Self-Determination Theory-Based Promotion Intervention for Physical Exercise Behavior in Chinese College Students

Wenjuan Zhang

A Thesis Submitted in Partial Fulfillment of Requirements for
degree of Doctor of Philosophy in Exercise and Sport Science
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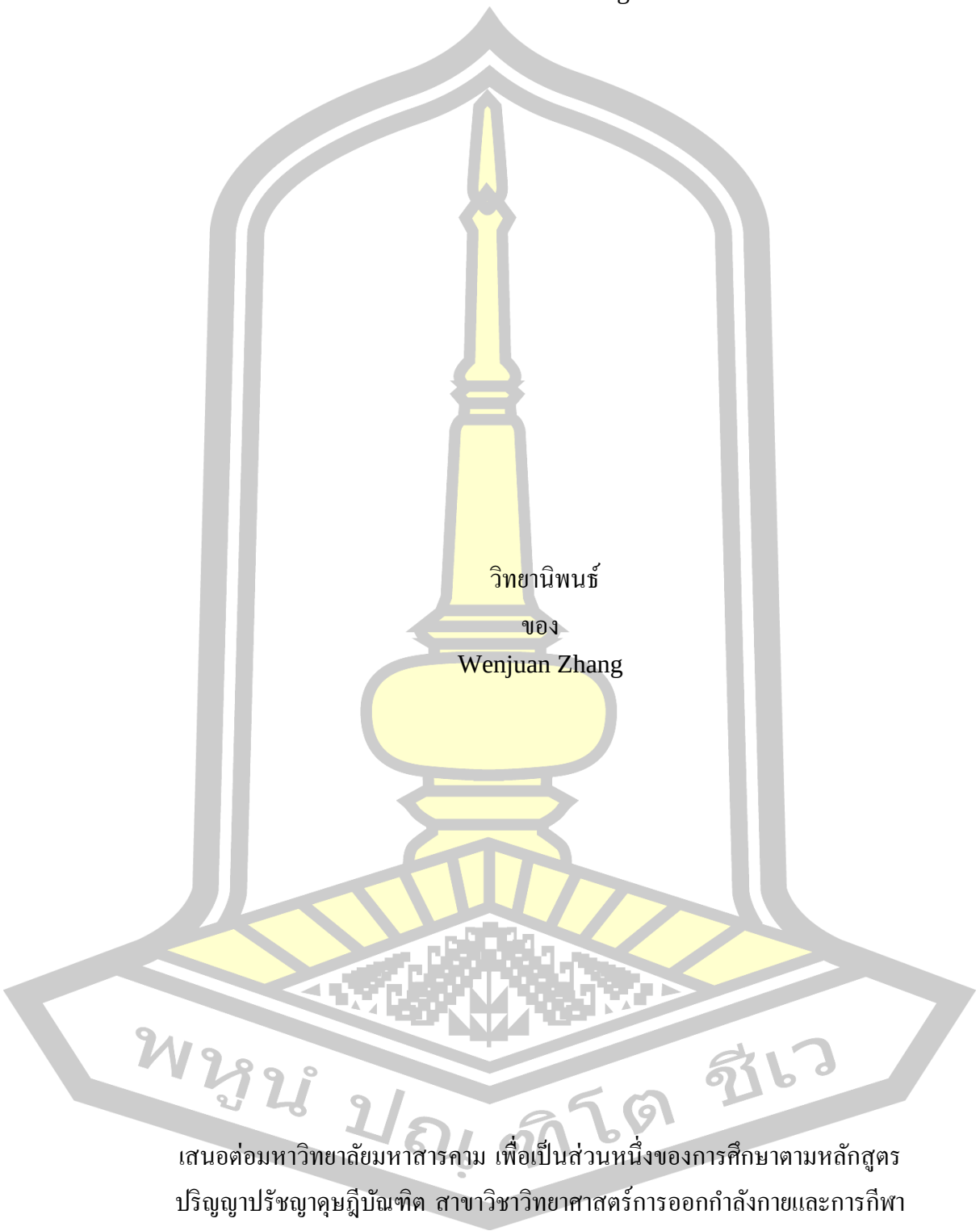

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ABSTRACT

Although the health benefits of physical exercise are widely recognized, the physical fitness level of college students is still very poor in recent years, and the decrease in physical exercise is the direct cause of the decline in the physical fitness level of college students, and how to improve the physical fitness of college students has been the focus of global public health concerns. This study takes self-determination theory as the theoretical basis of the research, explores the promotion path of college students' exercise behavior change, tries to establish and validate the intervention model of exercise behavior of self-determination theory, and is able to take effective interventions to provide theoretical basis for stimulating and promoting the form of autonomous motivation for college students and provide effective service and practice.

Therefore, this study constructed a self-determination theoretical model to predict Chinese college students' physical exercise behaviors, and applied the theoretical model to conduct an intervention study on college students' exercise behaviors using a quasi-experimental design. Research objective 1: is to construct a theoretical model for predicting exercise behavior suitable for the Chinese college student population; Research objective 2: is to test the revised theoretical model using a cross-sectional study; Research objective 3: is to apply the theoretical model using a longitudinal intervention study. Research Methods: The mechanism of the influence of autonomy support provided by physical education teachers on college students' exercise behavior was studied mainly by using literature, questionnaire survey, experimental method and mathematical statistics.

The main conclusions are as follows:

1. The self-determined exercise behavior model is applicable to the Chinese college student population; autonomy support, basic psychological needs, and autonomous motivation are important constituents that promote college students' physical exercise behavior.

2. The self-determined exercise model can effectively explain and predict

the exercise behavior of college students, and the chain-mediated model constructed using structural equation modeling has good fit and simplicity.

Autonomy support provided by physical education instructors positively affects college students' behavior toward exercise (β= 0.235, R^2= 0.06, P＜0.01).

Basic psychological needs completely mediated the relationship between autonomy support and the effect of exercise behavior (β= 0.304, R^2=0.11, P＜0.01).

Autonomous motivation partially mediated the relationship between autonomy support and the impact of exercise behavior (β= 0.465, R^2=0.25, P＜0.01).

Autonomy support positively predicted college students' exercise behavior through the chain-mediated effects of basic psychological needs and autonomous motivation (R^2=0.26). The path of autonomy support→basic psychological needs→autonomous motivation→exercise behavior, had an indirect effect of 1.825, 95% CI [1.354, 2.322] indicating a significant chain mediation effect.

3. An applied study based on the self-determined exercise model was conducted with 200 college students in a longitudinal intervention experiment, and the results verified that the intervention of exercise autonomy support significantly influenced college students' basic psychological needs satisfaction, autonomous motivation, and exercise behavior. Students in the experimental group, who adopted the autonomy support strategy, were significantly higher than the control group in terms of basic psychological needs satisfaction, autonomous motivation level and exercise behavior.

Keyword : Self-determination theory, Physical exercise behavior, Chinese college students

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Wenjuan Zhang

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CHAPTER I

INTRODUCTION

Background

The report of the World Health Organization (WHO, 2002) clearly states that physically inactive or sedentary lifestyles have become one of the top 10 causes of death, disease, and disability worldwide, and that it can increase the mortality rate from almost all diseases. However, physical inactivity and sedentary lifestyles have become a recognized public health and social problem worldwide (Ntoumanis, 2021). Previous studies have shown that regular physical activity brings many positive effects on an individual's health, and that regular participation in physical activity improves physical health (cardiorespiratory fitness and muscular fitness), mental health (reduction in depressive symptoms), cardiovascular fitness (normalization of blood pressure, blood lipids, blood glucose health, and insulin secretion), bone fitness, enhancement of cognitive functioning (academic performance, executive functioning), and reduction in the prevalence of obesity (Si et al., 2022). At present, however, various health problems caused by physical inactivity pose a great health challenge to governments around the world, and have become the highest risk factor for non-communicable disease (NCD) deaths globally (zhang et al., 2022; Bull et al., 2020). Government departments in various countries and regions have also increasingly emphasized the importance of public health for the healthy development of a harmonious society. The physical exercise guidelines recommended by the Canadian government state that adults should participate in no less than 60 minutes of moderate-intensity physical exercise per day (at least 10 minutes of exercise per session).

According to the latest data from the World Health Organization (WHO, 2020): 80% of adolescents worldwide are still experiencing varying degrees of slippage in their physical health status, and the World Health Organization and many countries have successively put forward physical exercise guidelines for adolescents, recommending at least 60 min of cumulative moderate to high intensity physical exercise per day, and at least 3 times per week of strength exercises (Piercy et al.,

2018; Chaput et al., 2020; Zhang et al., 2017; Guthold, 2020). Ma's (2019) pointed out that physical exercise brings many benefits to college students' health, such as strengthening cardiorespiratory fitness, reducing obesity and promoting mental health; and by comparing the physical exercise guidelines for college students issued by Canada, the United States, and Australia, it was found that all three countries recommend that college students insist on engaging in moderate-intensity physical exercise for no less than 60min per day. Studies have shown that the physical fitness of China's college students has shown a declining trend in recent years, with less than 30% regularly participating in physical exercise, and insufficient physical exercise is the main reason for their declining physical fitness and increasing obesity rates (Yang et al., 2020; Fang, 2020); According to the"Healthy China 2030"plan, the number of people who regularly participate in physical exercise will reach 530 million by 2030, and the rate of reaching the physical fitness standard for young people needs to reach more than 25%. It can be seen that the physical health of college students is getting more and more attention from the state (State Council, 2016). The results of the National Survey of Students' Physical Fitness and Health, released by China's Ministry of Education in 2021, showed that "the overall decline of college students' physical fitness and health attainment rate", a disappointing result (Ministry of Education, 2021). However, the problem of insufficient physical exercise and unsatisfactory physical health among adolescents is also prevalent in developed countries, according to the U.S. Department of Health & Human Services (U.S. Department of Health & Human Services, 2009), which showed that adolescents spend less and less time participating in physical activities (especially girls), and that their physical health status is accompanied with age growth is also getting worse; some research results show that the proportion of American adolescents who exercise for one hour a day is 8%, and nearly half of the young people do not form regular physical exercise (Guthold et al., 2008). It can be seen that the physical health of adolescents in developed countries in Europe and the United States is also not optimistic, and the governments of various countries attach great importance to the physical health of adolescent students and continuously introduce measures and policies to improve the physical health of students, such as the Physical Exercise Recommendations and the National Physical Exercise Program issued by the United

States, and developed countries such as the United Kingdom and Canada have also enacted relevant systems and measures (Peng et al., 2020; Huang and Zhang, 2020).2021 Five departments in China, including the Ministry of Education and the State General Administration of Sport, once again issued opinions on strengthening students' physical exercise and emphasized the need to increase the amount of time students spend on physical exercise in an effort to improve students' physical fitness and health (Ministry of Education, 2021).

In summary, it can be seen that the decline of college students' physical health has become a serious global social problem, which has been highly valued by governments and closely watched by researchers, and the decrease of physical exercise is the direct cause of the decline of college students' physical health, and how to improve the physical health of adolescents has been a focal point of concern for global public health.

The health benefits brought about by regular physical exercise have been generally recognized, and the fitness function of physical exercise, as one of the positive means of enhancing physical fitness, preventing diseases and improving the quality of life, has long been confirmed by medical research and clinical practice. However, the current physical fitness status of Chinese college students is worrying. The sedentary lifestyle of college students has not changed, and the frequency and intensity of their physical exercise is gradually decreasing. During college, unhealthy lifestyles have caused college students to develop more and more physical health problems, and studies have shown that college students who lack physical exercise have a 1.25 times higher risk of obesity diseases than those who actively participate in physical exercise (Wang, 2019). At the same time, participation in physical exercise has a very great impact on students' psychology and sleep, and university campuses have more developed sports resources compared with primary and secondary schools and high schools, but the unique conditions have not improved the occurrence of sub-health problems caused by the lack of physical exercise among college students (Chow and Choi, 2019). Li et al. (2019) compared the health data of college students in several years, and found that the physical quality of college students in China has deteriorated in recent years, which is mainly due to the fact that students spend most of their time in the dormitory, indulging in the Internet, games, increased academic

pressure, reduced participation in sports time and irregular diet and rest habits. Lack of appropriate physical exercise, the body's muscles and organs can not be fully exercise, the physical quality will naturally decline, and the main factor in the decline of college students' physical fitness is the lack of physical exercise. Therefore, strengthening college students' awareness of physical exercise motivation and promoting physical exercise behavior to enhance students' physical fitness and health level has become an important issue facing physical education in colleges and universities in China.

Physical inactivity among adolescents has become a global phenomenon, and an expert group of foreign sports researchers has published a review article in the Lancet that answers the focus question: "Why do adolescents participate in low levels of physical exercise? Why are some adolescents active? And others inactive?" The study concluded that "only by identifying and understanding the Determinants of Physical Exercise can public health interventions be developed and improved, as is the case with symptomatic treatment in etiology" (Bauman et al., 2012). Combined with this review of research, we can conclude that psychological, cognitive, social, and policy factors all play an important role in adolescent physical exercise.

Physical exercise can bring about good physical health and psychological effects. A large number of experimental studies have shown that regular and effective physical exercise is conducive to the development of people's physical and mental health. Although we all know that adhering to a lifestyle of effective exercise is very important and can improve many physical and mental health problems faced by modern civilized societies, most of the people are still in the state of knowing but failing to do so. They do not participate in physical exercise regularly, and even when they do participate in physical exercise, there is a high rate of people quitting in the middle of the exercise. Research has shown that there are many factors affecting the development of good, positive physical exercise behavior in students' participation in physical exercise, such as: the basic psychological needs for physical exercise cannot be met, lack of awareness of and motivation for physical exercise, high pressure of study, high pressure of employment, college students' subjective belief that there is no time for physical exercise, lack of a suitable physical exercise environment, and insufficient awareness of the value of physical exercise, etc., and one of the most

important reasons is the lack of motivation for college students to engage in physical exercise (Cao, 2023). College student groups are in the critical period of transition from adolescence to youth, which is the best period for the exercise effect of many important physiological indicators. How to stimulate college students' motivation to exercise, explore methods and measures to improve the level of exercise behavior, and cultivate positive and regular exercise habits are important issues of concern to exercise psychology researchers.

The research on exercise promotion has a long history, and there is a large amount of literature on factors affecting people's exercise behavior in both domestic and international academic circles, among which the research on constructing, testing, integrating, and perfecting various prediction models of exercise behavior is predominant, and especially the behavioral models with mature theoretical guidance are more likely to arouse the interest of the researchers, because it was found that the theoretically-guided behavioral models can more comprehensively examine the factors affecting exercise behavior, and the intervention effect on exercise behavior is better than that of the theoretically-unguided behavioral models.

In the field of physical exercise behavior, psychologists have proposed many theoretical models that prompt changes in health behaviors with the aim of explaining and predicting people's exercise behaviors and providing theoretical guidance for interventions in exercise behavior. There are two main categories: health behavior theories and social cognitive theories (Mao, 2014), and health behavior theories include the health belief model (HBM) (Janz et al., 1984), theory of reasoned action (TRA) (Fishbein & Ajzen, 1975), and theory of planned behavior, (TPB) (Ajzen, 1991), the transtheoretical model (TTM) (Prochaska et al., 1983), the health action process approach, (HAPA) (Schwarzer, 1992). Social cognitive theories include the self-efficacy theory (SET) (Bandura, 1986), the self-determination theory (SDT) (Deci & Ryan, 1985), and others. These theories understand the psychological characteristics of individuals from the onset to maintenance of exercise behavior from different perspectives and social-environmental contexts. For example, the Theory of Planned Behavior model is concise and easy to operate, it has relatively high explanatory power for behavioral intention but low explanatory power for behavior and cannot be effectively used for the intervention of exercise behavior (Duan, &

Jiang, 2008; Feng, 2014; Zhang et al., 2022); the trans-theoretical model can be effective for the intervention of exercise behavior but cannot be effective for the prediction of exercise behavior (Yin, 2007). Health action process approach (HAPA), as a stage model, emphasizes the “stage dynamics” of behavior, and it does not explicitly include social influences in the model to predict exercise behavior (Shen, 2016). These theories have contributed to the prediction of individuals' physical exercise behaviors from different perspectives, but each theory has strengths and weaknesses, and cannot comprehensively predict, explain, and intervene in people's activities or exercise behaviors, and there are great limitations.

In the field of exercise psychology research, theories about exercise motivation and intention have been at the forefront of research on exercise antecedent variables, mechanisms, and interventions, and a large number of studies have demonstrated that an individual's exercise behavior is influenced by his or her motivation to exercise (Fan, 2018; Xue, 2010), and that motivation is a motivating factor in the initiation of an individual's activity as well as an important factor in maintaining the continuity of the activity, and it has been recognized as the strongest and most stable individual-level predictor variable of physical exercise. SDT proposed by Deci and Ryan provides a plethora of suitable explanations for understanding exercise behavioral patterns and exercise participation, as well as the process by which their internal, interpersonal factors promote autonomous motivation for exercise.

Self-Determination Theory (SDT) is a motivational theory of human social situations. The core idea of this theory states that the external environment must satisfy the three basic needs of the individual (autonomy, competence, and relatedness) in order to obtain high-quality autonomous motivation for optimal individual behavioral performance. Its theoretical model assumes that "social environmental factors→basic psychological needs→motivation→behavioral performance", which systematically explains the paths and mechanisms of the external environment, basic psychological needs, individual motivation and individual participation in behavior, and greatly promotes the optimization of individual physical and mental health and behavior. Its core view is that the external environment can influence individuals' basic psychological needs, and when individuals' basic psychological needs are satisfied, autonomous motivation can be predicted. Typically,

the higher the satisfaction of basic psychological needs, the higher the individual's level of autonomous motivation, and higher autonomous motivation is associated with more desirable performance of participatory behaviors. Conversely, when the external environment fails to satisfy or partially satisfies an individual's basic psychological needs, higher levels of controlled motivation are demonstrated, along with negative behavioral engagement (Maldonado, et al. 2019).

SDT theory believes that the stronger the autonomy the closer the motivation is to internal motivation, internal motivation is the reason why individuals change their behavior from inactive participation to active participation, and it is the driving force to maintain individual behavior and exert creativity. However, the exercise behavior of college students is also in line with such a law, how to effectively regulate the social environment factors to stimulate the internal motivation of college students to participate in physical exercise, so that students can form more autonomous exercise motivation in the process of exercising, so that physical exercise persistently shows lower probability of withdrawal, has become a hot topic in the field of physical exercise.

At present, the relationship between interpersonal support, students' basic psychological needs, autonomous motivation, and students' sports participation in physical education has been extensively explored at home and abroad using SDT. It has been confirmed that to improve the level of physical exercise of Chinese adolescents, not only the external conditions need to be guaranteed, but also should be tapped from the individual psychological state of the exerciser, because the interest and motivation of exercise are the top 2 factors affecting the extracurricular physical exercise of adolescents (Xiang, 2013). Effectively stimulating exercise motivation and cultivating a good interest in physical education and learning become important markers for maintaining and promoting adolescents' physical exercise participation. SDT can help researchers understand the motivational qualities of exercise participants, and its principles can also be utilized to promote the motivational development of exercise participants.

SDT extensive attention and scientific explanation of SDT on sports participation as a behavioral performance provides a theoretical basis for this study. Therefore, this study decided to adopt SDT as the theoretical basis of the study, exploring the

promotion path of college students' exercise behavior change, trying to establish and validate the intervention model of SDT exercise behavior, and being able to take effective interventions to provide a theoretical basis for stimulating and promoting the form of autonomous motivation of the college students and effective service and practice.

Objectives

Based on the background, formation process, basic ideas and research results proposed by the SDT, this study provides a comprehensive and in-depth overview and discussion of the theory, with the following main objectives:

1. To construct a prediction model of self-determined exercise applicable to the actual situation of Chinese college students' physical exercise.

2. To verify the effect of the self-determined exercise model on Chinese college students' exercise behavior, and to explore the relationship between the variables in the model and exercise behavior.

3. To develop an intervention program for Chinese college students' physical exercise based on SDT, and to verify the intervention effect of the SDT prediction model on Chinese college students' exercise behavior.

Research Problem

1. Is the constructed prediction model of self-determined exercise validated?

2. Can the self-determination exercise model predict college students' exercise behavior? What is the relationship among the variables of autonomy support, basic psychological needs, autonomous motivation and exercise behavior in the model?

3. Does the application of the constructed self-determined exercise model have an impact on the physical exercise of Chinese college students in intervention studies?

Hypothesis of the Research

1. The exercise prediction model based on SDT is applicable to the Chinese college student population.

2. The SDT exercise model can effectively predict and explain the exercise behavior of college students. Among them, the positive effect of teacher autonomy support on college students' physical exercise behavior is significant. Basic psychological needs and autonomous motivation respectively play a mediating effect in the process of teacher autonomy support influencing exercise behavior. Basic psychological needs and autonomous motivation have a chain mediating effect between teacher autonomy support and exercise behavior.

3. The SDT exercise intervention model with autonomy support as the intervention method can improve the physical exercise behavior of Chinese college students.

Theoretical framework diagram

Based on SDT and the purpose of this study, this study reviews the relevant literature to initially identify a theoretical framework for physical exercise interventions for college students in China.

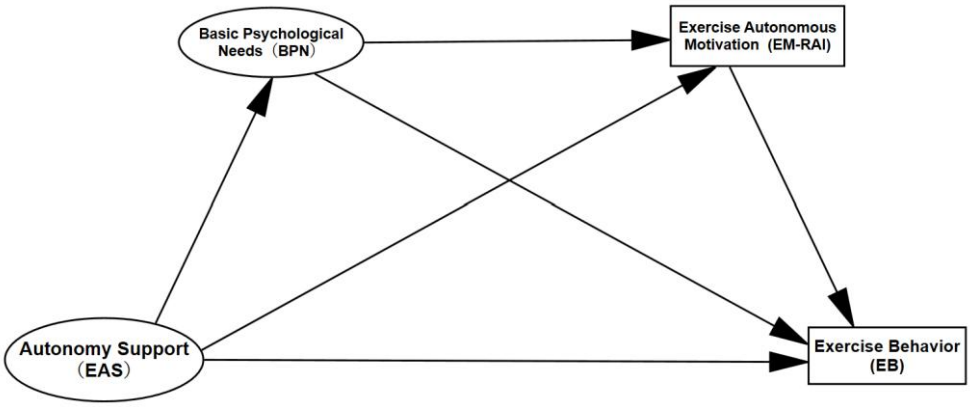

Figure 1 SDT- Research hypothesis model

Significant of Study

1. By reviewing the existing literature, SDT has a wide range of applied research in the field of education, but relatively few empirical studies have been conducted in the context of Chinese college students on the relatedness between external environmental support and autonomous motivation. This study attempts to construct

and validate a self-determined exercise behavior model, and tries to expand the research on autonomous motivation of Chinese college students, to provide new research perspectives on autonomous exercise motivation, to fundamentally mobilize the internal motivation of college students to participate in physical exercise, and to make their exercise more autonomous, competent, and relational, which helps to enrich the practical application of SDT.

Practical implications

2. This study used the research method of controlled experiments to validate the effectiveness of the self-determination theoretical model in the intervention of college students' physical exercise behaviors, and to further validate the effectiveness of exercise autonomy support on the formation of autonomous motivation and exercise behaviors of Chinese college students from the practical level. This study attempts to identify effective methods for autonomous exercise motivation formation, which will provide clear and explicit guidance for future physical exercise interventions for college students, and will have positive significance for promoting Chinese college students' exercise behavior.

3. The autonomy support provided by teachers can cultivate and stimulate the autonomous motivation of college students to participate in physical exercise, and fully mobilize the enthusiasm of college students to engage in physical exercise, which is good for enhancing students' physical fitness and improving their physical and mental health.

