen et al., 2020; Martínez-Bello et al., 2017; Pengpid et al., 2015). This evidence is strengthened by the increasing pattern of sedentary lifestyles among college students, whereby lack of time due to intense academic and work demands became the major

reason for the neglect of the importance of PA. The transition period from adolescence (age 10 to 19 years old) to adulthood (above 20 years old) is a critical stage for forming a healthy lifestyle and developing healthy behaviours. College students are in this critical period. Therefore, it is very important to find a more effective and easy to adhere to exercise mode, which will be conducive to the formation of healthy behaviours (Huotari et al., 2011).

Given evidence indicating that few college students engage in the minimal amount of PA (Fagaras et al., 2015), and the associated chronic diseases of insufficient PA (Aceijas et al., 2017), it is crucial that interventions that encourage adoption and long-term adherence to PA are established and evaluated. Moreover, many college students are frequently exposed to factors associated with academic commitments and social life which have led to a difficult situation (i.e., lack of time, energy, and motivation) to maintain and engage with the PA routines in the college or university (VanKim & Nelson, 2013).

Consequently, apart from the physical health problems, recent findings also found that the mental well-being levels of college students continue to decline (Dong et al., 2024). A recent systematic review by Zhang and colleagues (2022) has reported that vigorous PA benefits college students' physical and mental well-being compared to low or moderate intensities of PA. Specifically, the author indicates that vigorous PA predicts

an optimal healthy lifestyle for Chinese dental and medical students. Indeed, King et al. (2013). concluded that greater vigorous PA (a minimum of two days) involvement is strongly correlated with perceived benefits (e.g., improving health, fitness, and appearance) among university students. This evidence may indicate that developing and implementing strategies to increase vigorous PA should be considered when targeting college or university students. Consequently, there is a strong rationale to study alternative forms of PA for college-age groups, with one strategy adopting smaller volumes of vigorous-intensity PA.

Exercise motivation is the internal driving force that drives individuals to participate in exercise, and it plays a key role in the occurrence, maintenance, and persistence of exercise behavior(Hird et al., 2023). Among college students, the motivation for exercise exhibits diverse characteristics. Different exercise motivations not only affect the frequency and intensity of students' participation in exercise, but are also closely related to their exercise persistence. Students with strong intrinsic motivation are more likely to persist in exercise for a long time, while students driven by extrinsic motivation may easily give up exercise after external motivation disappears (B. Li et al., 2022). Researchers have commonly utilized exercise to enhance the quality of PA participation while promoting health benefits in various populations. Indeed, evidence-based scientific guidelines recommend that exercise is a cornerstone in

primary prevention of chronic diseases. Given the lack of sufficient time is the most cited barrier to engaging in regular exercise, researchers have recently focused on high-intensity interval exercise (HIIE) to deliver short bouts of vigorous-intensity PA for the promotion of health and well-being. The application of HIIE protocols is intriguing in youth as their PA is characterized by spontaneous and intermittent behaviour rather than continuous PA. Despite the fundamental concepts of HIIE protocol being linked to sports training for endurance athletes (Billat, 2001), such protocols have recently been designed and implemented for both general and clinical populations (Bond et al., 2017; Gibala et al., 2012). Indeed, a meta-analysis by Reljic and colleagues (2019) revealed that HIIE - based interventions produce lower dropout rates than traditional exercise programs, which is moderate continuous exercise, in physically inactive individuals, indicating that HIIE is feasible and tolerable.

HIIE typically involves alternating periods of high-intensity exercise, where the effort corresponds to 85% of maximal effort, with low- to moderate-intensity recovery intervals, in which the effort corresponds to 30% to 60% of maximal effort (Gibala et al., 2006). Recent studies have suggested that HIIE protocols elicit comparable or superior benefits at considerably lower volumes of total exercise work than continuous-type exercise at a lower intensity (Costigan et al., 2015; Logan et al., 2014; Bond et al., 2017). The multiple health benefits of HIIE have recently been compiled in published

reviews (Costigan et al., 2015; Logan et al., 2014; Bond et al., 2017), showing that HIIE protocols as a time-efficient strategy lasting from 2 to 12 weeks can improve cardiometabolic health markers such as body composition, blood lipids, glucose, and insulin, and augment cardiorespiratory fitness in young adults.

Despite the well-known health benefits of the HIIE protocol, applying HIIE as a public health strategy is controversial due to the high-intensity workload required in this exercise regime, such as above 85% of maximal effort or heart rate. According to Ekkekakis (2003), high-intensity exercise typically leads to more negative affective responses, namely feeling of displeasure, than exercise performed at low to moderate intensity, thus leading to poor exercise adherence towards HIIE in future sessions. Data indicates that some variations of HIIE protocols may not entirely evoke negative affective responses while producing greater post-exercise enjoyment regardless of HIIE work intensity. For example, Malik and colleagues (2019) have reported that the HIIE protocol that utilized work intensities of 70% and 85% of the MAS elicited greater positive affect response, specifically pleasurable feelings, compared to 100% of MAS in boys and girls aged 12 - 18 years old. However, all three HIIE protocols have generated comparable post - exercise enjoyment. This valuable study provides insight into the role of work intensity in producing optimal positive perceptual responses, namely pleasurable feelings and enjoyment, during the HIIE protocol. However, this

evidence is limited to the comparisons of affective responses, including pleasure and displeasure feelings, to different work intensities within the HIIE protocols, which may not adequately consider the impact of interval exercise, such as moderate - vs. high - intensity, on affective responses to exercise.

Given the significant contribution of exercise intensity to the changes in affective responses during exercise, Jiménez-Pavón and colleagues (2017) has suggested examining the potential role of moderate intensity interval exercise (MIIE) in promoting better exercise implementation, maintenance, and adoption as opposed to HIIE. A previous study in adolescents has reported that MIIE (8 x 1 min work interval performed at 90% of ventilatory threshold) elicited more pleasurable feelings compared to low volume HIIE (8 x 1 min work interval performed at 90% of peak power) in 13 to 15 years boys and girls (Malik et al., 2019). However, this previous study is limited to the acute bout of exercise and did not consider the impact of physical aspects such as cardiorespiratory responses and body compositions, as well as mental well-being aspects including stress, anxiety, and mental well-being, within an extended time period, for example, a period of more than two weeks' intervention, for both conditions. Moreover, a study by Malik and colleagues (2019) have been conducted in a laboratory setting, whereby the ecological validity of affective experience to interval exercise will be compromised.