4. This study provides valuable theoretical references for the development of strategies to promote college students' exercise behaviors, enriches the theoretical perspectives of exercise behavior research, and helps to inspire more college students to participate positively in physical exercise, improve their physical fitness, establish a team of Chinese college students with high quality physical fitness, and then develop a lifelong awareness of physical exercise.

Related concepts and definitions

1. Physical Exercise Behavior

Physical exercise, is a fundamental method of realizing the goals and tasks of the sport, which is also is realized through a variety of sports. In Physical

Exercise and Mental Health, Ji (2006) points out that physical exercise usually refers to those physical activities that are planned, regular, and repetitive for the purpose of enhancing physical fitness, including various forms of activities related to cardiorespiratory fitness, muscular strength and endurance, agility, and body composition. According to scholar Qiu (2015), physical exercise is a sport aimed at improving physical health, motor skills and sports interest. According to Wang et al. (2016), physical exercise behavior refers to, physical activities that people perform in order to seek physical and mental health, using their free time to subjectively adopt certain means and methods.

Physical exercise behavior (PE) in this study refers to the planned and regular physical activities carried out by college student groups with the purpose of enhancing physical fitness and improving or enhancing physical health, using sports means and scientific exercise methods in physical education classrooms and extracurricular leisure time, including forms of exercise mainly related to muscular strength, endurance, flexibility, body composition, and cardiorespiratory fitness, etc., and with a certain physical exercise intensity, exercise frequency and duration of physical activity. The Physical Activity Rating Scale (PARS-3), which was used in this study and revised by Liang Deqing et al. according to our country, measures the amount of exercise in terms of exercise intensity, duration and frequency of exercise, with physical exercise= Intensity×(Duration -1)×Frequency.

2. Self-Determination Theory

SDT proposed by American psychologists Deci and Ryan in the 1980s, is a motivational theory about human social situations, which powerfully explains the causal paths and mechanisms by which external environments influence individuals' motivation and behaviors, and is an important guide to individual behavioral incentives and change (Ryan & Ryan, 2002). The assumption model of SDT is “external environment→basic psychological needs→motivation→behavioral performance”, which believes that the social environment can enhance internal motivation and promote the internalization of external motivation by supporting the satisfaction of the three basic psychological needs: autonomy, competence, and relatedness. It reflects a person's self-determination and intrinsic desire to engage in

an activity, desire for knowledge, and pleasure, and is an internal driver of individual behavior that is associated with more desirable participatory behavior. The theory states that the internalization of human motivation is not spontaneous but needs to be supported and nourished through the external environment.

Autonomy support

SDT identifies a sense of autonomy support as an important external environment that influences the fulfillment of an individual's basic psychological needs. A sense of autonomy support for exercise refers to an individual's perception of support from significant others (e.g., teachers, peers, family members) for their views on exercise, understanding of their feelings, and provision of information and opportunities for autonomous choice (Deci et al., 2008).

Whether or not exercisers feel "autonomy support" depends on the perceived level of support for their basic psychological needs, especially their autonomy needs. Teacher autonomy support should include a variety of behaviors such as providing students with more freedom and choice, encouraging self-enlightenment, reducing control and tension, and satisfying positive emotional experiences.

For the purpose of this study, perceived teacher autonomy support was defined as: students' perceived autonomy support from their physical education teachers, students' belief that their physical education teachers support their autonomous motivations, understand them, and provide opportunities for autonomous choices, and encourage students to solve problems independently.

Basic Psychological Needs

Basic psychological needs satisfaction is the feeling of dominant control and choice over behavior that an individual can experience. Basic psychological needs theory, which emphasizes that human mental health is affected by basic psychological needs, also suggests that the way motivation is regulated is affected by basic psychological needs (Deci & Ryan, 1985).

Deci divides basic psychological needs into three categories: need for autonomy, need for competence and need for relatedness. Among them, autonomy is regarded as the individual's need to be free from other people's control, to be able to make choices and decide his/her own behavior, and to be able to satisfy his/her autonomy from activities; competence is regarded as the individual's need to control his/her

environment, to be able to skillfully and successfully complete a certain action or a certain activity, and to experience a sense of competence from it. Competence is considered to be the individual's need to control the environment, to be able to skillfully and successfully perform an action or an activity, to experience a sense of competence and accomplishment, and to obtain the need for competence; relatedness is considered to be the individual's desire to receive care, understanding and support from the surrounding environment and others, to establish an emotional link with others in the activity, and to experience a sense of belonging. When basic psychological needs are genuinely satisfied in social situations, it promotes the internalization of the individual's extrinsic motivation and the formation of intrinsic goal orientation.

This study defines the basic psychological needs as: it means that when college students are in the external environment of physical exercise, they are able to complete a certain exercise according to their own ideas, and at the same time, they can get the support and care from others during the exercise period, and the fulfillment of the basic psychological needs of physical exercise is beneficial to the stimulation of the motivation of the individual to exercise, so as to better promote the individual to produce the behavior of physical exercise.

Autonomous Motivation

According to SDT, autonomous motivation refers to the motivation of individuals to engage in a behavior out of their own interests and wishes. Including Identified Regulation, Integrative Regulation and Intrinsic Regulation are collectively called self-determined motivation or autonomous motivation. Controlled motivation includes two specific forms of motivational regulation, External Regulation and Introjected Regulation.

Autonomous motivation is defined in this study as the motivation of an individual to engage in physical exercise behavior out of his or her own interest, personal beliefs, and will. Motivation to engage in exercise with an adequate sense of willingness and volition is the dominant factor that stimulates individual behavioral initiative and persistence. Based on the motivational continuum, autonomous motivation scores are usually expressed in the form of Relative Autonomy Index (RAI), RAI =3×Internal Motivation + 2×Integration Motivation + Identity Regulation

– Intrinsic Regulation – 2×Extrinsic Regulation – 3×No Motivation, with higher scores indicating higher motivation. No Motivation, with higher scores indicating greater autonomy in motivational orientation Negative scores represent individuals who are control motivated.

3. College Students

College students in this study refer to the group of full-time enrolled college students who are receiving basic higher education in state-recognized institutions of higher learning and have not yet graduated, which are divided into specialist and undergraduate groups. The survey respondents of this study are male and female college students aged 17-23 years old in grades 1-2 of 6 colleges and universities in Shandong China.

CHAPTER II

REVIEW OF RELATED LITERATURE

In order to better understand the relevant theories and establish the SDT intervention model, the relationship between SDT, autonomy support, basic psychological needs, autonomous motivation and college students' physical exercise behavior is the focus of this study. According to the purpose of the study, this chapter will discuss the following important issues: relevant studies on physical exercise behavior of college students; background of SDT; related research on autonomy support; studies related to basic psychological needs; related research on autonomous motivation; related research on SDT in the field of physical exercise; status of research on SDT-based physical exercise intervention programs. Therefore, in terms of literature sorting, the relationship between these variables is also mainly used as a clue to explore the college students' physical exercise behavior by using SDT, and the pre-existing related literatures were summarized and organized, in order to provide important theoretical support for the construction of the theoretical model and the analysis and discussion of the research results.

Relevant studies on physical exercise behavior of college students

1. Concept of physical exercise

In the Dictionary of Physical Education published in China, physical exercise is interpreted as "a physical activity that uses a variety of means of exercise for the purpose of improving health and strengthening the body". The encyclopedia adds that physical exercise is a physical exercise that can satisfy spiritual needs on the basis of health promotion. According to Ji (2006), physical exercise is a physical exercise that can enhance health and physical fitness, using a certain intensity, frequency and time of exercise means and exercise content. According to Xi (2004), physical exercise is a kind of sport that is carried out to enhance physical fitness, improve physical and mental health, and improve and maintain the ability of the organism by means of physical exercises and exercise loads, and by means of fitness, recreation and leisure, health care and rehabilitation, and psychological and intellectual exercise. Foreign

experts Caspersen (1985) believes that physical exercise should be carried out purposely and systematically to achieve the purpose of enhancing physical fitness and health. Hu's (2019) studied a Chinese scholar, found through experiments that physical exercise has a positive effect on physical and mental health, self-discipline and other psychological factors, and that appropriate participation in physical exercise can effectively improve the physiological and psychological health of the exerciser.

Relevant studies have shown that physical exercise behavior mainly has the functions of strengthening the body, improving the functions of various body systems, promoting intellectual development, sounding the overall development of personality, harmonizing interpersonal relatednesss, promoting mental health and recreation. The main purpose of people's participation in physical exercise is to maintain and improve their health, and a deep understanding of the health benefits of physical exercise may influence people's physical exercise behavior. Physical exercise behaviors are goal-directed and conscious behaviors that are psychologically driven by the individual.

2. The current situation of college students' physical exercise

Research on exercise behavior first appeared in foreign countries, Nolson (1954) in the medical field of treatment of cardiovascular disease introduced the relevant knowledge of the field of physical exercise, around 1980, foreign sociology, psychology and other fields have also begun to introduce the theory of exercise behavior into their respective fields of study, in-depth exploration of the behavior of physical exercise in promoting the positive role of human behavioral habits in a variety of ways The positive role of physical exercise behavior in promoting the formation and development of human multifaceted behavioral habits has been explored in depth. With the development of science and technology and humanities and arts, the field of physical exercise has also been studied in conjunction with various fields such as medicine, psychology and sociology. It is a positive and healthy way of exercise, which is beneficial to both individuals and society, constantly promotes human growth and development, cultivates the awareness of fitness and exercise, and relieves fatigue through exercise so as to regulate emotions and alleviate stress; in the process of sports development, it is necessary to pay attention to guiding and encouraging people to actively participate in sports and exercise, and applying the exercise behavior to various forms and contents of sports activities, which makes the

exercise behavior In the process of sports development, we should focus on guiding and encouraging people to actively participate in physical exercise, and apply the exercise behavior to various forms and contents of sports activities, so that the exercise behavior can become the most important method of activity and behavior.

Research on physical exercise behavior at home and abroad mainly focuses on the potential or obvious effects of physical exercise on individuals, mostly on the overall characteristics of physical exercise behavior, theoretical models, influencing factors, and the relatedness between mental health and so on. The research targeting college students mainly focuses on the investigation of the current situation of college students' participation in physical exercise behavior, factors affecting college students' participation in physical exercise, and what measures should be taken to intervene in college students' physical exercise.

Scholars in China have investigated the participation of college students in physical exercise in colleges and universities in many different regions of China, covering a wide range of areas. Wang's (2008) study of college students' participation in physical exercise in Shandong Province shows that college students in Shandong Province are increasingly diversified in their interest in participating in physical exercise activities, are actively involved in physical exercise, and have a variety of forms of physical exercise and richer content, but college students do not have clear exercise plans and goals, lack of space and equipment, high pressure of study, and lack of organization and management of physical exercise. Scholar Zhu's (2015) study found that the main reason for both male and female college students to participate in physical exercise is to enhance physical health, enrich extracurricular life and enjoyment of the body and mind is the second reason, and in order to achieve the standard of physical education courses is also one of the main reasons for female students to participate in physical exercise. Zhang et al. (2012) and other scholars investigated extracurricular physical exercise in eight major cities in China, and found that the influence of college students' participation in physical exercise varies greatly in terms of gender, grade level, school development and organization, and that local economic conditions, sports policies and greater study pressure have a greater impact on whether and how college students participate in physical exercise, and that subjective factors, such as interest and motivation, also have a crucial influence on

college students' participation in physical exercise. Students' interest, motivation and other subjective factors also have a crucial influence on college students' participation in physical exercise.

Liu (2011) investigated the attitude, motivation, form, program, and time of participation in physical exercise and found that college students have positive attitudes toward participation in physical exercise and have various motives for participation, and that there are significant differences between male and female students in the time and intensity of their participation in physical exercise. Fu (2014) believes that at present college students are very positive in their attitudes to participate in physical exercise, and also found that students with positive attitudes also have relatively high levels of physical health, both of which are positively correlated, so it is proposed to cultivate college students' correct and positive attitudes to participate in physical exercise, as well as to enhance college students' physical health, and the school should also attach great importance to this.

Zhang et al. (2021) concluded from their study that appropriate participation in physical exercise can promote good behavioral relatednesss among students, reduce their negative emotions, release pressure, and achieve the purpose of enhancing their own self-confidence as well as improving their physical and mental health. Lei (2020) believes that sports not only has the function of making friends and at the same time participating in physical exercise has an important role in enhancing the participants' sense of well-being, so we should vigorously develop our national fitness movement, improve the utilization of resources around us, and give full play to the function of physical exercise in the fitness, making friends and other aspects. Tong’s (2012) study pointed out that young people sitting by the computer for a long time for a long time brings great health threats to their lumbar vertebrae and spine, and more and more college students have obesity, myopia, muscle weakness and so on. Regular sports will gradually change the appearance of the human body, thereby developing physical quality, the results of the study show that often participate in sports college students, BMI value, lung capacity, endurance, sportsmanship and other indicators are significantly higher than those who do not take part in sports, so active sports on the physical health, psychological change is obvious. In summary, participating in physical exercise can not only have a positive effect on all aspects of the body to

improve physical health and strengthen the body's immunity, but also has an important significance for the improvement of academics and students' social interaction ability.

3. Relevant Research on Influencing Factors of Physical Exercise for College Students

Scholars have explored in depth the mechanisms influencing the exercise behavior of students in general colleges and universities, and concluded that physical exercise behavior is related to a variety of intra-individual psychological factors, such as exercise self-efficacy, physical exercise cognition, and attitudes toward physical exercise, sense of autonomy support, and exercise identity. In addition, social support, peer pressure, exercise commitment, limited space, incomplete equipment, insufficient online publicity, lack of supervision, and family exercise atmosphere are also major factors that influence students' physical exercise (Li, 2021).

Related research on the factors influencing physical exercise behavior: Jing and Mu (2020) pointed out that the factors influencing college students to engage in physical exercise broadly include intrinsic factors and external reasons; intrinsic factors are mainly that college students are not interested in sports; external factors such as the lack of time for exercise, social support and so on. Studies by scholars such as Li (2009), Qiu (2011), and Dong et al. (2013) have shown that college students participate in sports for a variety of purposes; most of them do so to enhance their physical fitness and physical and mental health. Some other students participate in physical exercise in order to cope with physical education exams, pass leisure time and other external influences that promote their participation in physical exercise. In a study of participation in physical exercise among South African university students by foreign researchers Meyer and Bevan-Dye (2014), Generation Y female university students were more motivated to engage in physical exercise by motivations such as health stress, avoidance of health problems, active health, weight management and appearance. In contrast, Generation Y male university students were more inclined to engage in physical exercise through intrinsic motivation (e.g., enjoyment, challenge, competition, strength, and endurance).

Yin’s (2005) study showed that from the perspective of pedagogy, categorized the factors influencing the formation of college students' physical exercise habits into

the students themselves, teachers, teaching contents and materials, and environmental factors, and proposed that: college students' awareness of the interest and importance of physical exercise is the basis for the formation of exercise habits, teachers are the primary factor systematically influencing the formation of students' physical exercise habits, and the necessary school rules and regulations on physical exercise are the guarantee for the formation of physical exercise habits. The necessary rules and regulations of physical exercise in schools are the guarantee for the formation of physical exercise habits. Jian's (2008) study showed that through the use of structural equation modeling and other malefactors, concluded that interest and hobby is the main motivation of college students' physical exercise, sports ability and school sports facilities are the main dimensions influencing students' motivation for physical exercise, and the quality of physical education teachers has a greater role in cultivating students' interest and hobby in physical exercise.

Yu et al. (2021) explored the factors influencing college students' physical exercise behaviors mainly at the individual and interpersonal levels, and used structural equation modeling to analyze data from physical exercise ratings, self-efficacy, behavioral attitudes, behavioral perceptions, instructor support, and peer support scales to argue that the quality of instructors' classroom teaching and peer support play important roles in students' extracurricular physical exercise behaviors.

Huang & Zhang (2020) analyzed the factors affecting college students' sports lifestyles in China based on the theory of social-ecological model, including three major factors: individual (sports self-efficacy, sports values), social (social support factors, media support), and environmental (stadium facilities, accessibility, and climatic conditions).

Intervention research on college students' physical exercise behavior, on the one hand, to prompt more people to devote themselves to exercise and to form a healthy and active exercise lifestyle; on the other hand, to develop educational strategies for those who lack exercise, and to take appropriate interventions to help them form and maintain scientific and reasonable exercise behavior, so that their physical and mental conditions and quality of life can be improved. Liu's (1991) study concluded that the incentive methods of sports behavior intervention for college students: there are publicity and education incentives, goal incentives, praise and reward incentives,

sports value incentives, data incentives, role model incentives, collective honor incentives, and physical education teacher behavior incentives. The study of Yang et al. (2000) concluded that the main intervention methods for college students' physical exercise behavior include adjusting teaching methods and means, giving play to the fun role of physical education, designing school physical education in a student-oriented way, exploring new ways to achieve the purpose and tasks of school physical education, improving the conditions of school physical education facilities, and creating a good exercise environment. Lee et al. (2021), in order to explore the behavioral aspects of college students' extra-curricular physical exercise promotion strategies, an experimental research method was used to conduct a semester-long intervention study of ballroom dance participation behaviors among 234 college students in South Korea with ballroom dance courses, ballroom dance videos, posters, and emails. The results showed that the video and poster interventions were more effective in changing students' individual behaviors than the lesson and email approaches; the students' single exercise time increased significantly through this approach, which had a better effect.

4. Theoretical Foundations of Exercise Behavior Research

As we all know, human physical exercise activities are mainly affected by physiological and psychological factors, and most scholars have tried to use different theoretical models to explain the various factors that affect people's participation in physical exercise from multiple perspectives, but unfortunately almost every theory or model cannot fully explain this problem or phenomenon.

Some scholars believe that the theoretical models currently used in the field of exercise psychology can be divided into four common types: the first is the "belief-attitude" theory, which mainly includes the health belief model and the theory of rational behavior and the theory of planned behavior. The second type is the ability-based theory, which is dominated by self-efficacy theory. The third type is the control-based theory, mainly the SDT. The fourth type is the decision-based theory, which is mainly the stage change model, also known as the trans-theoretical model (Si, 2007).

Applying theoretical models is of general importance for studying physical exercise behavior change, and many research models have been applied to describe, explain and predict physical exercise behavior. Related studies on the overall

characteristics of physical exercise behavior and theoretical models: Si (2005) pointed out that the exercise behavior of college students in China can be divided into five stages: indifference, conditional attachment, preparation, action and maintenance stage.

In universities and colleges, very few students in the final maintenance stage engage in regular physical exercise activities, and the vast majority of students participate in occasional exercise but do not form the relevant physical exercise habits, and the number of female students who participate in physical exercise increases negatively as they grow older. Scholars such as Mao (2003) and Yin (2007) have used relevant theoretical models to make their own interpretations of physical exercise behavior, which cover the following theoretical models: the Eight-Factor Model, the Nine-Factor Model, The Health Belief Model (HBM), The Theory of Plan Behavior (TPB), The Trans-Theoretical Model (TTM), etc. These models have a very good effect on the prediction of physical exercise behavior and analyze in depth the pattern of changes in exercise behavior.

In summary, the research on the mechanism and influencing factors of physical exercise behavior is relatively extensive, and many scholars use different theories and perspectives to put forward their own views. In today's college campuses, students' extracurricular physical exercise is a crucial part of the program, which promotes students' active participation in physical exercise, enhances their awareness of extracurricular exercise, develops good habits, and provides a theoretical basis for the improvement of students' health.

5. Brief Summary

From the viewpoint of the literature reviewed, the domestic research on college students' physical exercise behavior is similar to the foreign research situation, mainly focusing on descriptive research, the research on the types of college students' physical exercise behavior, the content of exercise, and the factors affecting exercise. The vast majority of them belong to status quo investigation and static research, and most of the methods used are questionnaire survey method, interview method and so on. The number of longitudinal studies and intervention studies on university participation in physical exercise, the use of theoretical guidance on the exercise behavior of college students is relatively small, and the methods of intervention

experimental research are not diverse enough.

Although relevant researches show that participating in physical exercise has an important role to play in promoting the harmonious and healthy development of college students' body and mind, at this stage, college students still can't actively participate in physical exercise and haven't developed good habits of participating in physical exercise. The study found that the main reasons affecting college students' participation in physical exercise may be that college students do not have strong motivation for physical exercise, do not have time to participate in physical exercise activities, and do not realize the importance of physical exercise, among which the main reason is that college students do not have strong motivation for physical exercise, and weak motivation for physical activity plays a primary role in the motivation of college students to participate in physical exercise. The relatedness between physical exercise motivation and physical exercise behavior in previous studies is more of an overall descriptive study, but seldom a quantitative study.

Regardless of foreign or domestic, researchers generally pay attention to physical exercise behavior to enhance college students' physical health and mental health in their studies, and there are more research results for the effect of exercise in foreign countries, while domestic research mainly focuses on the characteristics of physical exercise behavior, influencing factors, and the enhancement of mental health. Moreover, the significance and value of physical exercise in the healthy development of college students are emphasized, and corresponding suggestions and development countermeasures are put forward, providing corresponding theoretical support for this study. Exercise behavior is determined by a combination of physiological, social, environmental and psychological factors, and the study of the relatedness between exercise motivation and exercise behavior is an important topic in exercise psychology research. Therefore, based on the theoretical model of physical exercise self-determination, this study analyzes the influencing factors affecting college students' physical exercise behavior, promotes college students' physical exercise behavior, and improves college students' physical fitness and health more effectively.

Background of self-determination theory

1. Formative Constructs of SDT: SDT's Mini-Theories

The SDT system consists of five sub-theories, namely: cognitive evaluation theory (CET), organic integration theory (OIT), causality orientations theory (COT), basic needs theory (BNT), and goal content theory (GCT). The theory reveals the ways and processes through which social and environmental factors influence individual exercise motivation from an organic dialectical perspective, providing an effective way for external interventions to influence individual motivation. Cognitive appraisal theory emphasizes the influence of social factors on an individual's internal motivation; organic integration theory suggests that internal motivation can be gradually transformed from external motivation, emphasizing this transformational process unique to human beings; and causal orientation theory highlights the influence of individual differences on human development (Lin, 2008); The basic psychological needs theory, which holds that an individual generates behavior primarily on the basis of the individual's satisfaction with that behavior, is the core theory of SDT. These five sub-theories describe human development from four aspects: external social environment, individual development, individual differences, and internal psychological needs of the organism, and emphasize the decisive role of individual self-selection and self-determination in human development, which together constitute the basic content of the SDT (Lin, 2008). Among them, the basic psychological needs theory and the organic integration theory are often used to test physical exercise behaviors.

1.1 Cognitive Evaluation Theory-Environmental Factors on Motivation

Cognitive Evaluation Theory (CET), the earliest ideological essence of SDT and the first subtheory of SDT, focuses on the interactive relatedness between external factors and motivation, emphasizing the role of environmental factors on human motivation. The theory suggests that the creation of an environmental climate conducive to autonomy stimulates autonomous or internal motivation, which in turn is beneficial in promoting and maintaining individual behavior.

The CET categorizes external factors into three types: (1) Informational, which means that individuals will receive positive feedback that will enable them to make self-determination in the context of making choices, increase their sense of

competence, enhance their internal motivation, and promote their internal causality perceptions. (2) Controlling, which means that the individual feels controlled and pressured to decide on his or her behavior, improves the individual's external causality perception and reduces the individual's autonomy, which leads to weakened internal motivation. (3) Unmotivated, which refers to the fact that it creates a feeling of incompetence in the individual and weakens internal motivation.