1.2 Problem statement & Study rationale

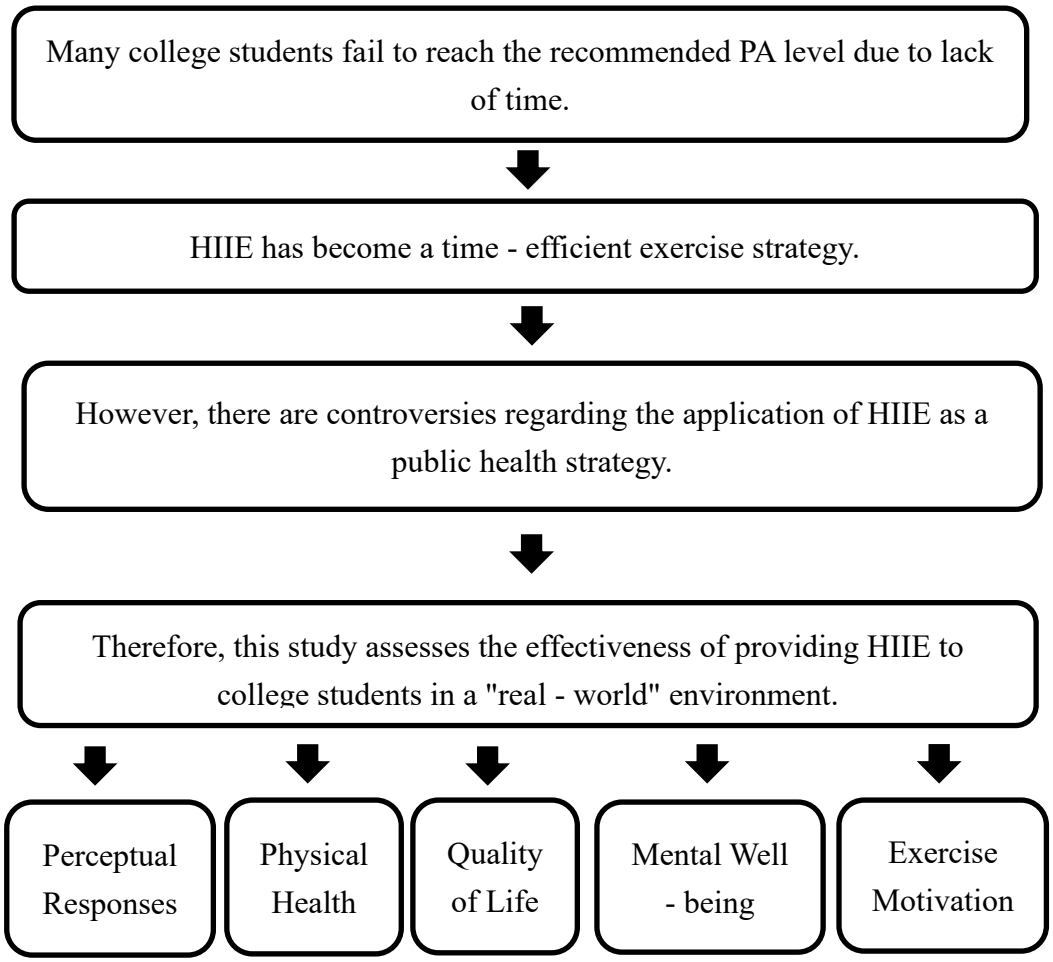
The latest updated World Health Organization (WHO) 2020 guidelines on sedentary and PA recommend performing at least 150 minutes of PA to achieve optimal health benefits. However, many college or university students did not achieve the recommended levels of PA. Given an increasing trend of physical inactivity in this cohort with "lack of time" being one of the most cited barriers to regular participation (Del Vecchio et al., 2015; Sequeira et al., 2011), there is a need to develop alternative strategies to engage college students in sufficient PA to maintain and improve their physical and mental well-being. Recently, small doses of vigorous-intensity PA have been adopted in PA guidelines for individuals aged 18 to 69 years old as at least 75 minutes per week for vigorous-intensity PA (WHO, 2020). Therefore, HIIE has emerged as a time-efficient exercise strategy to improve health benefits in various populations, yet the feasibility and application of this protocol to be applied in college students is unclear.

Apart from the health benefits of HIIE, the application of HIIE as a public health strategy is contentious. Sceptics suggest that the high-intensity exercise in HIIE has a psychologically aversive nature, such as being less pleasurable, and causes greater exertional stress, which may lead to poor implementation and adherence (Ekkekakis, 2003). Moreover, there is a suggestion to divert the attention of exercise strategy to

moderate interval exercise rather than HIIE per se (Jiménez-Pavón & Lavie, 2017). Therefore, the novel aim of this thesis is to optimize the prescription and implementation of interval - type exercise protocols. This will be achieved by evaluating the impact of different work intensities of interval exercise, specifically comparing HIIE and MIIE, on perceptual responses such as affective responses, enjoyment responses, and perceived exertion. Additionally, the study will assess the impact on the overall health and well - being, covering both physical and mental well-being aspects, among college student populations. There are many valuable reviews on the effects of interval training on health in various populations (Martland et al., 2020, 2022; Sant'Ana et al., 2020), but to the best of our knowledge, fewer studies to date have evaluated the efficacy of this type of training delivered in a 'real world' setting for young adults. Consequently, this thesis will evaluate the applicability of different interval protocols, specifically MIIE contrasted with HIIE, in college settings where an outdoor - based protocol will be employed. Moreover, it will contribute to and expand upon the current body of knowledge in the area of how perceptual responses of college students, such as affective responses, enjoyment levels, and perceived exertion, are related to exercise. Documenting this information during interval - type exercise is important as perceptual responses during exercise, which include affective responses, enjoyment responses, and perceived exertion, could influence the implementation and adherence of PA while

facilitating overall health benefits, particularly in physically inactive college students. To strengthen this notion, this thesis also tends to evaluate the role of exercise motivation factors (intrinsic and extrinsic) to the changes of perceptual responses in both MIIE and HIIE protocol among college students. Indeed, evidence has indicated that both affective and enjoyment responses are linked to the intrinsic type of exercise motivation, but fewer studies have provided evidence related to this relationship during interval-type exercise.

1.3 Theoretical framework



1.4 Research questions

1. Is there any significant difference between high-intensity interval exercise (HIIE) and moderate-intensity interval exercise (MIIE) across 12 weeks of intervention on perceptual responses (affective response, enjoyment responses, perceived exertion) in college students?
2. Is there any significant difference between HIIE and MIIE across 12-week intervention on physical health parameters (cardiovascular fitness and body composition) in college students?

3. Is there any significant difference between HIIE and MIIE across 12-week interventions on mental well-being (stress, anxiety and depression) in college students?
4. Is there any significant difference between HIIE and MIIE across 12-week interventions on HRQOL in college students?
5. Is there any significant difference between HIIE and MIIE across 12-week intervention on the components of exercise motivation (amotivation regulation, introjected regulation, identified regulation, intrinsic and extrinsic) in college students?
6. Are there any significant correlation between the perceptual responses and the different aspects of exercise motivation following HIIE and MIIE?

1.5 Research objective

1.5.1 General objective

To evaluate the effects of a 12-week HIIE and MIIE on perceptual responses, physical health, mental well-being, quality of life, and exercise motivation among college students.

1.5.2 Specifics objective

The following will be examined over a 12-week intervention in college students:

1. To determine the effects of high-intensity interval exercise (HIIE) and moderate-intensity interval exercise (MIIE) on the affective responses, enjoyment, and perceived exertion.
2. To compare the effects of HIIE and MIIE on the cardiorespiratory fitness and body composition.
3. To examine the effects of HIIE and MIIE on the stress, anxiety, and depression.
4. To investigate the effects of HIIE and MIIE on the HRQOL.
5. To compare the effects of HIIE and MIIE on the exercise motivation.
6. To explore the correlation between the perceptual responses and the different aspects of exercise motivation following HIIE and MIIE.

1.6 Research hypothesis

H_{O1}: There is no significant difference between HIIE and MIIE across a 12-week intervention on affective and enjoyment responses, and perceived exertion in college students.

H_{A1}: There is a significant difference between HIIE and MIIE across a 12-week intervention on affective and enjoyment responses, and perceived exertion in college students.

H_{O2}: There is no significant difference between HIIE and MIIE across a 12-week intervention on body composition and cardiovascular fitness in college students.

H_{A2}: There is a significant difference between HIIE and MIIE across a 12-week intervention on body composition and cardiovascular fitness in college students.

H_{O3}: There is no significant difference between HIIE and MIIE across a 12-week intervention on mental well-being status (stress, anxiety and depression) in college students.

H_{A3}: There is a significant difference between HIIE and MIIE across a 12-week intervention on mental well-being status (stress, anxiety and depression) in college students.

H_{O4}: There is no significant difference between HIIE and MIIE across a 12-week intervention on quality of life in college students.

H_{A4}: There is a significant difference between HIIE and MIIE across a 12-week intervention on quality of life in college students.

H_{O5}: There is no significant difference between HIIE and MIIE across a 12-week intervention on exercise motivation in college students.

H_{A5}: There is a significant difference between HIIE and MIIE across a 12-week intervention on exercise motivation in college students.