CET believes that the influence of external events in the social environment on internal motivation is elicited through the individual's perceptions and evaluations, and that the development of internal motivation is realized through the satisfaction of the three basic needs. Factors in the social environment that enable individuals to feel a sense of autonomy, competence, and belonging enhance internal motivation to engage in activities; conversely, factors that impede a sense of autonomy, competence, and belonging diminish internal motivation, which may lead to a sense of control and unmotivation (Gagné & Deci, 2005).The SDT describes social environments that provide a sense of autonomy, competence, and belonging as autonomy-supportive environments, which facilitate need fulfillment and can lead to a feeling of control and unmotivation. It refers to autonomy-supportive environments as those that are conducive to need fulfillment and ensure the development of autonomous motivation; conversely, socially coercive environments diminish the development of autonomous motivation and may promote controlling internalizing or externalizing regulation. Autonomy-supportive environments are characterized by a reduction in control by significant others, an understanding of others' perspectives, and the provision of choice.

1.2 Organic Integration Theory-Autonomous Motivation Formation Processes

Organic Integration Theory complements the explanations of Cognitive Appraisal Theory with a perspective that explains the different forms of external motivation and the impact of extrinsic motivation on behavior, and proposes the concept of "internalization of motivation". According to this theory, external motivation is internalized only under necessary conditions, such as when the three psychological needs of relatedness, autonomy and competence are satisfied, the individual's motivation tends to be internalized, or when the help, care and advice of others make the individual feel competent in the current work, the individual's internal

competence and internal needs are satisfied, the individual's motivation will be gradually transformed from external motivation to internal motivation.

Organic Integration Theory divides motivation into three different motivational states-amotivation, intrinsic motivation, and extrinsic motivation. External motivation is also categorized into four forms of regulation: external regulation, introjected regulation, identification regulation, and integrated regulation (Deci & Ryan, 1985). Internalization in this study refers to the process of changing from external to internal motivation. The weakest to strongest order of the degree of self-determination is as follows: unmotivated - externally regulated - internalized regulated - identity regulated - integrated regulated - internally motivated. In addition, Organic Integration Theory categorizes human motivation into autonomous motivation (also called self-determined motivation) and controlled motivation. It categorizes identity regulation, integration regulation, and internal motivation as autonomous motivation, also known as self-determined motivation, and external regulation and intake regulation as controlled motivation.

Taken together, there are two basic core assumptions of self-determined motivation theory about human motivation to learn. The first core assumption is (Deci & Ryan,1985) that human beings, as active organisms, have an intrinsic tendency to self-integrate, improve and continuously learn, but this positive tendency does not occur naturally, but rather is an interactive link between individual learning and the social environment. The second core assumption is (Riley, 2015) that not only internal motivation promotes individual development, but internalized external motivation (autonomous motivation) also promotes student development. Therefore, promoting the internalization of external motivation and stimulating autonomous motivation in individuals is important for students' development.

1.3 Causal Orientation Theory-Individual Differential Effects of Motivational Internalization and Integration

Causal Orientation Theory, the third subtheory of SDT, is a theory of the differential individual influences on self-integration; it refers to the tendency of individuals with idiosyncratic traits to attribute causes to their own behavior (Deci & Ryan, 1985). The theory suggests that individuals have a developmental tendency to fixate on self-determined environments.

Researchers in SDT have found significant individual variability in human awareness, initiation, orientation, and regulation of events and the existence of three levels of relatively independent causal orientations, autonomous, controlled, and impersonal, each of which Deci and Ryan suggest exists relatively independently of each other and works in conjunction with environmental factors in the process of internalization of an individual's motivation.

1.4 Basic Needs Theory-the source of motivation for individual behaviors

Basic needs theory is the core theory of SDT, and its ideas underlie many of the important assumptions of SDT. The theory suggests that an individual's self-determined motivation arises because of the fulfillment of intrinsic basic psychological needs, which include the need for autonomy, the need for competence, and the need for relatednesss, and proposes that the conditions that promote an individual's motivation are the fulfillment of the individual's basic psychological needs by support from the external social environment. When an individual perceives a sense of external support and is able to satisfy the individual's three basic psychological needs, the individual's activities and behaviors are largely self-determined and controlled, i.e., autonomous motivation drives the individual's behavior. When the three basic psychological needs are not satisfied, people produce controlled motivation or no motivation. And the core point of the basic psychological needs theory is that, in addition to the individual's internal motivation, external motivation transformed to the inside can also promote the healthy development of the individual, and the proposal of the theory provides theoretical support for the transformation of motivation under the influence of external factors, and has been confirmed by the studies of many researchers. Basic needs theory explains the basic logical structure of human behavioral motivation that is adapted to the social environment. Individual internal motivation is the key to the emergence of individual autonomous behavior, while the satisfaction of basic psychological needs is the basic condition to stimulate internal motivation.

1.5 Achievement Goal Content Theory-internal goals promote individual motivational autonomy and internalization

It is the fifth subtheory of SDT proposed by Kasser and Ryan in 1993. The theory states that everyone has the tendency to pursue different life goals, which are

mainly divided into internal and external goals, and whether an individual pursues internal or external goals will have different effects on the individual's motivation and health of the Goal content theory is the role of the nature of different goals on the individual's sense of well-being and behavior, and emphasizes that internal goals stem from the basic psychological needs, and that when pursuing internal goals (such as the individual's growth and development, interests, etc.), it facilitates the realization of an individual's self-worth; External goals (e.g., money, external rules, etc.), on the other hand, refer to the individual's desire to gain recognition and appreciation from others and to gain some psychological comfort, but external goals do not work to satisfy basic psychological needs. Therefore, goal content theory suggests that the ability of external or internal life goals to satisfy an individual's basic psychological need demands for autonomy, competence, and emotion will result in the individual's ability to achieve a high sense of well-being or healthy psychological growth.

2. Research Framework of Self-determination theory

SDT suggests that as people develop cognitively, they have an innate tendency to internalize the need to integrate the external environment, to continue to learn, and to be motivated, but that this tendency does not occur inevitably, and that the external environment is needed to satisfy the individual's needs for autonomy, competence, and relatednesss. The theory states that the internalization of human motivation is not spontaneous, but needs to be supported and nourished through the external environment. When the external environment meets the individual's psychological needs for autonomy, competence, and relatednesss, the individual is able to persist in participating in behaviors that promote the internalization of external motivation to form autonomous motivation, and conversely, when this is not met, the individual is passive or avoids participation in behaviors, and there is an obstacle to the internalization of external motivation to form controlled motivation (Deci, 2000). In other words, social environments have a dual effect of facilitating or hindering individuals' basic psychological needs, which in turn can have a positive or negative impact on individuals' motivation and behavior. Therefore, it is important to explore which social environments satisfy students' basic psychological needs.

Vallerand et al. (1997) proposed a hierarchical model of internal and external motivation based on SDT, which argues that social environmental factors affect

people's basic needs for autonomy, competence, and relatednesss, which in turn lead to the emergence of different forms of motivational regulation and motivational outcomes, i.e., social environment→psychological needs satisfaction→motivational regulation forms→motivational outcomes (cognitive, affective, and behavioral), and emphasizes the mediating roles of psychological needs satisfaction and motivational regulation between the social environment and outcome variables. It is important to note that the three basic psychological needs of an individual are complementary as a whole, i.e., optimal functioning and truly integrative behavior can only be achieved when all three basic psychological needs are supported. It has also been shown that the three basic psychological needs can act as a holistic factor (Standage et al., 2005; Ntoumanis, 2005), and intervention studies have demonstrated that synergistic support of the three basic psychological needs results in better behavioral engagement than individual support (Deci et al., 1994).

SDT is a needs-based theory of organismic motivation that explains human motivation and behavior primarily in terms of external rewards or punishments and motivational orientations, focusing on the quality of an individual's motivation in a given context and the environmental factors that influence motivation, this theory centers on distinguishing between autonomous and controlled motivation, individuals with autonomous motivation participate in actions experiencing a sense of personal choice and autonomy, representing authentic self-worth, and are able to persist in their behaviors more consistently, without the need for external rewards and coercion. Individuals who are control motivated act in a way that demonstrates a sense of compulsion and responsibility to external pressures, engaging in action only when external stimuli are present, and ceasing behavior as soon as the external stimuli are removed. From a physical exercise perspective, autonomous motivation is adaptive because it implies that participants persist in engaging in behaviors that are unaffected by external stimuli or reinforcement. This implies that fostering autonomous motivation for physical exercise may be important for health promotion interventions aimed at increasing population activity levels.

3. Brief Summary

Self-Determination Theory (SDT) suggests that social-environmental factors can either facilitate or hinder an individual's autonomous motivation to engage in activities. Socially supportive environments can have an impact on an individual's positive behavior because they satisfy the individual's basic psychological needs. SDT refers to social environments that provide a sense of autonomy, competence, and belonging as autonomy-supportive environments, which are beneficial in terms of satisfying basic psychological needs and ensuring the development of autonomous motivation; conversely, socially coercive environments diminish the development of autonomous motivation and may promote Contrary to this, socially coercive environments undermine the development of autonomous motivation and may promote controlling internal or external regulation. In summary, it can be seen that SDT provides a comprehensive approach to the study of motivation and its related antecedents and consequences, and that the multidimensional theory of self-determined motivation is based on the satisfaction of the three basic psychological needs as the underlying forces of motivated behavior. It analyzes the relatedness between the human organism and the social environment from an organic dialectical perspective.

SDT suggests that self-determined motivation is closely linked to an individual's internal factors such as interest, sense of value, and sense of well-being, and enables individuals to experience a sense of competence, relatedness, and autonomy, which is significant to the engagement and persistence of an individual's behavior. Therefore, self-determined motivation is the most antecedent variable and internal motivator of behavior, and studies have shown that SDT is also feasible and operational for interventions in exercise behavior. Although SDT is theorized to stimulate students' interest in learning and enhance their internal motivation, leading to changes in their behavior. However, SDT does not elaborate on the specific ways in which individual behavior works. It needs to be integrated with other theories. SDT provides a large number of suitable explanations for studying exercise behavior patterns and exercise participation and the process by which its internal factors (basic psychological needs), and interpersonal factors (autonomy support context) promote autonomous motivation for exercise (self-determined motivation). The present study decided to adopt two

sub-theories of SDT-organic integration theory and basic psychological needs theory- as the theoretical basis of the study.

Self-determined motivation theory provides theoretical support for how to improve students' autonomy and motivation in the process of participating in physical exercise. This study centers on the basic psychological needs theory and the influence of external motivation internalization on individual human behavior, in which the research in the field of exercise mainly centers on the basic psychological needs theory, focusing on the influence of the satisfaction of basic psychological needs on self-determined motivation to exercise, the drive of external factors on autonomous motivation and the mediation of autonomous motivation in the relatedness between external factors and exercise behavior, and so on.

In summary, from the perspective of the number, methods, perspectives, contents, contexts, theoretical foundations and other aspects of the existing research on physical exercise behavior, expanding and integrating theories of different behavioral sciences to complement each other in explaining, predicting, and intervening in the physical exercise of college students from the psychological level has been a cutting-edge topic and an important trend in multiple disciplines such as kinesiology, public health, and psychology, and it is also the point of entry and the logical starting point of the present study.

Related research on Autonomy Support

Autonomy support is a current hot topic in the field of motivation and personality research and is a central factor in promoting psychological needs, autonomous motivation, and adaptive outcomes. Deci (1985) identified autonomy support as a central factor in promoting psychological needs, autonomous motivation, and adaptive outcomes. Reeve (2009) identified autonomy support as the process by which individuals enhance the internal motivation, volition, perceived selectivity, and self-identity of others through words, interpersonal emotions, and behaviors. SDT researchers believe that an individual's perceived external support for autonomy can be mediated by the satisfaction of basic psychological needs, resulting in further motivation for autonomy and, in turn, ultimately influencing the corresponding behavioral outcomes. The autonomy-supportive environment, as an important external environmental factor, is not only supportive of an individual's self-determined

motivation, but also capable of satisfying an individual's basic psychological needs.

The important role of autonomy support for internal motivation has been recognized in the field of education abroad. The behavior of educators affects the feelings and attitudes of students towards learning, and the sense of autonomy felt in an autonomous environment, when students are able to achieve their goals according to their own desires and interests, promotes the formation of internal motivation (Grolnick, 1989). Deci and Ryan's (2008) study concluded that autonomy support is an educator's educational behavior and approach to stimulate students' intrinsic motivation and to promote the continuous internalization of students' extrinsic value systems, social norms, and so on. Teachers' autonomy support should include a variety of behaviors such as providing opportunities for choice, encouraging self-enlightenment, being less controlling, and understanding students' feelings. The support of significant others is important for the internalization of motivation. Mageau & Vallerand (2003) defined students' perceived sense of autonomy and support from the teacher as students' belief in their own behavioral choices, arguing that the teacher provides students with a free and relaxed learning environment, understands them, supports them, provides them with choices, and encourages them to independently complete relevant tasks. In the extensive literature on the use of SDT to predict health-related behaviors, the findings are consistent in terms of the beneficial effects of autonomy support on meeting the three needs, developing autonomous forms of behavioral regulation and behavioral outcomes, and well-being outcomes (Ding and Mao, 2014).

In summary, many studies have demonstrated that an autonomy-supportive environment facilitates the gradual internalization of external motivation into internal motivation. Internal and external motivation can be transformed into each other under certain conditions, and the autonomy-supportive environment factor is one of the key conditions for the internalization of motivation.

SDT recognizes that a physical education teacher's sense of autonomy support is an important external environment that influences the satisfaction of an individual's basic psychological needs. A sense of autonomy support refers to having authority figures (e.g., teachers, parents, friends) who know how to think differently, understand and respect others' perspectives and ideas, and provide opportunities for others to

support their sense of autonomy and encourage self-determination.

For college students, teachers are the most important social subjects in the learning environment, who are not only the practitioners of in-class teaching, but also the designers and organizers of out-of-class activities. The positive interaction between teachers and students can have a positive influence on students' exercise behavior and exercise effect. Therefore, teachers' behavior plays an indispensable role in influencing college students' exercise behavior. How can teachers have an impact on college students' exercise motivation and exercise behavior? Self-determined motivation theory suggests that the social environment's support of students' basic psychological needs, namely the need for autonomy, the need for relatednesss, and the need for competence, can facilitate students' self-regulated exercise behaviors and exercise outcomes. In the school environment, teacher support is the primary source of support for students' needs, which directly contributes to the fulfillment of students' basic psychological needs, and students who have their psychological needs fulfilled will be more motivated to engage in physical exercise.

Hagger et al (2003) and Fortier (2007) study showed that autonomy support from physical education teachers predicted students' actual participation in sports outside of school; and that parental autonomy support for adolescent physical exercise promotes children's active participation in sports. It suggests that autonomy support from teachers and parents promotes children's autonomous motivation to participate in sport.

Lim and Wang (2009) Perceived autonomy support in the context of physical education enhances students' willingness to be physically active outside of school and can facilitate physical exercise outside of school, adding to the body of research on the positive role of a sense of autonomy support in physical education.

Jang et al.'s (2009) study showed that came to a similar conclusion that when students perceive teacher support as autonomous rather than controlling, teacher support significantly predicts the fulfillment of students' basic needs, creates internal motivation and contributes well to students' academic achievement and their positive psychological experiences.

Shen et al. (2009) based on a series of multiple regression analyses, teacher autonomy support is directly related to the improvement of cardiorespiratory fitness,

and teachers create autonomy-supportive teaching and learning environments through teaching methods in physical education classes, which provide more support for students' autonomy and active participation, which in turn enhances physical exercise.

Mattila et al. (2012) believe that teachers with a strong sense of autonomy and support will give students more free space in the teaching process, meet the basic psychological needs of students, and create a relaxed learning environment for students, rather than often using command and coercive teaching methods, so that students feel a sense of ownership, which is conducive to stimulating the interest and motivation of students to participate in physical education and sports.

Zhang et al. (2018) study showed that the internal motivation study of perceived physical education teachers' sense of autonomy support on college students' participation in aerobics. The study concluded that when physical education teachers give students sufficient autonomy to choose their favorite sports in the physical education classroom, students choose their favorite sports, which is conducive to the enhancement of students' internal motivation.

Cheon et al. (2012) conducted a pedagogical intervention with Korean teachers and concluded that in the experimental group where autonomy support was provided, the teachers met the psychological needs of the students, which improved the behavioral outcomes in the corresponding physical education classes.

McDavid, et al. (2012) also found that physical education teachers, although not present in the context of recreational physical exercise participation, the autonomy-supportive instruction they give in physical education classes plays an equally important role in supporting adolescents' recreational physical exercise. Tang and Li (2017) and Huang (2019), among others, concluded in their studies that there is a positive correlation between autonomy support and extracurricular physical exercise that predicts extracurricular physical exercise, and that there are variables that mediate between both of them.

Abdoshahi et al. (2022), after investigating the perception of self-supportive teaching, internal motivation and willingness to participate in physical activities among 384 elementary school students in Iran, found that the higher the students' perception of self-supportive teaching, the higher their internal motivation in physical education classes and the higher their willingness to participate in physical activities

after class.

Hosseini et al. (2022) investigated 400 high school students' perceived autonomy-supportive teaching, basic psychological needs, motivation, and physical exercise participation in physical education classes using scales. The results indicated that autonomy-supportive teaching behaviors provided by physical education teachers were positively related to students and basic psychological needs and autonomous motivation, which in turn positively predicted students' willingness to participate in physical activities. From these findings, it is clear that autonomy-supportive instruction provided by physical education teachers can positively influence students' physical exercise learning outcomes.

Students who perform well in a supportive teaching style benefit from promoting teacher autonomy-supportive instructional practices that promote autonomy-supportive instructional practices and reduce controlling instructional behaviors (Collie et al., 2019). Therefore, physical education teachers can greatly enrich their teaching tools in the classroom by encouraging students to feel positively about their beliefs and control in terms of their self in the area of physical exercise in the physical exercise environment to continue to deepen the benefits and significance of engaging in physical exercise, which in turn can lead to the conscious participation of college students in physical exercise.

Foreign studies consider the intervention of social support as a good way for educators to stimulate students' intrinsic motivation and keep internalizing the extrinsic value system (Buttan & Choi, 2015; Lu & Hui, 2020). Individuals can significantly increase the level of motivation, pleasure, happiness and commitment in physical exercise when they feel more autonomy support from significant others (Zhu & Yin, 2017). Some studies have shown that the autonomy support of physical education teachers is more embodied in the classroom or physical education teaching, such as the autonomy support environment created for students in the physical education classroom can improve students' exercise adherence and exercise intention (Sun, 2010; Ntoumanis, 2005). While the autonomy support from peers is more reflected in the emotional and sports life (Yang, 2016), which can improve the individual's exercise self-efficacy and satisfaction. Therefore, different sources of significant others' sense of autonomy support are likely to have different effects on

sport participation awareness, and it is necessary to analyze and empirically compare the two differently.

The study by Bao et al.'s (2022) exploration of the mediating relationships between peer support, intrinsic motivation, and self-efficacy and physical exercise, peer support directly influences physical exercise in children and adolescents and indirectly influences physical exercise through self-efficacy. Zhu et al.'s (2023) study verified that peers' and physical education teachers' sense of autonomy support played a fully parallel mediating role in gender role conflict affecting the sense of sports participation, and that the mediating effect of peers' sense of autonomy support was significantly higher than that of physical education teachers' sense of autonomy support in terms of the will to be physically exercise.

The peer relationships that characterize the social and emotional growth of adolescents are irreplaceable contributions of adults, the social influence brought by peers stimulates physical behavior, and peers are able to influence students' physical exercise behaviors, with a significant impact on the level of participation in physical exercise among elementary school students (Quested, 2009). Kirby et al. (2011) argued that peer support should be more influential than parental support. Salvy (2008) argued that the likelihood of adolescents engaging in physical exercise is higher in the company of peers or companions. Exercise friendships, as an important element of the social environment, have a positive orienting efficacy on adolescent exercise behavior, making exercise maintenance possible (Zhang & Dong, 2017). Smith et al.'s (2006) study found that positive peer support can lead to more adaptive motivation among adolescents, which in turn leads to increased confidence in engaging in physical exercise and improved physical exercise.

It is crucial for teachers to provide students with an educational environment that meets the three basic psychological needs in the physical education classroom; if students are motivated autonomously to engage in physical exercise, they will stay engaged for longer periods of time and will reap the health benefits of long-term exercise. However, a number of empirical studies have come to different conclusions: teacher support does not have a direct effect on adolescents' physical exercise, but rather they engage in it indirectly by stimulating autonomous motivation (intrinsic motivation and identity regulation) or voluntary participation in physical exercise. So,

can teacher support influence students' physical exercise? This is one of the central questions to be addressed in this study.

In summary, in physical education classes, physical educators can stimulate students' intrinsic motivation to learn, satisfy intrinsic psychological needs and individualized interest needs by designing reasonable situational stimulation modes, which can have a positive effect on students' learning behaviors such as the improvement of sports participation and cognitive attitudes (Zhang et al., 2020). Research in the field of exercise has also demonstrated that the degree of autonomy of social support has a non-negligible role in the fulfillment of students' basic needs (Podsakoff, 2003). To provide support for the research hypothesis of the mechanism of social support's influence on motivation and the path of exercise behavior promotion.

Most college students initially engage in physical exercise because of the pressure of the external environment or the role model behavior of others, and this behavior inspired by extrinsic motivation will gradually decline or even withdraw from exercise because of the tediousness of exercise, and long-term regular exercise often lacks intrinsic interest for students, from this perspective, the autonomy experienced by students in physical exercise is very important to promote the internalization of motivation and maintenance of exercise behavior, and what kind of support for exercise autonomy to internalize the motivation of exercise to influence the behavior of exercise is a problem that needs to be solved.

Brief Summary

When individuals feel more autonomy support, they will regulate their behaviors more, and allocate more time and energy to physical exercise after school. Self-determined motivation theory provides a good theoretical basis for understanding the positive impact of teacher support, which corresponds to the basic psychological needs of students, and is specifically expressed as autonomy support, emotional support, and ability support, and students who perceive these aspects of the teacher's support will have a higher level of perceived ability and interest in exercise. Therefore, in the process of physical education teaching, physical education teachers should provide students with a higher sense of autonomy support, analyze students' psychological activities, satisfy their basic psychological needs, and promote the

internalization of their external motivation, so as to encourage college students to actively participate in physical exercise.

To summarize, physical education teachers' sense of autonomy support is an important environmental factor that influences individuals' participation in physical education and sport. In physical education, physical education teachers not only teach knowledge, but also provide students with a good learning environment, which is conducive to stimulate students' motivation to participate in sports. How physical education teachers can grasp the ruler of giving students a sense of autonomy support, which can give full play to the leading role of physical education teachers, but also allow students to experience the subject position, requires physical education teachers to continue to study in the future teaching.

Most college students initially exercise because of the pressure of the external environment or the example behavior of others, but this externally motivated behavior will gradually decline or even decline because of the tediousness of the exercise. This kind of externally motivated behavior will gradually decline or even quit because of the tediousness of exercise, and even quit exercising. Long-term regular exercise often lacks intrinsic interest for students, and from this perspective, the autonomy that students experience in physical exercise is important to promote the internalization of motivation and maintain exercise behavior, and what kind of autonomy support for exercise is used to internalize motivation to influence exercise behavior is a problem to be solved, which is one of the research focuses of this study.

Studies related to Basic Psychological Needs

In SDT, psychological needs provide the nutrition necessary for individuals to generate a sense of well-being and to integrate external values, i.e., needs are necessary for individuals to maintain health and growth. SDT proposes that human beings have three basic psychological needs: autonomy, competence, and relational needs, and on the basis of which it proposes internal motivation. The theory suggests that satisfying basic psychological needs can lead to the transformation and integration of their external motivation into internal motivation, and that the three basic psychological needs have different predictive effects on the degree of internalization of motivation. In addition, research has shown that basic psychological needs are predictive of autonomous motivation in physical exercise, and that

psychological need satisfaction and autonomous motivation also positively predict exercise behavior. Thus, only when the three basic psychological needs are satisfied can internal motivation formation and external motivation internalization be promoted, individuals will develop higher self-determined motivation, and the level of need satisfaction is positively associated with higher levels of well-being and health outcomes.

Deci and Ryan (2000) argued that needs determine an individual's motivation and provide a fundamental theoretical basis for motivating and guiding an individual's behavior in different environments such as the classroom, gymnasium, or playground, and that the level of need satisfaction that people experience in a given environment affects their motivation in that environment. In physical education, when the three needs of autonomy, competence, and affect are considered overall, total need satisfaction is a positive predictor of students' intrinsic and intrinsic motivation (Ntoumanis, 2005). Based on this, we can infer that environments that support students' overall intrinsic needs contribute to the development of autonomous motivation. Conversely, in a controlling learning environment, such as one that restricts students' task choices, behavioral freedom, etc., students are likely to succumb to imposed external rules and thus fall into a passive or reactive learning state.

In foreign countries, studies have shown that basic psychological needs have a positive impact on physical education learning outcomes. Markland and Tobin (2010) concluded in their study that the satisfaction of psychological needs for physical exercise promotes the process of identity regulation of physical exercise behavior, in which the satisfaction of autonomy needs and competence needs both play a role in promoting the process of internal regulation of physical exercise behavior. Spray et al (2006), in an experimental study of students' motivation to learn golf exercise, demonstrated that when individuals engage in physical exercise behavior, autonomy needs are the basis for maintaining internal motivation for physical exercise, competence needs are the support for internal motivation for physical exercise, and relational needs promote the development of internal motivation for physical exercise and physical exercise behavior.

Taylor et al. (2010) and others investigated the basic psychological needs and

leisure physical exercise levels of 78 secondary school students in England and found that the competency needs of the basic psychological needs were positively correlated with the students' participation in leisure physical exercise and showed an interaction between time and competency needs, suggesting that students with high satisfaction with competency needs increased their LTPA behaviors more than students with low perceived competency over time.

It has also been shown that basic psychological needs can have an impact on physical exercise behavior. Leptokaridou et al. (2015) conducted a self-report survey on three basic psychological needs, autonomy, competence, and relatedness, pleasure and effort, among 213 elementary school students in grades 5-6. A mediation analysis found that all three basic psychological needs positively predicted pleasure and effort in primary school students. Navarro-Patón et al. (2017) investigated autonomous motivation, basic psychological needs, and pleasure in physical education learning using a quasi-experimental pre- and post-test design with 104 primary school students in Spain. The results showed that autonomy needs had a positive contributory effect with students' intrinsic motivation, interpersonal relationships and pleasantness.

Cronin et al. (2020) studied the longitudinal association between teacher autonomy support, students' basic psychological needs fulfillment and physical skill development, teacher autonomy support will fulfill the students' basic psychological needs, which will make the students more engaged in the learning of physical skills, and the resultant learning outcomes will perform better.

The results of Gholidahaneh et al. (2020), in order to investigate the relationship between elementary school students' basic psychological needs satisfaction and their leisure physical exercise behaviors in physical education classes, basic psychological needs, motivation and leisure physical exercise participation in physical education classes of 516 Iranian elementary school students were measured by using the Sports Climate Questionnaire, Motivation for Exercise Scale and Leisure Physical exercise Behavioral Scale, and the results showed that there was a significant correlation between the basic psychological needs satisfaction and leisure time physical exercise.

Gråstén et al. (2021) investigated the basic psychological needs, MVPA in physical education, and all-day MVPA of 523 5th grade students in a Finnish elementary school during a one-year follow-up, and the results of the study indicated

that competence and emotional need satisfaction in physical education positively predicted students' all-day MVPA participation, and stated that it is crucial for all children to receive positive and satisfying psychological need satisfaction in order to increase students' participation in physical exercise.

In China, there are also studies showing that basic psychological needs have a positive impact on interest in physical exercise. Su Yu (2007) conducted a study to analyze the mechanism of physical education learning mechanism, internal rules of high school students, and examined the variables between individual's goal orientation, needs, and context through an experimental design. The results of the study show that the three basic psychological aspects of autonomy needs, relatedness needs and competence needs are mediating variables affecting the level of motivation in physical education and that all three are indispensable, and that their combined effect can increase motivation, interest and sense of effort in physical education, and that the combined effect of a high sense of belonging with a high sense of autonomy and sense of competence can increase the student's sense of effort in carrying out physical education.

Basic psychological needs can have an impact on physical exercise behavior. Zhang and Li (2017) found that adolescents' physical exercise behavior is related to three factors: support from important people in interpersonal relationships, satisfaction of basic psychological needs, and increased motivation for autonomy, and the need for competence from an individual can directly influence exercise behavior.

Ding and Mao (2014) conducted a study of 371 high school students using structural equation modeling, found that the satisfaction of basic needs for physical exercise has different degrees of influence on enhancing an individual's self-determined motivation, which promotes the internalization of external motivation, in which the basic psychological need satisfaction role is ranked in order from the strongest to the weakest: autonomy needs, relational needs, and competence needs.

Xiang and Ding (2014) tested 664 adolescents based on the Three Basic Psychological Needs Theory (BPNT), and the test results showed that the three basic psychological needs then mediated the relationship between the sense of autonomy support in sports and adolescents' subjective vigor.

In a study of overweight and obese college students' physical exercise adherence

by Lan Mingsheng (2020), the results showed that basic psychological needs play a fully mediating role in the effect of autonomy support on physical exercise adherence.

Fan Wen's (2018) study of 803 college students found that self-determined motivation to engage in extracurricular physical exercise could be promoted when three basic psychological needs were satisfied.

Zhu and Yin (2017) study pointed out that the inspiration and sense of autonomy support given to exercisers by teachers, peers, and parents can all compensate for the lack of competence, relatedness, and even autonomy in adolescents' participation in sports, and have a positive effect on autonomous motivation, which in turn enhances motivation to participate in sports.

Li Xueyan's (2017) studied the relationship between coaches' sense of autonomy support, basic psychological needs and sports motivation. She pointed out that the key to stimulate the athletic motivation of youth track and field athletes is to satisfy their basic psychological needs and give them the right to make autonomous choices. In the process of sports training, coaches should create a good environment for athletes' sports training, respect athletes, and satisfy athletes' basic psychological needs, which is conducive to stimulating athletes' internal motivation.

Chen et al. (2018) used students' basic psychological needs as a mediator to study students' concentration, effort, and self-confidence in the physical education classroom. It was found that three basic psychological needs were the strongest predictors of self-confidence, effort, and concentration in physical education classrooms: the need for competence, followed by the need for relatednesss, and finally the need for autonomy. Thus, basic psychological needs have a positive effect on students' concentration, effort, and information in the physical education classroom.

Song’s (2016) studied the relationship between the satisfaction of college students' psychological needs for physical exercise and exercise behavior, and concluded that the satisfaction of college students' basic psychological needs has a positive impact on their exercise behavior. Therefore, in institutions of higher education, physical education teachers provide students with an autonomous learning environment, so that students can choose the appropriate sports according to their own preferences. When students encounter difficulties and setbacks in the learning process,

physical education teachers need to give students encouragement and enhance their confidence instead of sarcastic remarks. At the same time, colleges and universities carry out more group sports programs, which is conducive to the cultivation of the spirit of unity and cooperation among college students, and is conducive to the formation of good interpersonal relationships between students. When the basic psychological needs of college students are satisfied in participating in sports activities, and they can perceive the care and support from the sports teachers, they will be more satisfied. When the basic psychological needs of college students are satisfied in participating in sports activities and they can perceive the care and support from physical education teachers, their internal motivation will be stimulated.

Brief Summary

In summary, scholars have explored the effects of basic psychological needs on physical education learning pleasure, effort, and physical exercise in and out of class. Overall, the vast majority of studies indicate that the higher the perceived satisfaction of basic psychological needs in physical education classes the better the learning outcomes. Overall, the research related to basic psychological needs for physical exercise is positive and promotes the internalization of individuals' motivation, and also contributes to individual exercise behaviors. However, the mechanism of which need satisfaction promotes which motivation that leads to exercise behavior still needs to be discovered by subsequent studies.

Summarizing the results of foreign research shows that whether it is the need for autonomy or the need for competence and relatedness, the support given by the external environment will have a certain impact on their acquisition and satisfaction, and predicts the degree of effort and persistence of individual behavior through internal motivation, which is an effective way to improve the behavior of the participants, and thus the study of the degree of autonomy support given by the external environment has a non-negligible role in the field of exercise for the satisfaction of the basic needs of the students.

Therefore, we can understand the basic needs of an individual as the individual's perception of external influences, and when some external factors make the individual's basic psychology get appropriate satisfaction, the individual's behavior does not need to make extra efforts and attempts to stimulate the individual's intrinsic

autonomous motivation, and the intrinsic motivation will drive the individual to have a better performance. In different fields of social science research, the study of basic psychological needs has received different attention, and an individual's intrinsic motivation is an important influence on behavior.

Related research on Autonomous Motivation

Physical exercise is a long-term persistent activity, and motivation is the guarantee of persistent exercise. Exercise motivation is the internal driving force for students to engage in physical exercise, which is one of the factors affecting the effect of physical exercise (Hong, 2019). If a student himself has a strong motivation to exercise, he will show an optimistic and positive attitude, and instinctively produce the will quality to overcome difficulties, so as to achieve good exercise results. Physical exercise motivation to a certain extent affects the purpose of physical exercise, exercise attitude, exercise habits, plays a role in stimulating behavior, guiding behavior, maintaining behavior. Therefore, positive exercise motivation is an important basis for independent participation in physical exercise, is to engage in activities with a full sense of will, sense of will motivation, is to stimulate individual behavior initiative and persistence of the leading factors.

According to Self-Determination Theory (SDT), exercise autonomous motivation is the psychological motivation or internal driving force for individuals to produce physical exercise, which has a certain guiding and promoting effect on individual physical exercise behavior, and the lack of intrinsic motivation will reduce the willingness to participate in physical exercise. Exercise motivation is the implicit of physical exercise behavior, and physical exercise behavior is the manifestation of exercise motivation, and they complement each other (Xia, 2006). In order to explore the influence of exercise motivation on individual physical exercise, scholars at home and abroad have conducted different empirical studies, and researchers have investigated the level of self-determined motivation of individuals from different perspectives, such as physical education learning, psychological interventions in competitive sports, exercise adherence, and participation in exercise, as well as the influence on individual participation in physical exercise.

SDT divides motivation into intrinsic motivation, extrinsic motivation and amotivation according to the degree of self-determination. On this basis, scholars

further distinguished between autonomous and controlled motivation according to changes in motivation, and compared the effects of the two types of motivation on students' physical education learning outcomes. SDT explains the relationship between motivation and behavior, and previous studies have mainly explored it from 2 levels: in-class and out-of-class.

In the field of physical education, most research has concluded that autonomous motivation (intrinsic motivation and identity regulation) produces more positive physical education learning outcomes. Ryan et al. (1997) found that intrinsic motivation promotes adherence to exercise. Pelletier et al. (2001) showed that athletes who perceived coach support for autonomy When athletes perceive a coach's support for autonomy, swimming motivation will be more autonomous, at which point athletes will have a self-determined level of identity regulation or internal motivation and show long-term adherence to their training habits, while internal regulation predicts short-term adherence, while unmotivated or externally regulated athletes are more likely to give up. Ryan et al. (2009) showed that autonomous motivation is the primary dominant motivator for an individual's participation in and prolonged adherence to physical exercise. factors, and indirectly affects the individual's own emotional experience, psychological well-being, and internal and external orientation consistency, and has a long-term and far-reaching impact on their behavior and psychology.

Ommundsen and Kvalø (2007) investigated the motivation levels of 194 10th grade students in five Norwegian lower secondary schools in physical education classes and found that the level of motivation students had within physical education classes was positively correlated with after-school physical exercise participation, and that the probability of participating in after-school physical exercise was significantly higher among students with higher autonomous motivation, with a 14% difference rate. Cox et al. (2008) followed 344 students in seven elementary and five middle schools in the Midwestern United States for three years and found that students' after-school physical exercise participation rates were positively correlated with their motivation for perceived autonomy within physical education classes, and that the satisfaction of students' competence, autonomy, and relational needs in physical education programs positively predicted after-school physical exercise participation.

Mouratidis et al.'s (2008) found that autonomous motivation was a significant predictor of students' subjective vigor in physical education classes.

Lonsdale et al. (2009) found that self-determined motivation enhances exercise behavior and self-determined motivation is more influential on adolescents' exercise behavior during non-physical education classes by examining the relationship between self-determined motivation and exercise behavior during physical education and non-physical education classes among 528 Hong Kong students.

Bagøien, et al. (2010) investigated the relationship between motivation in physical education classes, motivation for leisure time physical exercise, physical exercise and mental health among 329 high school students based on SDT. The results found that autonomous motivation in physical education classes was positively related to autonomous motivation for leisure time physical exercise and was positively related to leisure time physical exercise and mental health.

Duncan et al. (2017) found that autonomous motivation had a positive effect on students' physical exercise participation after analyzing 544 junior high school students' self-reported autonomous motivation and physical exercise behaviors. Therefore, physical education teachers need to strengthen the cultivation of students' autonomous motivation in physical education to better promote students' physical exercise participation in unstructured educational settings.

Brickell and Chatzisarantis's (2007) research suggests that those who exercise tend to be autonomously motivated are more likely to achieve spontaneous exercise intentions, which promotes more autonomous exercise behaviors. Duncan et al. (2010) conducted a cross-sectional study of 1,022 general exercisers, and found that stronger autonomous motivation was significantly more effective in predicting indicators of exercise behavior than weaker autonomous motivation, while integrative and identity regulation predicted exercise frequency in an exercising population, and endocannabinoid regulation predicted exercise intensity in female exercisers.

Hartmann et al. (2015) argued that intrinsic motivation has an important influential role in adherence to high-intensity physical exercise. Thøgersen-Ntoumani and Ntoumanis (2006) examined the role of self-determined motivation on exercise behavior, cognition, and physical self-assessment and found that, relative to unmotivated and extrinsic motivation, intrinsic motivation was more autonomous and

more important in terms of positive coping and emotional-cognitive experiences. Ferrer-Caja and Weiss (2000) argued that when the environment is coordinated with exercise, it satisfies an individual's need for autonomy and competence, which in turn promotes the internalization of motivation.

Foreign scholars Kalajas-Tilga et al. (2020) selected students from different schools as research subjects, and after having students fill out motivation scale questionnaires and using specialized equipment to measure their exercise for a week, the results showed that intrinsic motivation has a positive relationship with exercise activity, suggesting that in order to increase the daily exercise activity of adolescents, special attention should be paid to students' increase in intrinsic motivation for physical exercise.

Abula et al. (2020), in order to verify whether autonomy-supportive instruction provided by physical education teachers affects students' motivation for autonomy in physical education classes as well as outside of physical education classes, used a cross-sectional survey to investigate the perceived autonomy support for physical education classes and motivation for autonomy inside and outside of classes of 681 college students, and found that teacher autonomy-supportive behaviors in physical education classes had a significant and positive impact on student motivation for autonomy inside and outside of the classroom. Leyton-Román et al. (2020) used structural equation modeling to examine the impact of 922 high school students' perceived sense of autonomy support on their autonomous motivation in physical education class, and found that autonomy-supportive instruction not only has a direct impact on autonomous motivation, but also indirectly influences autonomous motivation by meeting the students' basic psychological needs.

In China, in the related research on the theory of autonomous motivation, Su Yu's (2007) study pointed out that the sense of learned helplessness, lower need fulfillment, social evaluation anxiety (competition anxiety and body shape anxiety), and poor form of teaching are the main reasons for students' lack of motivation, and that students who lacked motivation for physical education showed low-involvement behaviors and passive attitudes toward learning when they participated in physical education activities. At the same time, he pointed out that the atmosphere in physical education is conducive to the formation of internal motivation of students, and the

basic psychological needs of the mediating variable that affects the level of motivation in physical education, and that the combined effect of the need for autonomy, belongingness, and competence can effectively increase the motivation, interest, and sense of effort in physical education during the school hours. Chen (2008) and others found that when internal motivation is increased the frequency, duration, and intensity of exercise exhibited increases, while when external motivation is increased the frequency, duration, and intensity of exercise exhibited decreases.

In applied research in the field of sports training, Sun and Zhang (2013) and others found that the autonomous motivational components of external motivation (integrative regulation, identity regulation) were negatively related to psychological fatigue, and the controlling motivational components of external motivation (introspective regulation, external regulation) were positively related to psychological fatigue through a study of psychological fatigue in 225 professional athletes. Self-determined motivation had a moderate to high negative predictive effect on psychological fatigue, with the higher the degree of self-determination in motivation, the lower the likelihood of psychological fatigue, and the lower the degree of self-determination in motivation, the higher the likelihood of psychological fatigue.

Xiang (2013) conducted a survey on a sample of 664 adolescents, and he found that behavioral regulation (i.e., identity regulation and intrinsic regulation) with higher levels of autonomy positively predicted physical exercise behavior. Ma, L. (2014) found that elementary and middle school students' autonomous motivation in physical education classes can positively influence their motivation to participate in physical exercise. Liang, P.A. (2020) found that adolescents' level of autonomous motivation to exercise was positively correlated with their actual level of physical exercise.

Xue (2010) analyzed the relationship between college students' motivation and physical exercise behaviors by measuring their motivation and physical exercise behaviors: there was a significant positive correlation between autonomous motivation and the dimensions of physical exercise, and a significant negative correlation between controlled motivation and the dimensions of physical exercise; meanwhile, autonomous motivation positively predicted physical exercise behaviors,

while controlled motivation was a negative predictor of physical exercise behaviors.

Zhu and Zhang (2016) pointed out in the study of the influence of college students' exercise motivation on exercise behavior that the autonomous motivation of college students to participate in sports has a significant predictive effect on physical exercise behavior, but there is a certain variability between male and female students' exercise motivation and physical exercise behavior, female college students lack of dependence on sports compared to male students, in which controlling motivation leads to female college students' participation in sports tends to be also lower in time, so it is necessary for physical education teachers to take measures to enhance the autonomous motivation of female college students so as to improve the motivation to participate in prolonged physical education and sports.

Yang Jiapeng's (2017) study found that physical exercise motivation positively predicts physical exercise behavior; and that the dimensions of internal motivation for physical exercise are more predictive than the dimensions of external motivation, and support a partial mediating role for physical exercise behavior. Xu Wei's (2020) study also indicated that physical exercise motivation can be a good predictor of physical exercise behavior.

Su, Y. (2007) pointed out the factors of high school students' lack of motivation in physical education and how to improve high school students' internal motivation to participate in physical education. The results of the study showed that motivation was not affected by the sport chosen by the students, and that the sense of autonomy and support of the physical education teacher and the fulfillment of the students' basic psychological needs played a crucial role in physical education.

Zhang, H. (2017) showed in his study that the mediating effect of autonomous motivation is significant when exercise friendship affects adolescents' exercise adherence, and stimulating autonomous motivation is an effective way to enhance adolescents' exercise adherence. Peng Chunzheng (2018) found that satisfying the three basic psychological needs is conducive to the formation of autonomous motivation for physical exercise among offshore workers and promotes their long-term regular physical exercise.

Luan Gongjie (2018) took the relationship between the current situation of physical exercise behavior of school college students and different levels of exercise

motivation as the object of research, and carried out survey research and analysis on the characteristics of physical exercise behavior of college students at different levels of motivation, and found that the reason why students do not participate in physical exercise is mainly because they are not interested in physical exercise, and that the level of exercise motivation has obvious differences in gender, specialty and grade.

Yu Bo (2019) conducted a study on the relationship between sports and sports motivation of college students of different majors, grades, and genders, and the results showed that although internal motivation plays a crucial role in college students' participation in sports, a strong external motivation is more likely to urge college students to go to participate in a sport. This indicates that although college students want to participate in sports internally and realize the importance of sports, they do not participate in sports very often and need external stimuli to increase their participation in sports.

Hu Xiaoqing (2020) systematically reviewed the foreign research literature on self-determined motivation theory and physical education learning effects from 2000-2018, exploring the effects of self-determined motivation on motor skills, physical exercise, affective attitudes, and cognitive learning.

Li Yan's (2022) results suggest that teacher support can have a positive effect on college students' sports skill learning engagement through autonomous motivation. Promoting external support is the key to stimulate the autonomous motivation of college students, and it can also indirectly promote the learning of sports skills by stimulating the autonomous motivation of college students in physical education.

In addition, most of the research on controlled motivation in the field of physical education suggests that controlled motivation can have negative effects on students. Standage et al. (2005) found that students' controlled motivation was positively correlated with their boredom in physical education classes after conducting a survey on middle school students. Liu Zhifeng (2017) found that there was a significant weak correlation between controlled motivation and willpower development among middle school students in Suzhou after using a questionnaire survey. Valenzuela, et al. (2021) investigated the basic psychological needs, motivation in physical education class, and body self-perception of 618 elementary and secondary school students. The results indicated that autonomy and affective needs significantly and negatively

predicted controlled motivation in physical education classes, while controlled motivation in physical education classes significantly and negatively affected students' self-esteem. de Bruijn, et al. (2022) also found that controlled motivation developed by students in physical education classes also had a significant negative impact on their basic and specialized motor skill performance. In summary, the consistent conclusion from most of the current research is that autonomous motivation can positively affect PE learning outcomes, while controlled motivation can negatively affect them.

Brief Summary

In conclusion, motivation originates from psychology and controls the occurrence and maintenance of all individual behaviors. Exercise motivation and exercise behavior complement each other, and internal motivation in exercise motivation has a significant positive impact on individual behavior in participating in physical exercise activities because exercise motivation has an important motivational role in the selection of exercise frequency, the increase or decrease of exercise intensity, the length of exercise time and other exercise factors. Whether it is primary and secondary school students or college students, athletes or ordinary participants in sports activities, self-determined motivation is very important for individuals to participate in sports activities, so to enhance the students' autonomous motivation to participate in sports is a matter that physical education teachers should pay attention to. How to make students form more self-determined motivational orientation in physical exercise has become a topic of greater concern to the majority of physical educators.

Autonomous motivation tends to be the transformation and integration of motivation, and in addition to the influence of external environmental variables, the internal factors are also the main reasons for an individual's autonomous motivation. Existing research on SDT attempts to explain what external environmental factors and individual interactions lead to more autonomous motivation, and how external motivation tends to internalize motivation to increase exercise autonomy.

In summary, although the related studies have pointed out that autonomous motivation is correlated with physical exercise, the explanatory power for exercise behavior is not high. On the one hand, because college students' motivation is usually

influenced by external factors, and related research theories have proved that external motivation can be transformed into internal motivation under some conditions to promote students' motivation for physical exercise. On the other hand, there are other factors influencing the relatedness between autonomous motivation and exercise behavior, which is the focus of future research.

Related research on SDT in the field of Physical Exercise

Experts in the field of health behavior promotion have now proposed numerous theoretical models of health behavior change and introduced them into the field of physical exercise to explain why people do not participate in or withdraw from exercise. Western developed countries have explored the theory of self-determination earlier, as early as the end of the 1980s, Western developed countries have applied the theory of self-determination to motivation research is more mature and extensive, and formed a more complete theoretical framework. It is widely used in the fields of psychology, education and sports.