H_{O6}: There is no significant correlation between the perceptual responses and the different aspects of exercise motivation following HIIE and MIIE.

H_{A6}: There is a significant correlation between the perceptual responses and the

different aspects of exercise motivation following HIIE and MIIE.

1.7 Significance of the study

The present study seeks to advance the discussion surrounding the adoption and maintenance of high-intensity interval exercise (HIIE) as a public health strategy. One of the key debates centres on the challenges associated with adherence to HIIE protocols due to their high intensity, which can be perceived as less enjoyable or sustainable for certain populations, particularly those unaccustomed to vigorous exercise. On the other hand, HIIE has been shown to produce significant benefits in a shorter period of time, making it an effective choice for improving aerobic capacity, quality of life, mental well-being, and exercise motivation. By addressing these opposing perspectives, this study aims to provide evidence-based insights into the feasibility of incorporating HIIE into college-based interventions. This research explores the "compromise between ideal overall health perspectives and a feasible behavioural prescription" by examining how HIIE can balance significant health outcomes (e.g., improved physical and mental well-being, and enhanced quality of life) with sustainable exercise adherence. Specifically, the study investigates how perceptual responses, such as enjoyment and exertion levels, and exercise motivation, including intrinsic and extrinsic factors, influence the long-term adoption of HIIE protocols. This dual focus on health outcomes and adherence provides a nuanced understanding of how interval-based exercise interventions can be

optimized for college students.

Building on previous research, this study aims to address key gaps in the literature, particularly regarding how HIIE impacts behavioural engagement in young, physically inactive populations. By focusing on this demographic, the study contributes to a better understanding of the factors that influence exercise adherence, such as enjoyment, motivation, and perceived exertion, in a group that often struggles with maintaining regular physical activity. The proposed guidelines derived from this study are anticipated to increase exercise participation by tailoring interval exercise prescriptions to the needs of college students. Specifically, the structured design of HIIE, combined with strategies to enhance enjoyment and intrinsic motivation, may reduce barriers to participation and foster greater long-term adherence. Consequently, the findings offer practical recommendations for teachers, exercise professionals, and health providers to design and monitor effective interval exercise programs, particularly in college-based settings.

1.8 Operational definition

1.8.1 Affective responses

A subjective experience of the basic component of all valanced states (e.g., pleasant or unpleasant, positive or negative), including, but not limited to, the concepts

of emotion and mood (Ekkekakis & Petruzzello, 2000).

1.8.2 Enjoyment responses

A positive affective state that occurs when an individual engages in an activity that satisfies a desire goal, including but not limited to belongingness, esteem, or desire (Scanlan, 1992).

1.8.3 Rating of perceived exertion

A Subjective tool use to monitor or evaluate individual effort or intensity (Robertson & Noble, 1997).

1.8.4 High-intensity interval exercise

HIIE typically involves alternating between high-intensity exercise and low-intensity recovery intervals (Gibala et al., 2006). In this study, participants performed 5-10 repetitions of 1-minute work intervals at 90% of their MAS, with 75 seconds of self-paced walking active recovery between work intervals.

1.8.5 Moderate-intensity interval exercise

MIIE typically involves alternating between moderate-intensity exercise and low-intensity recovery intervals (Jiménez-Pavón & Lavie, 2017). In this study, participants performed 5-10 repetitions of 1-minute work intervals at 60% of their MAS, with 75 seconds of self-paced walking active recovery between work intervals.

1.8.6 Anxiety

In this study, anxiety refers to a mixture of general distress such as irritability, agitation, difficulty relaxing, and impatience (Lovibond & Lovibond, 1995).

1.8.7 Depression

In this study, depression refers to low levels of positive affect, e.g., dysphoria, hopelessness, lack of energy, and anhedonia (Lovibond & Lovibond, 1995).

1.8.8 Stress

In this study, stress refers to the feeling of tension and pressure when facing challenges or threats, including feelings of tension, irritability, and inability to relax. It is a psychological and physiological response to external stressors (Hammen, 2005).

1.8.9 Health-related quality of life

Health-related quality of life (HRQOL) refers to the health status of individuals and populations, as well as the impact of diseases on health, from various perspectives including physiological, psychological, and social functioning (Karimi & Brazier, 2016).

1.8.10 Exercise motivation

Exercise motivation refers to the psychological factors that drive individuals to engage in sports or exercise. Factors that involve in the exercise motivation include

intrinsic, extrinsic, identified, and amotivation (Wilson et al., 2008).

1.8.11 Maximal oxygen uptake

During exhaustive exercise involving large muscle groups, the maximal amount of oxygen that can be consumed per minute when the oxygen transport system's cardiac pumping function and the muscles' ability to utilize oxygen have reached their personal limit (Nickols-Richardson et al., 2000).

1.8.12 20-meter shuttle run test (20-mSRT)

Field-based fitness test that involves with the progression of speed within a different stage to establish individulas cardiorespiratory fitness through the prediction of the value of $\dot{V}O_{2max}$ (Oakes, 1986).

1.8.13 Maximal aerobic speed

The maximum speed at which $\dot{V}O_{2max}$ is achieved can be measured through an incremental load test or field-based fitness test. In this study, maximal aerobic test refers to the highest speed that individual can achieve at the stage of termination of the 20-mSRT (Buchheit, 2008).

1.8.14 Intrinsic motivation

It refers to the motivation that an individual engages in an activity due to internal factors such as the inherent pleasure, satisfaction, and interest of the activity itself (Ryan

& Deci, 2000).

1.8.15 Extrinsic motivation

It means the motivation that an individual participates in an activity for external factors like obtaining external rewards, avoiding punishment, meeting others' expectations, or conforming to external requirements (Aljumah, 2023).

1.8.16 Amotivation motivation

It represents a state in which an individual lacks a clear motivation when engaging in an activity, shows no goal - orientation, and is indifferent to the activity and its outcomes, lacking the willingness and drive (Legault et al., 2006).

1.8.17 Introjected motivation

It is a form of motivation with a relatively low degree of internalization. An individual engages in an activity based on internal pressure, sense of responsibility, or to avoid negative emotions such as guilt and self - blame, which is a less autonomous form of motivation that has not been fully internalized (Vallerand et al., 1992).

1.8.18 Identified motivation

It refers to the motivation that an individual, after cognitively judging the value and significance of an activity, integrates the activity with their own goals and values, and thus spontaneously and actively generates the motivation to participate in the

activity (Ryan & Deci, 2000).

1.9 Summary

This chapter starts by highlighting the significance of HRQOL for college students and the widespread issue of physical inactivity. Considering the health advantages of PA and the challenges students face in maintaining it, investigating alternative exercise modes such as HIIE is crucial. Although HIIE is a time-efficient approach, its applicability to this group remains unclear. The study intends to optimize interval exercise by comparing the effects of HIIE and MIIE on perceptual responses, physical and mental well-being, HRQOL, and exercise motivation. Subsequently, this chapter presents the questions and hypotheses to explore the differences between the two types of exercise. Finally, this chapter also provides Operational definition of key terms to help readers better understand the content of this study.

CHAPTER 2

LITERATURE REVIEW

The purpose of this chapter is to critically examine a conceptual and methodological research on HIIE protocol to perceptual responses including affective and enjoyment responses. This literature review will initially presents an issue related to the prevalence of physical inactivity among college students. This will be followed by a brief explanation of the existing HIIE protocol that applicable as a health strategy recommendation to promote physical health, mental well-being, quality of life, and exercise motivation in young adults. While parameters such as physical health, mental well-being, and quality of life are equally important, affective responses are particularly critical in this study as they directly influence participants' short-term experiences and long-term adherence to exercise. Moreover, positive affective responses are key to fostering intrinsic motivation and sustaining exercise behavior. Next, discussion related to the key studies related to affective responses during HIIE will be highlighted that have contributed to the major themes examined in this thesis.