Researchers in the field of SDT in the area of physical exercise have focused on the analysis of the effects of the SDT model on maintaining physical exercise, keeping individuals physically fit, maintaining a good appearance, and developing a healthy lifestyle by maintaining their activity. In the extensive literature on the use of SDT to predict health-related behaviors, the findings are consistent with the beneficial effects of autonomy support on satisfying three needs, developing autonomous forms of behavioral regulation and behavioral outcomes, and well-being outcomes.

The results of many studies confirm that giving individuals an autonomy-supportive environment subsequently sustains behavioral change by satisfying basic psychological needs and stimulating the production of autonomous motivation. Ryan, Stiller & Lynch (1994) examined the effects of external factors on students' motivation and self-esteem in 606 middle school students, and found that good family relationships and harmonious teacher-student relationships could greatly increase students' academic motivation, on the contrary there is no significant correlation between the friendliness of the partnership and students' physical exercise motivation.

Cronin et al. (2019) found that students' perceptions of teachers' autonomy support were positively correlated with their basic needs satisfaction, and SDT explains that psychological needs promote internalization of motivation. Marlene et

al.'s (2010) one-year experimental study of obese menopausal women's problems with controlling their weight yielded the following results: obese women's exercise behaviors were affected by an autonomous environment , structural equations explained 62% of the variance in internal motivation and 16%-25% in exercise behavior, which showed that the more autonomous the environment, the more likely the patients were to be motivated to control their weight, but the explanatory power for exercise behavior was weak.

Ntoumanis (2010) study with 424 British secondary school students found that the satisfaction of competence needs positively predicted all forms of motivational regulation (except integrative regulation), whereas autonomy needs were significantly negatively correlated with extrinsic regulation and were able to achieve negative prediction, and that the satisfaction of relational needs positively predicted the three types of motivational regulation (intrinsic motivation, identity regulation, and introspective regulation).

Alvarez et al. (2009) conducted a correlational study on the relationship between perceived coach autonomy support, basic psychological needs fulfillment, and sport motivation among young soccer players. The results indicated that basic psychological needs mediated the effect between coaches' perceptions of autonomy support and sport motivation, and partial mediation for self-determined motivation in the links between psychological need satisfaction and enjoyment (positive) and boredom (negative).

Fernández-Espínola et al. (2020) argued through the theoretical framework of SDT that the satisfaction of basic psychological needs and self-determined forms of motivation are associated with positive behavioral consequences, as found in a survey of physical education students. Satisfaction of psychological needs for autonomy, competence, relatedness and novelty predicted autonomous motivation. On the other hand the need for autonomy positively predicted controlled motivation, while the satisfaction of relatedness negatively predicted controlled motivation. The need for competence and autonomous motivation positively predicted physical exercise intentions of physical education students, obtaining 33% of the explained variance. And the results of the hypothesized model highlighted the importance of meeting all basic psychological needs, with a special emphasis on the need for competence, as it

predicted autonomous motivation and intentions to be physically active outside of educational contexts; the study did not have an experimental intervention.

Ye Minsheng's (2021) Social support facilitates exercise behavior through the social environment, parent-peer relationships, and basic psychological needs theory, with relational, autonomy, and competence needs mediating between the social environment and physical and mental health. Targeting autonomous forms of motivation in interventions is an effective way to promote physical exercise in children and adolescents. Autonomous environments and motivation have an impact on physical exercise, hedonicity of physical learning, engagement, effort and willingness to continue to engage in physical exercise in the future. SDT can be used to predict behaviors related to the assessment of physical exercise, with positive predictive effects that promote individual motivation to engage in sport.

Ulstad et al. (2018) in a study based on the SDT model, students' perceived teacher autonomy support positively predicted students' need satisfaction, which in turn positively predicted students' autonomous motivation and sport participation, with no experimental intervention. GilPíriz et al. (2021), in a study for adults in physical exercise, based on the SDT, proposed a practical application to avoid frustration with basic psychological needs, increase self-determined forms of motivation, and reduce barriers to exercise and physical exercise practice, without experimental intervention.

Fenton, Duda, & Barrett (2016) Optimizing Physical exercise Participation in Youth Sport through SDT examined whether coach-created social environments and associated player motivation predicted objectively-measured variability in high-intensity physical exercise in youth sport settings. Their perceptions of the social environment (autonomy, support, and control) created by youth sports and their motivation (autonomy and control) for their soccer participation were assessed. Accelerometers were used to measure the intensity of physical exercise during youth sports. Results supported a model in which autonomy support perceptions significantly and positively predicted autonomous motivation in soccer, which in turn significantly and positively predicted adolescent sport MVPA (%time). Autonomy support perceptions had a significant indirect effect on adolescent sport %high-intensity physical exercise through autonomous motivation.

Ulstad et al. (2019) used SDT as a theoretical framework in his study to test that students' self-reported motivational rules would predict teachers' perceptions of students' motivational rules even after controlling for student performance. Another aim was to test a process model in which students' perceived teacher autonomy support would positively predict students' need satisfaction, which would positively predict students' self-reports of autonomous motivation and teachers' perceptions of students' autonomous motivation. Both of these in turn would positively predict student participation in sport. The results of the regression analyses and multilevel modeling indicated that only intrinsic and identified regulation were consistent between teacher and student ratings of student motivation.

Nogg et al. (2021) study from the perspective of SDT in the context of in-school, out-of-school, and weekend physical exercise. Examining motivation for physical exercise with American adolescents showed that all three linear back models were significant. In school-based motivation for physical exercise, external regulation, input regulation, recognition regulation, and intrinsic motivation were positively related to physical exercise. In physical exercise outside of school, external regulation, endogenous regulation, recognition regulation, integrative regulation, and intrinsic motivation were positively related to physical exercise. For weekend physical exercise, integrative regulation and intrinsic motivation were positively related to physical exercise. Indicating that the relationship between motivation and physical exercise varies by context. These findings have important implications for motivating adolescents to participate in physical exercise and may inform future interventions to increase physical exercise.

Xiang and Hu (2010) concluded through their research that SDT can enhance the internal motivation of individuals, satisfy their basic psychological needs, set up an autonomy-supportive environment, and promote their regular participation in healthy physical activities.

Ding and Mao (2014) analyzed through questionnaire modeling that the three basic psychological needs are satisfied by the autonomous supportive environment for adolescents to carry out exercise, autonomous personality and exercise goals, which enhances the internal motivation of adolescents to carry out physical exercise and the internalization of external motivation, so that the individual produces the behavior of

carrying out physical exercise on their own. The three factors of basic psychological needs satisfaction must be emphasized in order for individuals to perform physical exercise regularly. Tang and Li (2017) found that adolescents' physical exercise behavior is related to three factors: the support of important people in interpersonal relationships, the satisfaction of basic psychological needs, and the increase of autonomous motivation, and the need for competence from an individual can directly influence exercise behavior.

Xiang Mingqiang (2013) constructed a theoretical model to promote physical exercise and health and well-being among adolescents based on the SDT model and conducted an empirical study among 664 junior and senior high school students. The results showed that 2 mediating variables, basic psychological needs and autonomous motivation, were particularly important, and both predicted adolescents' exercise behaviors and subjective vitality, with autonomy needs being the strongest predictor of physical exercise and competence needs being the strongest predictor of subjective vitality.

Zhu and Yin (2017) added paths from competence needs to relationship needs and from competence needs to independence needs to the three models of the relationship between significant others' sense of independent support and adolescents' exercise behavior compared to the hypothetical model. Models of the relationship between sense of independent support from physical education teachers, parents, and partners and adolescent exercise behavior were fitted. The sense of independent support for exercise given by physical education teachers, parents, and partners was found to influence adolescents' exercise behavior by meeting three basic psychological needs. There was no significant difference in the effect of significant others' sense of independent support on exercise behavior.

Zhang and Li (2017), in exploring the path of physical exercise in adults based on SDT, showed that there was a significant positive correlation between the sense of autonomy support from significant others (the sense of autonomy support from family members and peers), basic psychological needs, autonomous motivation, and physical exercise behaviors; however, the explanatory power of physical exercise behaviors was only 32% and 31% of that of adult males, and 15% and 13% of that of adult females.

Yuan Hao (2019) in the study of campus soccer sport teaching, the sense of autonomy support of physical education teachers is an important external environment when high school students participate in campus soccer, and the basic psychological needs have a mediating effect between the sense of autonomy support of physical education teachers and the motivation of the sport, which has a positive impact on stimulating the motivation of high school students to participate in campus soccer.

Sun Haiyan (2016) studied three basic psychological needs through autonomous motivation was able to influence 21% of exercise behavior. Zhu and Yin (2017) constructed a SDT model in which 11% of exercise behavior was explained. Fan Wen (2018) constructed a model to promote extracurricular physical exercise behavior of college students, after adding self-efficacy, the basic psychological needs through self-determined motivation and self-efficacy can explain 26% of exercise behavior, further expanding the theoretical model of SDT basic psychological needs to promote exercise behavior, but the study did not consider the social factors that affect the basic psychological needs, and the exercise behavior's However, the study did not consider social factors affecting basic psychological needs, which did not have high explanatory power for exercise behavior, and it is recommended that other variables be considered for inclusion in future studies with the aim of explaining more extracurricular physical exercise behaviors.

Tang Guojie et al.'s (2021) study indicated that autonomy support in overweight and obese college students positively predicted basic psychological needs, and autonomy support influenced physical exercise adherence through the mediating variable of basic psychological needs.

The results of Liu Jiajing's (2021) study showed that elementary school students' perceived interpersonal support had a positive effect on their participation in physical exercise, and that relational need fulfillment mediated the relationship between interpersonal support and physical exercise without experimental intervention.

Guo Kailong (2021) based on SDT on the cultivation of college students' intrinsic learning motivation in physical education class proposed that, starting from the students' perspective, developing and cultivating students' intrinsic motivation for learning from three aspects of autonomy needs, competence needs and relational needs, in order to promote students' motivation and initiative in learning physical

education class, but found that in the physical education class teaching content can not be set up to meet the needs of the students, the teaching and organizing form of monotonous, the quality of physical education teachers need to be improved further, and the development of the sports venues and facilities lagging behind, and the utilization rate is low and other problems.

Li Deguo's (2022) findings showed that coaches' autonomy support behaviors can directly and positively influence athletes' commitment, and can also indirectly and positively influence youth athletes' commitment through the following pathways: the mediating effect of autonomy need, ability need and relationship need, the mediating effect of sport autonomy motivation, and the chain mediating effect of ability need, relationship need and sport autonomy motivation.

Brief Summary

SDT, as a cognitive theory of motivation, represents the current trend of motivation theory research, emphasizes the dynamic role of the self in the process of motivation, believes that the individual's ability to self-determination lies in the ability to flexibly control the interactions between themselves and the environment, and also emphasizes the important influence of the social environment on the development of human potential; identifies the three most basic psychological needs of human beings, and offers a new vision for a deeper understanding of human behavior.

SDT suggests that the satisfaction of psychological needs in sport provides the psychological "nutrients" for people to actively engage in physical exercise and to internally integrate physical exercise with the self. Therefore, individuals who have their psychological needs satisfied in physical exercise activities are better able to integrate their physical activities with their selves and integrate them into their daily lives in a positive and healthy way. From this I believe that assuming we satisfy the psychological needs of college students, they will actively participate in exercise and integrate exercise behavior into their college life, generating more exercise behavior, increasing the amount of exercise, and enhancing the physical fitness of college students.

To summarize: in recent years, a large number of investigations and analyses have been carried out abroad on the issues of motivation and exercise behavior of physical exercise participants from a theoretical perspective. The topics explored

mainly focus on the motivation of physical exercise participants, and the influencing factors of various dimensions of motivation are derived to interpret the exercise behavior of physical exercise participants. These results provide theoretical support for further exploring the relationship between college students' motivation for physical exercise and exercise behavior in the context of Chinese culture, but with the development of society also presents unique changes, and the study of changes in motivation for physical exercise and exercise behavior regarding the SDT is also changing with the times. We can't ignore the differences in cultural backgrounds at home and abroad, national systems, different humanistic environments and other factors, which will interfere with people's psychological tendency motivation to different degrees and lead to different motivation for physical exercise, therefore, future research needs more experiments to prove the accuracy, perfection and progress of the theory.

Status of research on SDT-based physical exercise intervention programs

To further validate the optimal exercise behavior model applicable to the Chinese college student population, a longitudinal intervention experiment was implemented to examine whether the model-based interventions could increase the physical exercise behavior of Chinese college students. Therefore, this study used the self-determined exercise behavior prediction model to implement an intervention on Chinese college students' exercise behavior. Therefore, the intervention needs to draw on previous research results of interventions targeting SDT.

SDT has been widely used in the field of education as a maturing theoretical framework that provides a theoretical basis for explaining how the environment influences motivation, persistence, and effectiveness in learning (Deci et al., 1991). With the widespread application of SDT in education, research has confirmed that autonomy-supportive, competence-supportive, and affective-supportive instruction provided by teachers are all positive predictors of students' basic psychological needs and intrinsic motivation (Ntoumanis, 2005). However, there is still a lack of intervention research on needs-supportive teaching.

In China, there are fewer intervention studies on SDT in the field of physical exercise, whereas overseas, physical exercise interventions guided by the SDT model have been carried out in children, adolescents, and older adults, etc. Various studies

have combined SDT-based physical exercise intervention strategies, such as providing choices and rationales, reducing control, supporting a sense of belonging and competence, and providing positive feedback, to improve individuals' autonomy support level, basic psychological satisfaction, and autonomous motivation through various intervention forms such as knowledge lectures, physical Functional skills teaching, motivational interviews, and talks to increase the level of autonomy support, basic psychological satisfaction, and autonomous motivation of individuals. According to the SDT model, autonomy support is a key factor that facilitates or hinders the satisfaction of basic psychological needs; therefore, providing autonomy support becomes the entry point for interventions, and numerous studies have designed intervention programs around this variable to validate the effectiveness of SDT-based physical exercise intervention programs.

Experimental studies have also found that SDT-based interventions can increase physical exercise. For example, Fortier and Gaumond (2007) found that the number of physical exercise behaviors was higher among individuals who received autonomy-supported physical exercise counseling over a three-month period than among those who received only brief counseling prior to the start. Additionally, research has shown that team physical exercise leaders can be effectively trained through a demand-supportive communication approach, which improves a range of outcomes for team members. For example, Cheon et al. (2012) examined the effects of an SDT-based physical education teacher intervention on a range of student outcomes. They found that students in the experimental condition demonstrated higher levels of self-determined motivation, classroom participation, skill development, intentions for future activities, and academic achievement compared to students who did not receive the teacher intervention; furthermore, the effects of the intervention on these outcomes were mediated by increases in psychological need fulfillment. Taken together, this study suggests that SDT not only provides a viable framework for explaining physical exercise behaviors, but can also be used to guide athletic intervention programs.

Chatzisarantis and Hagger (2009) verified the relationship between teacher-provided autonomy support in physical education classes to promote adolescents' leisure time physical exercise behaviors through a teaching experiment. However,

overall, there are fewer intervention studies in the field of physical education classes in which physical education teachers provide autonomy support situations, and Su & Reeve (2011) found some methodological limitations in previous intervention studies through Meta-analysis, such as the lack of a control group or baseline test, small sample size, and lack of randomized assignment of subjects.

Tessier et al. (2008) conducted an 8-week classroom follow-up and intervention study with five new physical education teachers and 96 students by dividing the five teachers into a control group consisting of three teachers and 62 students following a routine and an experimental group consisting of two teachers and 34 students by providing pre-classroom training to the teachers of the experimental group around autonomy-supportive teaching and learning environments Training was given in the form of a case study on the facts and principles that autonomy-supportive environments stimulate students' interest in learning more than controlled instructional environments and emphasized strategies such as self-selection and clear advice provided by teachers to students. The results of the experiment showed that there was a significant improvement in students' autonomous motivation and engagement in learning after teachers in the experimental group were trained in autonomy-supportive training and then provided students with an eight-week instructional intervention.

Edmunds et al. (2008) selected 56 female students and female employees (18-53 years old) from a university, all exercising in a fitness center, to be randomized into an intervention group and a control group, both for a 10-week intervention cycle, once a week. Both groups were taught by the same exercise instructor. In the intervention group, the exercise instructor developed a tailored content focused on increasing autonomy support, recording feedback and providing them with information and choices; the intervention group had access to a choice of classes, including the ones they wanted to do and the same ones as the control group; and the control group followed the usual exercise program and schedule. The results of the study showed that exercise participants in the autonomy-support condition reported higher levels of psychological need fulfillment, positive affect, and exercise adherence, and showed moderate effect sizes.

Chatzisarantis (2009) investigated with upper elementary school students in the

UK, where teachers in the experimental group used an autonomy-supportive style of teaching (teachers in the experimental group received training prior to the instructional intervention on providing positive feedback, recognizing students' difficulties in the classroom, demonstrating neutrality, and providing students with more choices), and teachers in the control group engaged in business-as-usual teaching. 5 weeks of teaching At the end of the intervention, students in the experimental group demonstrated higher intentions to participate in extracurricular sports as well as behaviors, and autonomous motivation and intentions were also found to mediate the effects of the intervention on extracurricular sports participation behaviors.

Hsu (2011) conducted a randomized controlled trial for 22 sedentary obese patients in the Ohio State University community, using primarily a health education curriculum for the intervention. Both groups received a 90-minute weekly program for 8 weeks of intervention and 4 weeks of follow-up. The control group implemented a 45-minute individualized exercise training session twice a week. Sessions consisted of moderate-intensity aerobic walking training and resistance training.SDT members, in addition to receiving 30-minute individualized training sessions (with elements designed to address the variables in the SDT), participated in 1-hour sessions (with content designed to address the variables in the SDT) once a week, and members of the SDT group were individually scheduled to make up for any absences from the training or sessions. In addition, SDT group members were required to participate in an unplanned basic exercise program of 150 minutes of moderate-intensity physical exercise per week that met public health recommendations, and SDT group members were required to keep a diary to record weekly exercise participation.The intervention topics for the SDT group were goal-setting, increasing activity, overcoming barriers, and teaching self-monitoring of exercise intensity.

Moustaka et al. (2012) examined the effects of an autonomy-supportive SDT-based intervention on perceptions of autonomy support, basic psychological needs, behavioral regulation, subjective vitality, and exercise behavior. Thirty-five female study participants recruited to participate in an 8-week, 24-session exercise program were taught with either an autonomy-supportive instructional style (n=19) or an instructional style lacking autonomy support (n=16). The results of the study showed

that the experimental group had increased perceptions of autonomy support, autonomy and competence need satisfaction, identity regulation, internal motivation, and subjective vitality, as well as increased attendance at the exercise program. Whereas the control group reported decreases in feelings of autonomy support, autonomy and competence needs, internal motivation, and subjective vigor. The study further supports the motivational benefits and psychological benefits of SDT principles and autonomy-supportive exercise instruction styles for middle-aged women.

Chang et al. (2016) used a quasi-experimental design to assign 126 elementary school students to an autonomy-supportive instruction group (n= 61) and a control group (n= 65) for a 6-week intervention period, and administered questionnaires on students' perceived autonomy support and self-determined motivation before and after the experiment, respectively. The results showed that students' levels of perceived autonomy support and intrinsic motivation increased significantly in the autonomy-supportive instruction group, whereas there was no significant increase in the control group, suggesting that autonomy-supportive instruction provided by physical education teachers can be successfully implemented in physical education classes and can increase students' perceptions of autonomy support and intrinsic motivation.

Lee et al. (2016) Feasibility analysis of an exercise program based on the SDT strategy applied to community-dwelling older adults in South Korea, with 89 sessions (face-to-face sessions) at 60 min twice a week for an intervention period of 13 months. The results showed that older adults had increased exercise adherence, improved physical functioning, variables in the SDT model, and promoted participants' motivation to be active.

Sánchez-Oliva et al. (2017) investigated Spanish secondary school students and organized 15 hours of training for teachers in the experimental group (including forms of motivation, the effect of teacher style on student need satisfaction, and the effect of need satisfaction on motivation. Teachers were then provided with strategies to satisfy students' autonomy, competence, and relational need satisfaction through video lectures as well as role-playing), and at the end of 10 physical education classroom interventions, the experimental group's motivation to participate in the physical education classroom, as well as their intentions to participate, were effectively

increased.

Mahmoodabad et al. (2017) conducted a randomized controlled trial of motivational interviewing for physical exercise in fertile women based on the SDT framework. There were 35 fertile women in the control group and 35 in the experimental group, and the experimental group implemented SDT-based motivational interviewing based on regular health education. Before the intervention, training was given on general knowledge of regular physical exercise (e.g., type and intensity) and the benefits of regular activity. At the end of the intervention, participants in both groups were given a training manual (containing the content of the training sessions). The intervention in the experimental group consisted of four 90-min sessions, one per week, at a local fitness center. The content of the training program in the intervention group focused on participants' understanding of the importance of activity, their experience of the value of activity, and helped to build self-confidence and set goals.

Polet et al. (2019), using Finnish junior high school teachers and students as survey respondents, trained teachers in the experimental group prior to the instructional intervention for a duration of 2 weeks, totaling 12 hours, which centered on autonomy-supportive instructional strategies, i.e., considering the student's point of view; using noncontrolling language; demonstrating patience; offering choices; and understanding the student's emotions of negativity. The control group teachers received 4 hours of training just monitoring students' physical mobility. This was followed by a 1-month instructional intervention, which showed that the experimental group's level of extracurricular physical exercise participation was better than that of the control class at the post-intervention measure, and at 1, 3, and 6 months after the end of the intervention. The study demonstrated both the effectiveness and stability of the experimental intervention.

Ding Weiwei (2016) conducted a 14-week longitudinal experimental intervention for middle school students and showed that an intervention based on a prediction model of self-determined exercise behaviors was able to increase the basic psychological need for exercise, motivation to exercise, and engagement in exercise behaviors among middle school students.

Tang Wei (2019) conducted an 8-week teaching experiment with questionnaires

and experimental interventions based on SDT research with overweight girls in junior high school as research subjects. After the experimental intervention, the internal motivation of overweight girls in junior high school was enhanced, and external motivation was reduced and transformed into internal motivation. Overweight middle school girls may have a greater need for teachers to meet their autonomy and relational needs in the classroom, which is more likely to help them increase their enjoyment of physical exercise.

Reeve & Cheon (2014) used SDT as a grounded theory to test the effectiveness and pedagogical benefits of the Autonomy-Supportive Intervention Program (ASIP), which assists teachers in learning how to better support students' autonomy during instruction in order to strengthen students' self-determined motivation, thereby reinforcing their PA behaviors. Ntoumanis et al. (2017) developed strategies to promote motivational internalization based on SDT's Psychological Need Satisfaction aimed at training instructors to conduct indoor cycling sessions with motivational communication. Instructors were taught how to maximize the use of motivational adaptive strategies to increase their client's motivation to PA.

Su and Reeve (2011) through a systematic analysis, reviewed 19 studies of teacher support interventions to argue that relatively more effective teacher support intervention programs should build their training content with a variety of self-directed support elements and present them in relatively brief (1-3 hours) sessions focused on skill acquisition and application of support strategies and utilize a variety of types of media to deliver their content, with intervention effectiveness were evident. The above intervention research provided the theoretical foundation for the action research in this paper. As seen above, the researchers' SDT-based, classroom intervention over time significantly increased students' perceptions of classroom autonomy support, motivation to participate in sports, and extracurricular sports behaviors through targeted training of teachers' classroom autonomy support behaviors at different school levels.

Previous researchers and scholars have not only conducted cross-sectional studies such as questionnaire surveys, but also empirical studies through experimental methods. When physical education teachers carefully design the physical education curriculum, give some autonomy in the course of study, provide timely feedback on

students' performance in the classroom, provide students with more encouragement and support, and appropriately enhance communication and interaction between teachers and students in the classroom, the students will show more concentration in the classroom practice. Therefore, teachers who have a good understanding of autonomy support will show more autonomy supportive behaviors in the teaching process, do not use coercive teaching methods, create a comfortable learning environment for students, meet the basic psychological needs of students, and strive to let students feel their own initiative, which is conducive to the cultivation of students' interest in physical exercise and motivation to participate in sports activities.

In summary, SDT-based physical exercise interventions include: lectures, talks, health manuals (exercise prescription), diary feedback, and physical function training; and interventions include: increasing knowledge about physical exercise, stress management, autonomy support, information communication, helping participants to set goals and self-monitoring, ways to overcome barriers to mobility, endurance training, flexibility training, muscle strength training, and aerobic training. training, balance training, and aerobic training. The interventions in the intervention group were based on the SDT model, incorporating techniques to enhance the individual's sense of autonomy and to meet their basic psychological needs into various forms of intervention. The intervention period ranged from 4 weeks to 1 year, with 1-2 weekly interventions of 60-120 min each; the intervention staff consisted of experts in different specialties, such as exercise physiology, nutrition, psychology, nursing and other fields, in order to give the intervention group the most professional and precise guidance. The study mainly used randomized controlled or self-controlled research design to analyze the effect of physical exercise intervention based on SDT, and the results of the study showed that the intervention program was feasible, scientific and effective.

Brief Summary

Whether in the physical education class or after-school exercise, the enjoyment, stimulation and self-presentation that college students feel will increase the degree of satisfaction of the psychological needs of physical exercise, and then involve more physical exercise behaviors and put in more exercise volume. On the contrary, the decrease in the degree of satisfaction of the psychological needs of college students'

physical exercise will directly lead to the willingness of not wanting to participate in physical exercise, or even refusing to participate in physical exercise. Therefore, it is very important to satisfy the psychological needs of physical exercise, whether in the physical education classroom or extracurricular physical exercise.

This researcher has found in many years of physical education class teaching that college students' active learning in physical education class is not strong, and some college students are even addicted to the Internet outside of class time and spend more time sitting still. Teachers need to better understand the current situation of physical exercise of college students and intervene. So as to promote students' independent physical exercise. To achieve the purpose of strengthening students' physical fitness. There are fewer studies on how physical education teachers can influence the extracurricular activities of college students through effective teaching in the classroom, and promote students to participate in regular physical activities outside the classroom.

In recent years, as the physical health status of college students has been declining year by year, it has gained extensive attention from many experts and scholars, and a number of intervention studies have begun to emerge, attempting to use a variety of different methods to promote physical exercise among college students. However, most of them have been confined to describing and analyzing the current situation of physical exercise and lack research on how to effectively intervene to promote physical exercise. This makes it difficult to know which interventions are most effective and feasible.

Therefore, to further validate the optimal exercise behavior model applicable to the college student population, a longitudinal intervention experiment was implemented to examine whether model-based interventions could increase college students' physical exercise behavior. Based on previous research literature, this study hypothesized that the self-determined exercise behavior prediction model is applicable to the Chinese college student population. Based on the SDT of sports behavior, this study proposed to use the self-determined exercise behavior prediction model to intervene in the exercise behavior of college students, and to analyze the influencing factors of college students' physical exercise behavior as a whole.

Summary and Discussion

SDT is an important part of Western motivation theory research, emphasizing the degree of self-determination of human behavior, dynamically observing various types of motivation, and also providing a basis for the integration of many motivation theories. The theory differs from other motivation theories in that it is the first to propose the concept of "internalization of motivation", which views motivation as a continuum and pays close attention to the process of gradual change in motivation, and therefore, the idea of internalization of extrinsic motivation is extremely valuable for the stimulation of exercise motivation. The idea of the three basic psychological needs is the core of SDT, and its concepts become the core of connecting the external environment with individual motivation and behavior, and when environmental factors provide support for the satisfaction of these three psychological needs, the internalization of extrinsic motivation will be promoted. Therefore, the three basic psychological needs can be satisfied in a specific environment to stimulate the motivation of college students to participate in exercise.

The application of SDT in the field of exercise and health is mainly reflected in the study of participatory motivation in exercise, and the study is mainly based on the causal perceptual trajectory model founded on the organic integration theory. SDT starts from the social environment of autonomy support and the individual psychology of basic psychological needs fulfillment to study the effects on physical exercise in the population. SDT recognizes that there are three basic psychological needs: autonomy, competence, and relationship. Meanwhile, SDT takes the support of autonomous social environment as the antecedent variable for the satisfaction of basic psychological needs. Autonomy-supportive environment refers to a kind of social environment system that supports individuals' autonomy, which is able to consider the problem from the viewpoint of the supported person, understand the other person, stimulate the other person's intrinsic motivation to take action, provide the other person with meaningful information and the opportunity to make choices, and encourage self-determination.

An increasing number of researchers have applied SDT to the field of exercise, with a larger body of research suggesting that individuals can promote exercise levels in an exercise autonomy-supportive environment, as well as through basic

psychological need satisfaction and thus exercise levels (Jin et al., 2017; Edmunds et al., 2007). Previous research has demonstrated that autonomy-supportive social environments have a positive effect on individual psychological need satisfaction and autonomous motivation; motivation internalization research provides supportive evidence that autonomy support leads to the gradual internalization of extrinsic values. The internal logic of SDT is that autonomy support promotes psychological need satisfaction, which in turn leads to the generation of internal motivation and the internalization of extrinsic motivation, and that internal motivation not only triggers behaviors, but also maintains behavioral change is sustained. A large amount of data shows that, as college students who are mainly engaged in mental labor, they lack physical activities in their lives and quit physical exercise at the end of physical education classes, resulting in a yearly decline in physical fitness, and the aftereffects of non-participation in physical exercise are more significant, and college students today generally lack the autonomy of physical exercise (self - determination) and lack of autonomy supporting environments. How to promote college students' self-determination to participate in physical exercise is an important issue that many sports workers are concerned about. Studies based on SDT have found that a more effective management method for college students is to use internal and autonomous motivation to promote exercise behavior.

Empirical studies in various fields in China and abroad have proved that satisfying the three psychological needs in a specific environment is indeed an effective path to promote individual behavioral motivation; autonomy-supportive social environments have a positive effect on individual psychological need satisfaction and autonomous work motivation; motivation internalization studies provide supporting evidence that autonomy support leads to the internalization of extrinsic values; and tests of psychological needs have also proved that the pervasiveness of intrinsic psychological needs and their positive correlation with individual psychological health and work performance (Zhang Jian, 2010), the above findings can be useful in improving the decline of exercise activities among college students today, and a more effective management approach for college students is to use internal and autonomous motivational approaches.

In summary, it can be seen that the studies of domestic and foreign scholars on

basic psychological needs, self-determined motivation and exercise behavior, as well as the related studies with other variables all have an impact on promoting exercise behavior, and also provide a solid foundation for the research of this paper. Although there have been studies revealing the specific process and mechanism of autonomy support acting on autonomous motivation from different perspectives, there are fewer empirical studies. Based on the synthesis of previous studies, this study hypothesized that autonomy support of physical education teachers has a positive effect on students' autonomous motivation, while the satisfaction of basic psychological needs mediates the relationship between autonomy support of physical education teachers and students' autonomous motivation. Individuals who feel more autonomy support will regulate their behaviors and allocate more time and energy to physical exercise after school. In the school environment, physical education teachers are an important node in the social support network that students possess, and the social support that exercisers draw from them can effectively motivate individual exercise behaviors, so the creation of an autonomy supportive physical education classroom is of great significance in promoting students' exercise behaviors.

Existing studies have mainly examined the correlation between autonomy support and certain factors, with fewer experimental studies and a lack of research on the mechanisms affecting autonomy support, thus making it difficult to reveal the psychological mechanisms underlying the positive psychological effects of autonomy support. The vast majority of conceptual and empirical studies on autonomy support have been proposed and developed based on Western psychological theories, and the applicability of their conclusions to our country needs to be supported by a large number of localized studies. Therefore, we believe that the development of a scale to measure people's general feelings about autonomy support, the use of various methods (especially experimental methods) to explore the psychological mechanisms of the positive psychological effects of autonomy support, and the development of localized research on autonomy support should be the areas that need special attention in the current research on autonomy support.

There has also been a gradual increase in the number of intervention studies based on SDT as a theoretical foundation, and the development and formation of autonomous motivation is a central part of SDT, which provides theoretical

implications for improving the teaching strategies of physical education teachers and increasing the level of physical exercise of students.

Future research should also provide more robust evidence for the need to validate the structural model of SDT. Focusing on the conditions of motivation internalization in trait states, the dialectical relationship between psychological needs and motivation internalization has yet to be explored by a large number of empirical studies, with a view to exploring the mechanisms by which individuals perceive environmental information to generate need experiences and motivation and the internal mechanisms by which individual factors influence motivation.

Summarizing the previous studies can be found that the exercise model based on SDT is being gradually improved, which is a process of simple theoretical models being enriched in reality. Most of the studies mainly introduce SDT or apply this theory to theoretically describe and analyze certain phenomena, and fewer of them conduct empirical studies. Therefore, this study applied SDT to a Chinese college student exercise group to provide an autonomy-supportive environment to promote the generation of intrinsic motivation as well as the internalization of extrinsic motivation by fulfilling their psychological needs, which triggers the development and maintenance of physical exercise. Before implementing the intervention, the SDT model should be validated to determine whether the model holds true in the Chinese college student exercise group, analyze the relationship between the variables in the SDT model, and determine the optimal path to promote physical exercise.

CHAPTER III

RESEARCH METHODS

This chapter describes the overall design of this study, including sampling, construction and testing of the SDT prediction model, experimental intervention, data collection procedures, and statistical analysis. This study will utilize a combination of cross-sectional and longitudinal research methods, and data will be collected from general undergraduate students in six universities in Jining, China. This chapter is divided into two phases, in which the first phase consists of two parts, pretest and formal test, in which the pretest is to construct a prediction model of self-determined exercise behavior for Chinese undergraduates; and the formal test is to test the applicability of the prediction model of self-determined exercise behavior, and to analyze the relationship between the structural variables of SDT. The second stage is a longitudinal study, where the experimental intervention of the self-determined exercise behavior prediction model supports the validity of the SDT prediction model (Figure 2).

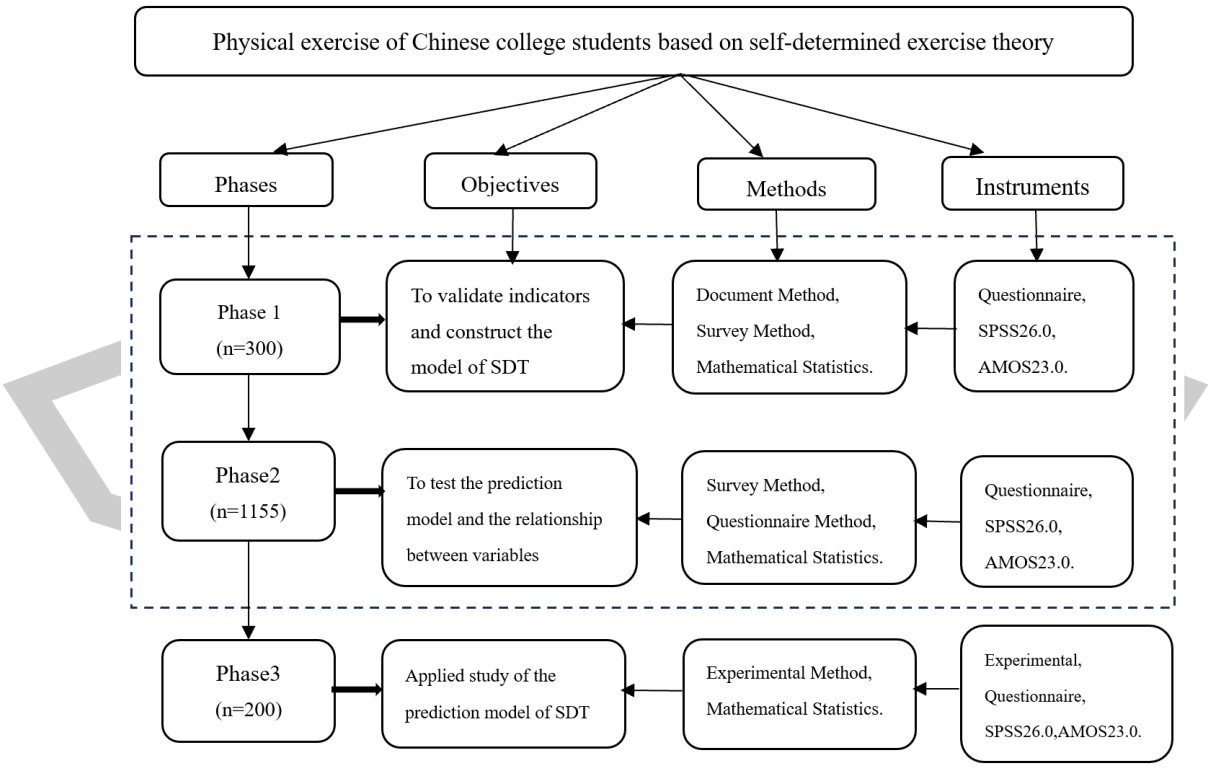

Figure 2 The Research Framework

Phase 1

1. Research Objective

1.1 To develop a prediction model of self-determined exercise behavior applicable to the actual situation of Chinese college students' physical exercise.

In phase 1, To conduct pre-tests. The purpose is verify the validity and reliability of College students' physical exercise behavior change questionnaire, and to develop a self-determined exercise behavior prediction model for Chinese college students.

1.2 To validate the model of physical exercise of Chinese college students based on SDT; to explore the main factors affecting the motivation and behavior of Chinese college students in participating in physical exercise.

In phase 2, To conduct a survey in 6 Universities and colleges in Jining, China. The purpose is to understand the current situation of College students' physical exercise and to analyse the relationship between the structural variables of the SDT.

2. Research Questions

Is the constructed theoretical model for predicting Chinese college students' physical exercise behavior validated?

What are the relationships among the variables of autonomy support, basic psychological needs, autonomous motivation and exercise behavior in the SDT Chinese college students' physical exercise prediction model?

3. Participants

Participants in this study were general undergraduate students from six colleges and universities in Jining, Shandong Province, between the ages of 17-23 years old, and data collection was completed in two separate sessions. The collection methods are offline questionnaire filling and online filling questionnaire.

In this study, convenient sampling in non-probabilistic sampling was used to conduct the survey. Before conducting this survey, Ethics Review Committee of Mahasarakham University has approved (mention to the ID of MSU ethic approve officially litter) the survey design of this study.

The pre-test questionnaires were distributed 320 copies, 320 copies were actually

recovered, 20 invalid questionnaires were excluded, and a total of 300 valid questionnaires were obtained; of these, ages 17-23 (19.22± 0.947), 159 were boys and 141 were girls.

The formal test questionnaires were distributed 1253, 1253 questionnaires were recovered, 98 invalid questionnaires were eliminated, and 1155 valid questionnaires remained; among them, ages 17-23 (19.38± 0.979); 524 were boys and 631 were girls. In two phases of data collection, volunteers inclusion criteria：

(1) College students aged 18-24, both male and female. (2) The students were interested in this study and singed consent forms. (3) The students were healthy, and have a certain Chinese language foundation, able to complete the questionnaire independently.

Volunteers exclusion criteria：

(1) The volunteers are not interested in this study. (2) The volunteers can't exercise, and can't complete the questionnaire independently. (3) Physical deformities or psychiatric disorders. (4) Underlying diseases including musculoskeletal, neurological and cardiopulmonary disorders.

4. Data Collection Procedure

The pre-test data collection method in the first stage was convenience sampling (paper version), the questionnaire was distributed by obtaining the consent of the research school and physical education teachers, the informed consent form was distributed to the students and they were informed that they could participate in this study voluntarily, the questionnaire was distributed by the researcher's personal administration and by entrusting the trained physical education teachers in the survey school, the standardized instructions and instructions for completing the questionnaire were standardized. The students answered the questionnaires in a quiet classroom, and the purpose and significance of the questionnaires were briefly explained to the students prior to the administration of the questionnaires. It was emphasized to the students that there is no right or wrong answer to the questionnaire, that it is anonymous, that their answers will be kept confidential, and that it is important for the students to answer honestly and conscientiously about their feelings. The

questionnaire took about 15-25 minutes to fill out and was collected on site.

The data collection method for the second formal test was convenience sampling, taking into account a number of factors such as resources, financial resources and manpower, and fully adopting the online form of filling out the online questionnaire, utilizing the web-based “questionnaire star” platform to conduct the large sample survey work (Wenjuanxing, a professional online questionnaire survey platform in China). Wenjuanxing, a professional online questionnaire survey platform in China). The questionnaire was distributed with the consent of the research schools and physical education teachers, and the students were given an informed consent form and told that they could participate in the study voluntarily; the questionnaire was set up with a link and a QR code, which was shared through WeChat and QQ to provide students with a convenient way to fill in the questionnaire and improve the efficiency of the recovery process; the questionnaires in the online questionnaire were all mandatory, which means that if there were any missing options, they would not be able to be submitted successfully, thus improving the completion rate of the questionnaires. The completion rate of the questionnaire can be improved. In the process of administering the questionnaire, the researcher and the commissioned physical education teachers conducted centralized training on the operation methods and precautions of the web-based questionnaire and established a WeChat exchange group to facilitate timely answers to problems encountered in the process of completing the questionnaire. Filling in the questionnaire was done using the end of physical education classes or during self-study time, with physical education teachers on hand to answer students' questions, emphasizing voluntariness and confidentiality, and being able to withdraw at any time. After filling out the questionnaire, students submit it through online submission, which takes about 15-25 minutes to fill out.

Data elimination:

(1) Data with omissions, multiple selections, or consistent answers in the paper questionnaire will be eliminated. (2) Since the online questionnaire is set to be a mandatory form, there are no omissions or multiple selections in the questionnaire, and only sample data with consistent answers will be eliminated.

5. Measurement Instruments

The tools of this study were the Sense of Autonomy Support Scale for Exercise, the Basic Psychological Needs Scale for Exercise, the Motivation Scale for Exercise, the Physical exercise Rating Scale-3, and demographic information such as gender, grade level, and date of birth.

Based on the existing scientific research and related data, it was found that the testing of the SDT variables in this study was supported by mature scales, which had been subjected to rigorous development procedures and reliability tests, and had been effectively utilized in physical education in China, therefore, instead of conducting an exploratory factor analysis, this study used a validation factor analysis to examine its structural validity, as well as a reliability test to determine the accuracy of the measurement data in the course of the study. accuracy of the data during the study.

5.1 Autonomy support questionnaire

The full version of the Sport Climate Scale (SCQ) developed by Lu Wen (2012) et al. was used, which consists of 6 questions to evaluate the level of perceived autonomy support from different significant others when college students engage in physical exercise, and a single dimension, which uses a 7-point scoring method, with specific questions such as, “My physical education teacher encourages me to to do exercise after class.”

5.2 Questionnaire on basic psychological needs for exercise

The Psychological Need Satisfaction in Exercise Scale (PNSE, Lu Wen, 2012) was used: the scale has a total of 18 items, with a Cronbach's alpha coefficient of 0.827; it is divided into three dimensions: autonomy need satisfaction, competence need satisfaction and relatedness need satisfaction. The scale has 18 items with a Cronbach's alpha coefficient of 0.827, and is divided into three dimensions: satisfaction of autonomy needs, satisfaction of competence needs, and satisfaction of relatedness needs, with 6 items for each dimension. The scale is scored on a 6-point scale, such as “I feel that I have the freedom to choose and decide on my own exercise program.

5.3 Exercise motivation questionnaire

The Behavioral Regulations in Exercise Questionnaire-3 (BREQ-3; Fan Wen, 2018) was used, which contains 6 motivational dimensions with 23 question items,

and its Cronbach's alpha coefficient is 0.81. They are: no motivation, extrinsic regulation, introspective regulation, identity regulation, integration regulation, and internal motivation. The scale was scored on a 5-point Likert scale, with scores ranging from 0-4 in descending order according to the level of endorsement of the questions, with specific questions such as “I value the benefits of exercising” (identity regulation), “I exercise because other people say that I should” (extrinsic regulation). (external conditioning). The scores of this scale can be used to calculate the autonomy index (RAI), which is calculated as follows: RAI = 3×Internal Motivation + 2×Integration Motivation + Identity Regulation – Intrinsic Regulation – 2×Extrinsic Regulation – 3×No Motivation, with higher scores indicating greater autonomy in motivational orientation.

5.4 Physical exercise questionnaire

The Physical Activities Rank Scale-3 (PARS-3) of Liang Deqing (1994) was used, with 3 questions and a Cronbach's α coefficient of 0.821. The scale mainly assessed the amount of exercise from 3 aspects, namely, intensity of exercise, duration of exercise and frequency of exercise, and the amount of physical exercise = Intensity × (Duration-1) × Frequency. The exercise volume score was used as an indicator of the subjects' exercise behavior.

5.5 Demographic variables

The demographic variables mainly include gender, age, grade, height, weight, place of birth, and school name.

6. Data Analysis

The collected data were statistically analyzed using SPSS 26.0 and AMOS 23.0 software with the following statistical methods: descriptive statistics, multiple linear regression, validated factor analysis, and structural equation modeling analysis.

In the first step, the normality of the data was first tested and the means and standard deviations of the different variables were analyzed using descriptive statistics. In the second step, the correlation between different variables was tested using Pearson correlation coefficient. In the third step, the causal relationships between the variables of teacher autonomy support, basic psychological needs, motivation for autonomy and exercise behavior were tested using regression analysis,

meanwhile, this paper tested the mediating effect between the variables by stratified regression and Bootstrap was used to verify the robustness of the mediating effect. In the fourth step, the structural equation modeling analysis was carried out using AMOS software, and the method was Maximum Likelihood (ML), and the evaluation indexes of the model's fitness were the chi-square degrees of freedom ratio (x^2/df), the comparative fit index (CFI), the non-regulation fit index (TLI), the incremental fit index (IFI), and the value-added fit index (VAFI). index (IFI), incremental fit index (IFI), and root-mean-square error of approximation (RMSEA) were used as reference indicators. Among them, x^2/df between 2 and 5 indicates an acceptable fit and the smaller the value, the better; TLI, CFI, IFI, and NFI are all greater than .90, which indicates a good fit; and the RMSEA value is less than .08, which indicates a good model fit, and the smaller its value, the better. Fitness of hypothesized models and observed data for factors influencing exercise behavior. The mediating effect analysis used the international very popular bias-corrected percentile Bootstrap method to repeat random sampling 5000 times in the original data, if the path coefficients do not include 0 in the confidence interval (usually using 95% confidence interval), it means that the mediating effect is significant, and the confidence interval include 0, which means that the mediating effect is not significant.

Structural equation modeling is analyzed considering that the latent variables have more observed variables, and the increase in indicators will complicate the model and is not conducive to building relationships between key latent variables. For this reason, the study used item parceling (also known as item combination) to reduce parameter estimation in order to improve the degree of commonality and model fit, that is, these latent variables were transformed into manifest variables by summing and averaging their observed variables, which allowed for the purification of measurement error and simplified the model, ultimately improving parameter estimation as well as model fit. The structural model of this study is more complex, the basic psychological needs including autonomy needs, competence needs and relatedness needs, the average of the corresponding question items as an observational index, a similar approach is the exercise of autonomous motivation contained in the six latent variables, exercise of autonomous motivation in the form of an index: autonomous motivation (RAI) = 3×Internal Motivation+2×Integration Motivation+

Identity Regulation–Intrinsic Regulation–2×Extrinsic Regulation–3×No Motivation.