2.1 Prevalence of physical inactivity among college student in China

Physical activity (PA) is widely recognized as a critical means to prevent various health risks across multiple populations (Ekelund et al., 2016; Kyu et al., 2016; Myers

et al., 2015). Regular PA is a known protective factor in preventing and managing non-communicable diseases such as cardiovascular diseases, type 2 diabetes, breast cancer, and colorectal cancer (Hallal et al., 2012; I.-M. Lee et al., 2012; McTiernan et al., 2019), mental well-being issues (Schuch et al., 2016), and facilitates a healthy body weight and overall sense of well-being (Das & Horton, 2012).

With the advent of the technology age and the widespread use of smartphones, there has been a significant change in the PA patterns of college students. One of the most important changes is the increasing sedentary lifestyle among college students, such as spending long hours sitting in front of computers or constantly looking down at their phones. As more sedentary behaviors become prevalent, activities like walking, exercising, and other dynamic lifestyles are likely to decrease, leading to issues related to insufficient physical activity. This will directly lead to certain health issues, such as an increased risk of conditions like hypertension and osteoporosis (Gaetano, 2016). Moreover, insufficient physical activity has led to a trend of younger individuals developing chronic diseases, making it a major global public health concern along with mental well-being issues (Booth et al., 2012; Patel et al., 2007).

College students are at a stage of rapid physical and mental development, but they also face a multitude of pressures related to academic learning, daily life, employment, and interpersonal relationships. Insufficient physical activity not only has

a direct impact on their physical health but can also lead to various degrees of psychological problems (Li & Che, 2022). Research indicates that the global age-standardized prevalence of insufficient physical activity is 27.5% (Guthold et al., 2018). In 2016, 81% of college students aged 11-17 worldwide had insufficient PA, and in China, the issue of insufficient physical activity among young people is particularly severe, with a staggering 84.3% lacking adequate physical activity (Guthold et al., 2020). Recent evidence indicates college students are often exposed to unhealthy behaviour changes such as increased sedentary behaviour while decreasing PA (Anuar et al., 2021). Indeed, previous findings have reported that almost half of the college students (40% to 50%) are physically inactive regardless of gender across the world including in China (Chen et al., 2020; Martínez-Bello et al., 2017; Pengpid et al., 2015) . This evidence is strengthened by the increasing pattern of sedentary lifestyles among college students, whereby lack of time due to intense academic and work demands became the major reason for the neglect of the importance of PA. The transition period from adolescence (age 10 to 19 years old) to adulthood (above 20 years old) is a critical stage for forming a healthy lifestyle and developing healthy behaviours. Therefore, targeting college-age groups appears to be a significant period for the establishment of behavioural PA habits given behaviours accustomed during this period may continue into adulthood (Huotari et al., 2011).

A recent study by Zhang and colleagues (2022) has reported that vigorous PA benefits college students' physical and mental well-being compared to low or moderate intensities of PA. Specifically, the author indicates that vigorous PA predicts an optimal healthy lifestyle for a total of 723 undergraduates students registered as dental and medical students. Indeed, King et al., (2013) concluded that that greater involvement in vigorous PA, with a minimum of two days of participation, is strongly correlated with perceived benefits such as improving health, fitness, and appearance among university students. This evidence may suggest that implementing and development strategies to increase vigorous PA should be considered when targeting college or university students. Therefore, there is a strong rationale to study alternative forms of PA for college-age groups, with one strategy adopting smaller volumes of vigorous-intensity PA. Furthermore, small doses of vigorous intensity PA has been included in PA guidelines for young adults (below 25 years of age) as at least 75 minutes per week for vigorous intensity PA (Organization, 2020).

2.2 High-Intensity Interval Exercise

Sport scientist have commonly utilised exercise as a form of activity to improve PA levels while promoting health benefits in various populations including young adults (Costigan et al., 2015; Logan et al., 2014). Exercise can be defined as subset of PA that is planned, structured, repetitive, and purposive in the sense that improvement or