Phase 2

1. Objective

Using the experimental method, through 10-week experimental intervention was used to validate the effect of autonomy support from physical education teachers on college students' exercise behavior.

2. Research Questions

Does the application of the constructed exercise behavior prediction model have an impact on Chinese college students' physical exercise in intervention studies?

3. Participants

In conjunction with the research, the participants in this study were undergraduate students enrolled in general colleges and universities, and two experimental classes and two control classes were selected from each of the classes taught by the main subjects to participate in the experimental study. There were 100 students in the experimental group (48 males and 52 females; aged 17-22 years, 19.29±0.87) and 100 students in the control group (46 males and 54 females; aged 18-23 years, 19.41±0.97).

Volunteers Inclusion criteria: (1) Currently enrolled college students, both male and female. (2) The volunteers were interested in this study and singed consent forms. (3) The volunteers were healthy, and have a certain Chinese language foundation, able to complete the questionnaire independently. (4) The volunteers are willing to accept the 10-week intervention experiment.

4. Experimental Design

The experimental design is a 2×2 two-factor repeated measures mixed experimental design, in which the between-subjects factor (group factor) is divided into the experimental group and the control group, and the within-subjects factor (time factor) is divided into the pre-test and the post-test, the independent variable is

the autonomy support of the teachers, and the outcome variables are the basic psychological needs, autonomous motivation, and the exercise behaviors of the college students. In addition, in order to avoid the “Hawthorne effect” in students, a single-blind experiment was used, i.e., the students did not know whether they were in the control or experimental group.

5. Experimental Time

According to the previous intervention studies on autonomy support, the intervention cycle is generally dominated by 8-12 weeks. Therefore, the experimental intervention cycle of this study is 10 weeks, specifically from May 2024-July 2024, in which the pre-tests and post-tests of the variables of autonomy support, basic psychological needs, autonomous motivation, and exercise behavior were conducted in the first and tenth weeks. The informational intervention was twice a week and the behavioral intervention was once a week. Experimental sites: school gymnasium, playground, classrooms.

6. Experimental Process

6.1 Experimental preparation stage

Recruit the experimental schools, select research participants for the intervention experiment, and distribute the informed consent form for the teaching experiment to the partner schools and students to obtain the consent of the participants, and introduce in detail the purpose, significance and precautions of this study. Prepare the equipment and materials needed for the intervention experiment.

6.2 Pre-testing stage of the experiment

The experimental and control groups completed the pre-test in week 1 to measure the baseline levels of demographic variables, autonomy support, basic psychological needs, autonomous motivation, and physical exercise behaviors of college students.

6.3 Experimental implementation phase

The experimental group adopted an autonomy-supportive intervention, (1) Behavioral intervention: mainly on-site face-to-face intervention in the context of the main subject's physical education class. (2) Information intervention: the main subject

uses a cell phone to send 2-3 text messages to the participants via WeChat and QQ group every week.

No intervention was implemented in the control group.

6.4 Post-experimental testing phase

At the end of the 10-week complete experimental intervention, a posttest was completed using relevant scales and tools to measure students' autonomy support, basic psychological needs, autonomous motivation, and physical exercise behavior. The main experimenter thanked the participants, explained what had happened and why the intervention had taken place, and distributed gifts.

7. Intervention Content

Behavioral intervention: mainly on-site face-to-face intervention in the context of the main subject's physical education class;

Teaching styles: autonomy-supportive teaching styles are mainly reflected in teachers' designing instruction from the students' perspective and using non-controlling methods to give students a certain degree of autonomy and minimize pressure on students. (1) adopting an empathic attitude; (2) trusting and understanding students; (3) providing opportunities for choice: providing students with meaningful choices in teaching (e.g., choices of practice partners, choices of order of task practice, and choices of difficulty of task practice, etc.); (4) guiding questioning; and (5) providing students with the opportunity to explore problems on their own, and to practice and solve problems independently. In order to ensure the ecological validity of the study, the specific teaching organization and form of practice were reflected in the lesson plans, except for the content of the physical education teacher's verbal expression.

Information Intervention: The primary participant used his/her cell phone to send 2-3 text messages to the participants through WeChat and QQ group every week to publicize and supervise the exercise behavior intervention. Including: (1) Answers to questions and discussions related to physical exercise; (2) What is regular physical exercise? (3) how to have regular physical exercise; (4) the impact of a sedentary lifestyle and lack of exercise on physical health; (5) the physiological and psychological benefits of regular and active participation in physical exercise, etc.; (6)

how to choose an exercise program that suits one's needs and set up a correct attitude toward physical exercise; (7) the criteria for a physical exercise program, as well as how to grasp the intensity of the workout and the amount of exercise. (8) How to develop an exercise program that is suitable for oneself, and to provide new, varied and interesting exercise activities; (9) Encouragement to help students establish short-term goals, and to help students develop and use self-management and monitoring skills to promote a sense of autonomy; (10) Motivation to participate in physical exercise through supportive, encouraging, and praiseworthy words to encourage students to build up the determination and self-confidence to persevere in exercising.

8. Measurement Tools

Some of the measurement tools from Research Phase I: Exercise Support Scale, Basic Psychological Needs for Exercise Scale, Exercise Behavior Regulation Questionnaire-3, and Physical Activity Rating Scale-3 were selected to measure exercise support, basic psychological needs for exercise, and motivation for exercise among the study participants. Demographic variables such as grade, class, gender, and age were also measured. The reliability and validity of the research instruments have been tested in the research phase I.

9. Verification of Experimental Operations

In order to ensure the validity of intervention experiments, any intervention study must demonstrate the integrity of the intervention methodology and its effective implementation. The checking of the experimental operation in this study is mainly reflected in the following aspects: first, before the intervention was implemented, the researchers consulted five experts in the fields of psychology and training on the design of the intervention content, and at the same time revised and improved the intervention content; the expert group evaluated the purpose of the study and the experimental design of the current phase, and gave scores and suggestions for modification in the evaluation form (Appendix C). Second, the intervention content was strictly controlled and adjusted during the intervention process.

Table 1 List of Evaluation Experts

Name	Area	University	Professional Title
FENG YJ.	Sport Psychology; Physical Education	Shandong University of Art & Design	Associate Professor
XU T.	Sport Psychology; Physical Education	Bohai University	Professor
CHE GW.	Sport Physiology; Physical Education	Shandong University of Traditional Chinese Medicine	Associate Professor
LI DX.	Physical Education and Sports Training	Qufu Normal University	Professor
LI SM.	Physical Education and Sports Training	Qufu Normal University	Professor

10. Statistical Methods

Excel was used to organize the experimental data, and SPSS26.0 was used to statistically analyze the experimental data, using the mean and standard deviation (M±SD) for descriptive statistics, and initially analyzing the normal distribution of the data. Secondly, independent samples t-test was used to analyze the difference between the control group and the experimental group before the experiment. Finally, a 2 (time: pre-test, post-test) × 2 (group: control group, experimental group) repeated measures ANOVA was used to test the changes in autonomy support, basic psychological needs, autonomous motivation, and physical exercise behaviors between students in the experimental and control groups before and after the experiment. Simple effects analyses were conducted on data with a significant interaction (time x group) to further analyze the effect of group versus time on that data. Data are displayed as mean ± standard deviation (M ± SD) with $P < 0.05$ considered statistically significant.

CHAPTER IV

RESULTS

This study is divided into three stages. The first stage is to validate the constructed prediction model of self-determined exercise behavior using structural equation modeling on the basis of the prediction theory hypothesis model proposed in the previous chapter (Phase 1). The second stage is to test the applicability of the self-determination theoretical hypothesis model and the fit of the model to the data in the physical exercise of college student groups in the Chinese cultural context; to verify the mediating role between basic psychological needs and autonomous motivation between exercise support and exercise behavior, and the effect of autonomy support provided by physical education teachers on college is exercise behavior, i.e., to test the theoretical model of prediction of college students' exercise behavior (Phase 2) . The third phase was an experimental intervention based on the prediction model of self-determined exercise behavior (Phase 3).

Phase 1

The pretest: Construction of a prediction model for self-determined exercise

Firstly, the research instrument was tested for reliability and validity, and after confirming that the scales had good applicability, the questionnaires were distributed on this basis, and the collection of receipts was pre-processed and converted. Secondly, a cross-sectional survey was used to examine the influence paths of college students' physical exercise behavior, and structural equation modeling was used to verify the modified hypothesis model.

Based on the fact that the reliability and validity of the preliminary scale is the basis for the formation of a formal scale and effective research, the reliability test of the scale in this study used Cronbach's α coefficient test, when Cronbach's $\alpha > 0.70$, it reflects that there is a high degree of consistency in the internal questions of the scale. The scales in this study are mature scales that have been validated in previous studies. After the initial reliability test of the scales, the scales were further analyzed by validation factor analysis to test the structural validity of the scales.

1. Reliability analysis of the scales

As can be seen from the table 2, the study used internal consistency check to test the reliability of each scale (Cronbach's α), and the results showed that the reliability of each scale ranged from 0.851 to 0.979, with the alpha coefficient of autonomy support being 0.962; the alpha coefficient of the total basic psychological needs scale being 0.979, and the alpha coefficients of the three subscales being respectively 0.953, 0.957, 0.958; the α coefficient of autonomous motivation was 0.929, and the α coefficients of the 3 subscales were 0.912, 0.886, 0.871, 0.851, 0.913, 0.865; the α coefficient of exercise behavior was 0.87. The α coefficients of the scales were over 0.70, which represented good internal consistency, and therefore the reliability of the scales were Therefore, the reliability of each scale is good.

Table 2 Cronbach's Alpha Reliability Coefficients of SDT

Items	Cronbach's Alpha
Autonomy support (AS)	0.962
Basic Psychological Needs (BPN)	0.979
Autonomy Needs (AN)	0.953
Competence Needs (CN)	0.957
Relatednesss Needs (RN)	0.958
Exercise Autonomous Motivation (EM-RAI)	0.929
Amotivation	0.912
External Regulation	0.886
Introjected Regulation	0.871
Identification Regulation	0.851
Integrated Regulation	0.913
Intrinsic Motivation	0.865
Exercise Behavior (EB)	0.870

2. Validity analysis of the scale

2.1 Autonomous Support

The structural validity of the autonomy support scale was examined using exploratory factor and validation factor analyses, and the KMO value of the autonomy support scale was 0.919 ($p < .001$), which was higher than the critical value of 0.6 and

passed the Bartlett's spherical test, and the cumulative variance explained rate of the scale reached 81.244%, which was higher than the critical value of 50%, indicating that the scale had a good level of structural validity. scale has a good level of structural validity. The results of the validation factor analysis can be seen in the following table 3 and figure 3. The results of the overall fit coefficient table show that x^2 = 15.682, df = 7, x^2/df = 2.240 < 5, GFI = 0.982, NFI = 0.993, TLI = 0.991, IFI = 0.996, CFI = 0.996, and RMSEA = 0.064, which shows an ideal fit of the model. Therefore, the entries of the autonomy support scale meet the model fit criteria and the subscale has good structural validity.

Table 3 Fit index of Exercise Autonomy support scale

Model index	χ^2/df	*GFI*	*NFI*	*TLI*	*IFI*	*CFI*	*RMSEA*
Standard	＜5.00	＞0.90	＞0.90	＞0.90	＞0.90	＞0.90	＜0.10
Index result	2.240	0.982	0. 993	0.991	0.996	0.996	0.064

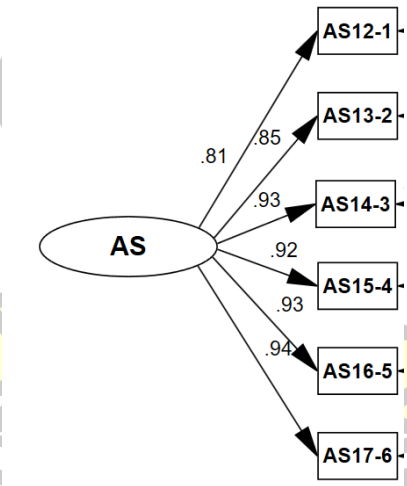

Figure 3 Model Diagram of Autonomy support (AS)

2.2 Basic Psychological Needs

The structural validity of the Basic Psychological Needs Scale was examined using exploratory factor and validation factor analyses. The KMO value of the Basic Psychological Needs Scale was 0.961 (p < .001), which was higher than the critical value of 0.6, and it passed the Bartlett's Spherical Test, and the cumulative variance

explained rate of the scale reached 82.974%, which was higher than the critical value of 50%, indicating that the scale had a good level of structural validity. which indicates that the scale has a good level of structural validity. The results of the validation factor analysis are shown in Table 4 and Figure 4 below, and the overall fit coefficient table results show that x^2 = 339.799, df = 119, x^2/df = 2.855 < 5, GFI = 0. 892, NFI = 0.953, TLI = 0.960, IFI = 0.969, CFI = 0.969, and RMSEA = 0.079, which indicates that the model has an ideal fit. fit was ideal. Therefore, the entries of the Basic Psychological Needs Scale meet the model fit criteria and the scale has good structural validity.

Table 4 Fit index of Basic Psychological Needs scale

Model index	χ^2/df	*GFI*	*NFI*	*TLI*	*IFI*	*CFI*	*RMSEA*
Standard	＜5.00	＞0.90	＞0.90	＞0.90	＞0.90	＞0.90	＜0.10
Index result	2.855	0.892	0. 953	0.960	0.969	0. 969	0.079

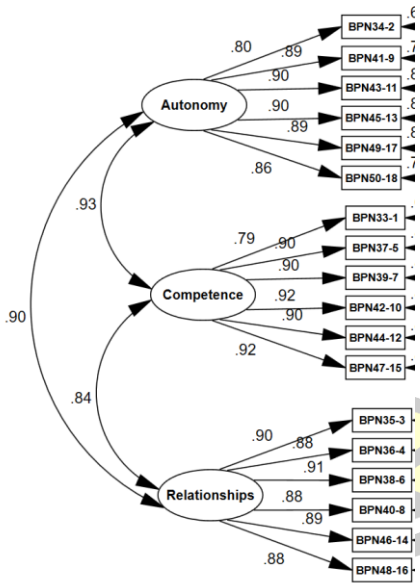

Figure 4 Model Diagram of Basic Psychological Needs（BPN）

2.3 Exercise Motivation

The structural validity of the exercise motivation scale was examined using exploratory factor and validated factor analysis, and the KMO value of the motivation scale was 0.935 (p < .001), which was higher than the critical value of 0.6, passing the Bartlett's spherical test, and the cumulative variance explained rate of the scale

reached 79.558%, which was higher than the critical value of 50%, indicating that this scale The structural validity level of the scale is good. The results of the validation factor analysis are shown in Table 5 and Figure 5 below. The results of the overall fit coefficient table show that x^2 = 601.204, *df* = 214, x^2/df = 2.809 < 5, GFI = 0.837, NFI = 0.902, TLI = 0.922, IFI = 0.935, CFI = 0.934, and RMSEA = 0.078, which is a good fit to the model. fit is ideal and meets the model fit criteria, therefore, the scale has good structural validity. Autonomous motivation for exercise in the study was in the form of an index, and different weights were used to assign weights to the six forms of regulation to form the Autonomous Motivation Index for Physical Exercise (RAI): RAI = 3×Internal Motivation + 2×Integration Motivation + Identity Regulation - Intrinsic Regulation - 2 ×Extrinsic Regulation - 3×No Motivation, with higher scores representing greater autonomy.

Table 5 Fit index of Exercise Motivation scale

Model index	χ^2/df	*GFI*	*NFI*	*TLI*	*IFI*	*CFI*	*RMSEA*
Standard	＜5.00	＞0.90	＞0.90	＞0.90	＞0.90	＞0.90	＜0.10
Index result	2.809	0.837	0.902	0.922	0.935	0.934	0.078

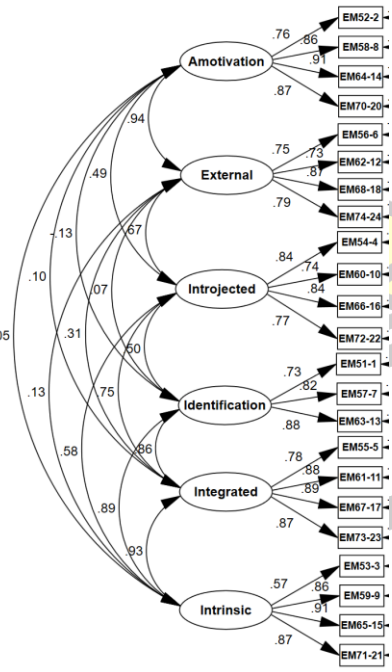

Figure 5 Model Diagram of Exercise Motivation (EM)

2.4 Pretest Structural Equation Modeling

The results of the validation factor analysis are shown in Table 6 and Figure 6 below, and the results of the pre-test structural equation model test: $x^2 = 85.518$, $df = 39$, $x^2/df = 2.193 < 5$, GFI = 0.952, NFI = 0.974, TLI = 0.980, IFI = 0.986, CFI = 0.986, and RMSEA = 0.063, all the indicators meet the model fit criteria, indicating that the hypothesized theoretical model fit indicators are ideal, the scale has good overall structural validity, and therefore the theoretical model is applicable to the Chinese college student population. The results supported research hypothesis H1.

Table 6 Fit index of Self-determined exercise behavior model（Pre-SDT-EB）

Model index	χ^2/df	*GFI*	*NFI*	*TLI*	*IFI*	*CFI*	*RMSEA*
Standard	＜5.00	＞0.90	＞0.90	＞0.90	＞0.90	＞0.90	＜0.10
Index result	2.193	0.952	0.974	0.980	0.986	0.986	0.087

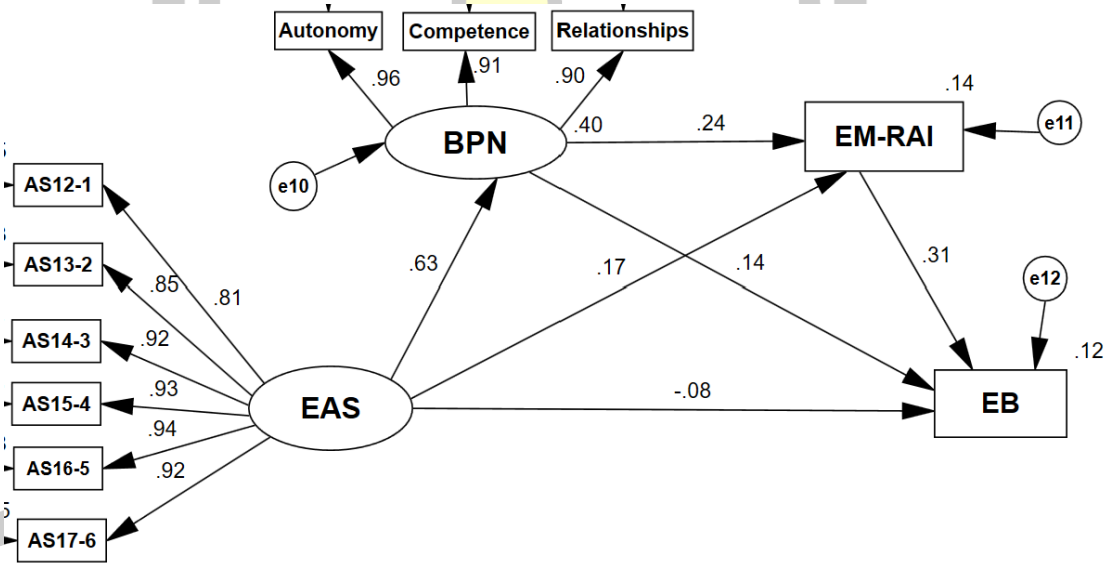

Figure 6 Model Diagram of Self-determined exercise behavior (Pre-SDT-EB)

3. Summary

In this stage, the main purpose of this study is to discuss the relevant questionnaires and prediction models of this study, to cite the mature domestic scales for the pre-survey, and to analyze the reliability and validity of the test scales through exploratory and validation factors.

The main objective of this phase is to analyze the reliability and validity of the

test scales through exploratory and validation factors. In order to achieve this objective, 300 university students were recruited as subjects in this phase of the study. Based on the variables to be investigated in this study, the scales were tested for reliability and validity, and the results of the study showed that the reliability of the scales was good, and the overall structural validity of the prediction model of self-determined exercise behavior was good. Therefore, the hypothesized model is applicable to the Chinese college student population and can be used as a test tool for the subsequent formal survey of this study, and the next step is to test the factor structure and hypotheses of this theoretical model.

Phase 2

Formal test: Validation of the self-determined exercise prediction model

In this phase, the proposed theoretical hypotheses will be empirically tested using actual survey data, and the constructed prediction model of self-determined exercise behavior will be validated using structural equation modeling. The practicality of the prediction model in Chinese college students' group physical exercise and the fit of the model to the data will be examined. And to explore the relatedness between college students' exercise behavior and autonomy support, basic psychological needs, and autonomous motivation.

1. Descriptive statistics of the variables

Descriptive statistics and non-parametric tests of normal distribution K-S (Table 7) for each variable showed that the mean value of autonomy support was 6.160 points out of 7, the mean value of basic psychological needs was 5.013 points out of 6, the mean value of motivation for autonomy (RAI = 3×Internal Motivation + 2×Integration Motivation + Identity Regulation – Intrinsic Regulation – 2×Extrinsic Regulation – 3×No Motivation) 28.100 points. The skewness values for each variable ranged from -1.559 to 1.067, and the kurtosis values ranged from -0.850 to 3.344, indicating that the variables all approximately obeyed a normal distribution. Descriptive statistics and non-parametric tests of normal distribution K-S for all question items are provided in Appendix F.

Table 7 Descriptive Statistics for all the Observed Variables for the SDT

variables	Min	Max	*M*	*SD*	Skewness	Kurtosis
Autonomy Support (AS)	1	7	6.160	1.034	-1.559	3.344
Basic Psychological Needs (BPN)	1	6	5.013	0.865	-0.781	0.759
Autonomy Needs (AN)	1	6	5.020	0.897	-0.953	1.412
Competence Needs (CN)	1	6	4.862	1.017	-0.855	0.668
Relatednesss Needs (RN)	1	6	5.159	0.831	-0.948	1.170
Exercise Autonomous Motivation (EM-RAI)	-73	91	28.100	28.464	0.127	-0.850
Amotivation	1	5	2.335	1.232	0.762	-0.417
External Regulation	1	5	2.663	1.150	0.485	-0.557
Introjected Regulation	1	5	3.114	1.072	0.123	-0.623
Identification Regulation	1	5	4.215	0.747	-0.860	0.724
Integrated Regulation	1	5	3.754	0.926	-0.348	-0.403
Intrinsic Motivation	1	5	3.933	0.847	-0.520	-0.055
Exercise Behavior (EB)	0	100	22.820	21.621	1.067	0.313

2. Reliability analysis

This study has already tested the reliability and validity of the collected relevant data during the initial survey, and the formal survey follows the questionnaire after the initial survey to measure the data. Considering the rigor of empirical research and the heterogeneity of the measurement sample and other factors, it is necessary to further test the reliability of the collected data after the formal survey. Cronbach's alpha coefficient was used for reliability analysis and validity analysis was used for validity analysis.

As can be seen from the table 8, the Cronbach's α coefficients of the internal consistency of each scale dimension range from 0.853 to 0.978, indicating that the scales have good internal consistency reliability.

Table 8 Reliability test of SDT

variables	Cronbach's Alpha
Autonomy Support (AS)	0.968
Basic Psychological Needs (BPN)	0.978
Autonomy Needs (AN)	0.954
Competence Needs (CN)	0.957
Relatednesss Needs (RN)	0.954
Exercise Autonomous Motivation (EM-RAI)	0.930
Amotivation	0.922
External Regulation	0.881
Introjected Regulation	0.880
Identification Regulation	0.853
Integrated Regulation	0.906
Intrinsic Motivation	0.885
Exercise Behavior (EB)	0.870

3. Correlation test of variables

Table 9 Indicates the Pearson correlation test between the variables of each dimension, the correlation coefficient reflects the degree of linear correlation between the variables, which can determine the dependent variable and independent variable correlation of the correlation hypothesis, and is the basis of the model test. From the table, it can be seen that there is a significant positive correlation ($p < 0.01$) between autonomy support, basic psychological needs and autonomous motivation and physical exercise behavior, with correlation coefficients of 0.235, 0.330 and 0.492, respectively, and the correlation coefficient between autonomous motivation and basic psychological needs is $r = 0.398$, the correlation coefficient between autonomous motivation and autonomy support is $r = 0.331$, and the correlation coefficient between autonomy support and Psychological Needs correlation coefficient is $r = 0.643$, in summary, there is a significant positive correlation between the main variables in this study ($p < 0.01$), and there is a significant positive correlation between autonomy support, basic psychological needs and autonomous motivation and college students' physical exercise behavior. The significant correlation among the variables constitutes

a sound precondition for subsequent analyses.

Table 9 Pearson correlation among study variables

variables	Pearson correlation			
	1. AS	2. BPN	3. EM-RAI	4. EB
1. Autonomy Support (AS)	1			
2. Basic Psychological Needs (BPN)	.643**	1		
3. Exercise Autonomous Motivation (EM-RAI)	.331**	.398**	1	
4. Exercise Behavior (EB)	.235**	.330**	.492**	1

Note. **$p < 0.01$, *$p < 0.05$.

4. Tests of Predictive Models of Self-Determined Exercise Behavior

4.1 Test of the direct predictive effect of teacher support on exercise behavior

In order to verify the main effect of teachers' autonomy support on college students' exercise behavior, this study conducted regression analysis using exercise behavior as the dependent variable and autonomy support as the independent variable, using the forced entry method (see Table 10 and Figure 7). The results showed that autonomy support ($F(1,1153) = 67.561$, $\beta = 0.235$, $p < 0.01$) had a significant predictive effect on exercise behavior. the above findings supported hypothesis H2.

Table 10 Simple linear regression on exercise behavior

Predictor	Exercise Behavior					
	B	*SE*	*β*	*T*	*F*	R^2
Autonomy Support	4.921	0.599	0.235	8.220	67.561***	0.055

Note. *SE* = standard error; **$p < .01$; ***$p < .001$.

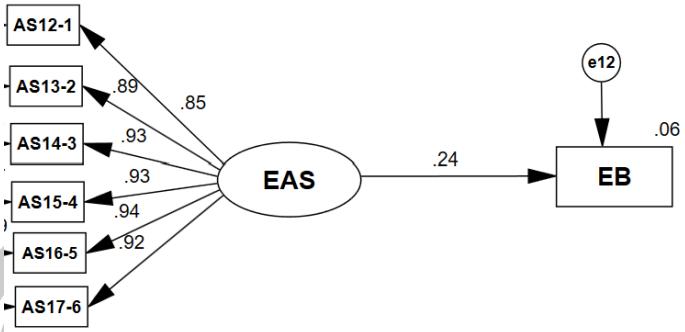

Figure 7 Path relatedness between Autonomy Support and Exercise Behavior

4.2 Mediation effect test of basic psychological needs between teacher support and exercise behavior

The mediation test used the sequential method to conduct regression analysis on autonomy support, basic psychological needs and exercise behavior, and the results are shown in Table 11 and Figure 8, with Model 1 using basic psychological needs as the dependent variable, and Models 2 and 3 using exercise behavior as the dependent variable in the regression analysis. The results of Model 1 showed that autonomy support was a significant positive predictor of basic psychological needs (β= 0.643, p < 0.01). The results of Model 2 showed that basic psychological needs had a significant positive predictive effect on exercise behavior (β= 0.330, p < 0.01). The results of model 3 showed that after adding the mediator variable, the regression coefficient of basic psychological needs was still significant (β= 0.304, p < 0.01), but the effect of the independent variable (autonomy support) was weakened, and the regression coefficient decreased from 0.235 to 0.040, and was reduced to a non-significant level (p > 0.05), which indicated that basic psychological needs played the role of a complete mediator, and that autonomy support had a positive predictive effect on exercise behavior through basic psychological needs have a predictive effect on exercise behavior.

Table 11 Regression analysis result Autonomy Support, Basic Psychological Needs and Exercise Behavior

Predictor variable		Model 1	Model 2	Model 3
		Mediator variable	Dependent variable	
		Basic Psychological Needs	Exercise Behavior	
Independent variable	Autonomy Support	0.643**		0.040
Mediator variable	Basic Psychological Needs		0.330**	0.304**
	R^2	0.413	0.109	0.110
	F	811.435**	140.505**	70.871**

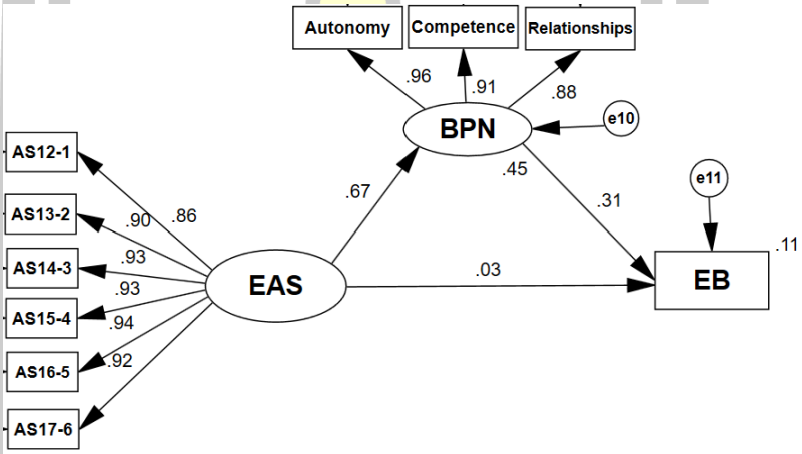

Figure 8 The mediating relationship between Autonomy Support, Basic Psychological Needs and Exercise Behavior

To further verify the robustness of the mediating effect, Bootstrap method was used to verify the mediating role of basic psychological needs between autonomy support and exercise behavior. As shown in the table 12, autonomy support was a significant positive predictor of exercise behavior through basic psychological needs (Direct Effect =4.085, SE =0.551, BootLLCI =3.013, BootULCI =5.176). After controlling for the mediating role of basic psychological needs, autonomy support was not a significant predictor of exercise behavior (Indirect Effect =0.836, SE =0.759, BootLLCI =-0.654, BootULCI =2.325).

Table 12 Bootstrap test result Autonomy Support, Basic Psychological Needs and Exercise Behavior

	Effect	*SE*	*T*	*P*	*BootLLCI*	*BootULCI*
Direct effect	0.836	0.759	1.101	0.271	-0.654	2.325
Indirect Effect	4.085	0.551			3.013	5.176

From the above results, it can be seen that autonomy support provided by physical education teachers positively predicts college students' basic psychological needs for exercise, college students' basic psychological needs satisfaction can positively predict their exercise behavior, and basic psychological needs play a fully mediating role between autonomy support and exercise behavior. The above results supported hypothesis H2.

4.3 Mediation effect test of autonomous motivation between teacher support and exercise behavior

The mediation test used the sequential method for regression analysis of autonomy support, autonomous motivation and exercise behavior, and the results are shown in Table 13 and Figure 9, with Model 4 regressing autonomous motivation as the dependent variable and Models 5 and 6 regressing exercise behavior as the dependent variable. The results of Model 4 showed that autonomy support was a significant positive predictor of autonomous motivation (β= 0.331, p < 0.01). The results of Model 5 showed that autonomous motivation had a significant positive predictive effect on exercise behavior (β= 0.492, p < 0.01). The results of model 6 showed that the regression coefficient of autonomous motivation remained significant after adding the mediating variable (β= 0.465, p < 0.01), but the effect of the independent variable (autonomy support) was weakened, with the regression coefficient decreasing from 0.235 to 0.081 (p < 0.01), indicating that autonomous motivation plays a partially mediating role, and that autonomy support, through autonomous motivation positive predictive effect on exercise behavior.

Table 13 Regression analysis result Autonomy Support, Autonomous Motivation (EM-RAI) and Exercise Behavior

Predictor variable		Model 4	Model 5	Model 6
		Mediator variable	Dependent variable	
		Autonomous Motivation (EM-RAI)	Exercise Behavior	
Independent variable	Autonomy Support	0.331**		0.081**
Mediator variable	Autonomous Motivation (EM-RAI)		0.492**	0.465**
	R^2	0.110	0.242	0.248
	F	141.937**	367.348**	189.478**

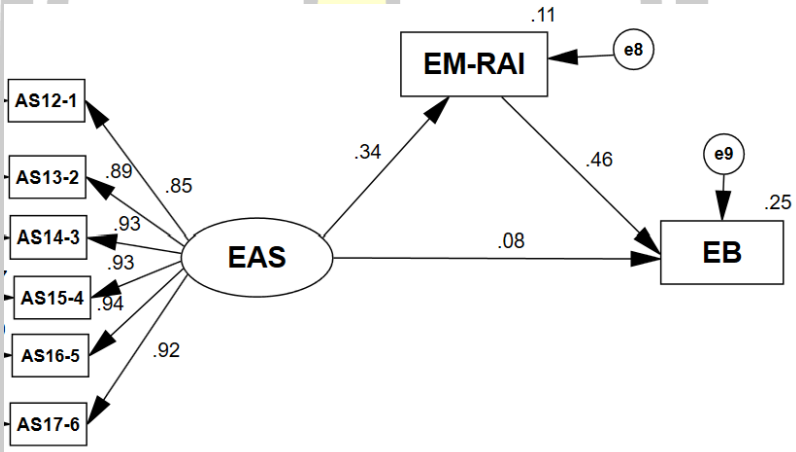

Figure 9 The mediating relationship between Autonomy Support, Autonomous Motivation and Exercise Behavior

To further verify the robustness of the mediating effect, Bootstrap method was used to verify the mediating role of autonomous motivation between autonomy support and exercise behavior. As shown in Table 14, the positive predictive effect of autonomy support on exercise behavior through autonomous motivation was significant (Indirect Effect =3.217, SE =0.335, BootLLCI =2.573, BootULCI =3.903). After controlling for the mediating role of autonomous motivation, the predictive effect of autonomy support on exercise behavior remained significant (Direct Effect =1.704, SE =0.567, BootLLCI =0.592, BootULCI =2.815).

Table 14 Bootstrap test result Autonomy Support, Autonomous Motivation (EM-RAI) and Exercise Behavior

	Effect	*SE*	*T*	*P*	*BootLLCI*	*BootULCI*
Direct effect	1.704	0.567	3.008	0.003	0.592	2.815
Indirect Effect	3.217	0.335			2.573	3.903

From the above results, it can be seen that autonomy support provided by physical education teachers positively predicts college students' exercise autonomous motivation, exercise autonomous motivation can positively predict their exercise behavior, and autonomous motivation plays a mediating role between autonomy support and exercise behavior. The above results supported hypothesis H2.

4.4 Chain mediation effect test for basic psychological needs and autonomous motivation

The mediating effects of autonomy support and exercise behavior were analyzed using the Process macro program of SPSS. The sequential test results are shown in Table 15, autonomy support positively predicts basic psychological needs (β= 0.643, p < 0.01), autonomy support (β= 0.128, p < 0.01) and basic psychological needs (β= 0.316, p < 0.01) significantly positively predict autonomous motivation, and when autonomy support, basic psychological needs, and autonomous motivation are entered into the regression equation at the same time, the Only basic psychological needs (β= 0.168, p < 0.01) and autonomous motivation (β= 0.430, p < 0.01) were significant positive predictors, while autonomy support (β= -0.015, p > 0.05) was not significant in directly predicting exercise behavior. The results showed that complete chain mediation effects between basic psychological needs and autonomous motivation were significant when autonomy support influenced exercise behavior.

Table 15 Regression coefficients of the variables

	Regression equation	Overall fit index			Regression coefficient significance	
Consequent variables	Predictor variable	*R*	R^2	*F*	*β*	*t*
Basic Psychological Needs	Autonomy Support	0.643	0.413	811.435**	0.643	28.486**
Autonomous Motivation (EM-RAI)	Autonomy Support	0.410	0.168	116.529**	0.128	3.647**
	Basic Psychological Needs				0.316	9.013**
ExerciseBehavior	Autonomy Support	0.513	0.263	136.929**	-0.015	-0.451
	Basic Psychological Needs				0.168	4.919**
	Autonomous Motivation (EM-RAI)				0.430	15.482**

Note. **$p < .01$; *$p < .05$

The bias-corrected nonparametric percentile Bootstrap method test was used to repeat the sampling 5,000 times for mediated effect testing and estimation of confidence intervals; if the confidence interval does not contain 0, it indicates that the indirect effect is significant. As shown in Table 16 and Figure 11, the direct effect of autonomy support on exercise behavior is not significant, and autonomy support is predictive of exercise behavior through the mediating path. The results of the mediation effect test showed that the Bootstrap 95% confidence interval did not include a value of 0 (BootLLCI = 4.150, BootULCI = 6.337) in the total indirect effect produced by autonomy support and exercise behavior, indicating that there was a significant mediation effect of basic psychological needs and autonomous motivation between autonomy support and exercise behavior. Further analysis revealed that this mediating effect consisted of three indirect effects: indirect effect 1, autonomy support→basic psychological needs→exercise behavior, with a confidence interval that did not contain 0 (BootLLCI = 1.257, BootULCI = 3.317), suggesting that the mediating effect was established; indirect effect 2, autonomy support→ autonomous motivation→exercise behavior, with a confidence interval that did not contain 0 (BootLLCI =0.555, BootULCI =1.797), indicating a significant indirect effect for this pathway; Indirect Effect 3, autonomy support→basic psychological needs→autonomous motivation→exercise behavior, with a confidence interval that did not contain 0 (BootLLCI =1.354, BootULCI =2.322), indicating a significant

indirect effect for this pathway. In summary, there were chain-mediated effects of basic psychological needs and autonomous motivation in the prediction of exercise behavior by autonomy support.

Table 16 Bootstrap analysis of mediation effect test

		Effect	*SE*	*BootLLCI*	*BootULCI*
Indirect path	Total Indirect Effect	5.235	0.555	4.150	6.337
	Autonomy Support＞Basic Psychological Needs＞Exercise Behavior	2.260	0.522	1.257	3.317
	Autonomy Support＞Autonomous Motivation (EM-RAI)＞Exercise Behavior	1.149	0.315	0.555	1.797
	Autonomoy Support＞Basic Psychological Needs＞Autonomous Motivation (EM-RAI)＞Exercise Behavior	1.825	0.246	1.354	2.322

Then, a chain mediation model was fit within the framework of structural equation modeling (see Table17 and Figure10), in order to a get a comprehensive picture of the impacting factors for Exercise behavior. The model has good fit, x^2= 290.724, df = 40, x^2/df = 7.268, GFI = 0.953, NFI = 0.978, TLI = 0.974, IFI = 0.981, CFI = 0.981(＞0.9), RMSEA = 0.067＜0.08.

Table 17 Fit index of Self-determined exercise behavior model(SDT-EB)

Model index	*χ2/df*	*GFI*	*NFI*	*TLI*	*IFI*	*CFI*	*RMSEA*
Index result	7.268	0.953	0.978	0.974	0.981	0.981	0.074

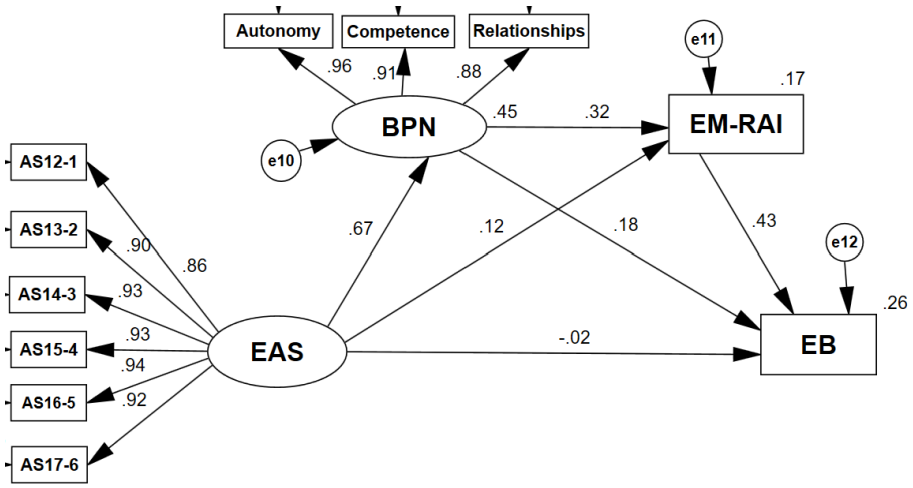

Figure 10 The mediating path of Basic Psychological Needs and Autonomous motivation between Autonomy support and Exercise Behavior

From the above results, it can be seen that autonomy support has a significant positive effect on basic psychological needs, basic psychological needs have a significant positive effect on exercise autonomous motivation, and autonomous motivation has a significant effect on exercise behavior. Based on this, basic psychological needs satisfaction and autonomous motivation in physical exercise play a chain mediating role in the process of teacher autonomy support acting on exercise behavior. The above results supported hypothesis H2.

5. Summary

Based on the data collected from questionnaires and actual measurements, the research hypotheses proposed in this paper were validated through statistical analysis. The research hypotheses proposed in this paper were all verified and in line with the research expectations.

1. The exercise behavior prediction model based on SDT is applicable to the Chinese college student population.

2. The SDT Chinese college students' physical exercise model can effectively predict and explain the exercise behavior.

The positive influence of teacher autonomy support on college students' physical exercise behavior is significant.

Basic psychological needs and autonomous motivation play mediating roles in

the process of teacher autonomy support affecting physical exercise behavior, respectively.

Basic psychological needs and autonomous motivation have a chain mediating effect between autonomy support of physical education teachers and exercise behavior of university students.

Phase 3

Experimental intervention: An intervention study based on self-determined exercise model

According to the findings of Phase 2, autonomy support of physical education teachers can positively predict physical exercise behavior by satisfying students' basic psychological needs and increasing their motivation for exercise autonomy. On the basis of the above findings, this phase will combine domestic and international related intervention studies to develop an autonomy support intervention program to further validate that physical education teachers' autonomy support has an impact on college students' exercise behavior from the practical level.

Therefore, this study adopts a longitudinal experimental intervention to select some samples from cross-sectional survey schools for the physical education teachers' autonomy support intervention, with the aim of verifying whether the physical education teachers' autonomy support will have a positive effect on college students' basic psychological needs, autonomous motivation, and exercise behaviors at the practical level, and to further obtain supportive evidence for the prediction model of self-determined exercise behaviors, which promotes exercise behaviors and maintains individual exercise Behavior.

Based on the previous research and the theoretical validation of phases 1 and 2, the following hypotheses were proposed in this chapter at the practice level:

Hypothesis 1: Students in the experimental group will satisfy significantly more basic psychological needs during physical exercise than those in the control class.

Hypothesis 2: Autonomous motivation of students in the experimental group in physical exercise is significantly higher than in the control class

Hypothesis 3: The exercise behavior of students in the experimental group is significantly higher than that of the control class.

1. Results of the study

1.1 Measurements of indicators in the control and experimental groups before and after the intervention

Table 18 shows the test results of the indicators of autonomy support, basic psychological needs, autonomous motivation and exercise behavior in physical exercise of college students in the control and experimental groups before the experiment, and in the control and experimental groups after the experiment. The independent samples t-test was used to analyze the differences in autonomy support, basic psychological needs, autonomous motivation and exercise behavior between the control group and the experimental group before the intervention, and the results showed that there was no significant difference in any of the variables ($p > 0.05$). In contrast, after the intervention experiment, there were significant differences in autonomy support, basic psychological needs, autonomous motivation and exercise behavior between the control group and the experimental group ($p < 0.001$), which also showed that the autonomy support of physical education teachers in the experimental group was significantly higher than that of the control group, indicating that the effectiveness of autonomy-supportive instructional interventions for physical education teachers in the experimental group was better ensured.

Table 18 Mean and standard deviation of pre-and post-measurement variables for experimental and control groups

variables	Pre-measurement				Post-measurement			
	Experimental groups		Control groups		Experimental groups		Control groups	
	M	SD	M	SD	M	SD	M	SD
Autonomy support (AS)	5.93	0.92	6.01	0.94	6.85	0.23	6.19	0.76
Basic Psychological Needs (BPN)	4.74	0.67	4.79	0.69	5.59	0.41	4.95	0.63
Exercise Motivation (EM-RAI)	35.66	21.67	35.97	21.73	54.62	14.19	37.62	22.45
Exercise Behavior (EB)	19.44	14.98	19.49	15.34	38.27	24.16	19.05	12.77

1.2 Analysis of the effect of the intervention on autonomous support

An independent samples t-test showed that there was no significant difference between the autonomy support of the students in the experimental and control groups

in the baseline test (pre-test) (t= -0.587, $p > 0.05$). A 2 × 2 repeated measures ANOVA on autonomy support revealed a significant main effect of group, [F(1,198) = 8.654, p = 0.004, Partialη2 = 0.042]; students' autonomy support in the experimental group was significantly higher than that of the control group; and there was a significant main effect of time, [F(1,198) = 140.139, $p < 0.001$. Partialη2 = 0.414]; and a statistically significant effect of the group × time interaction on autonomy support [F(1,198) = 61.111, $p < 0.001$, Partialη2 = 0.236]. Before the intervention, there was no statistical difference in autonomy support between the control (6.01 ± 0.94) and experimental (5.93 ± 0.92) students ($p > 0.05$). After the intervention, there was a statistical difference in autonomy support between the control (6.19 ± 0.76) and experimental (6.85 ± 0.23) students ($p < 0.001$). There was a statistical difference ($p <$ 0.001) between autonomy support before the intervention (5.93 ± 0.92) and autonomy support after the intervention experiment (6.85 ± 0.23). As can be seen in Table 18 and Figure 11, the intervention had a positive effect on autonomy support among university students.

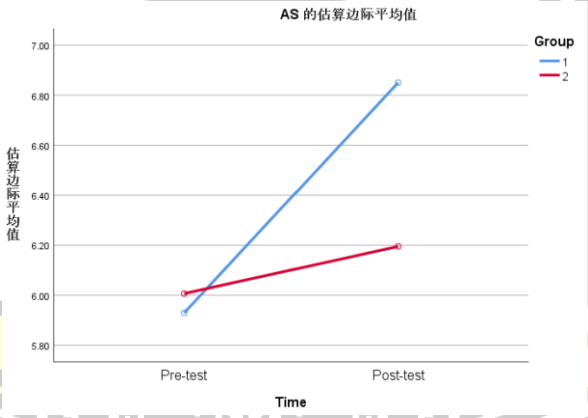

Figure 11 The autonomy support (AS) of the experimental group and control group

1.3 Analysis of intervention effects on basic psychological needs

The independent samples t-test showed that there was no significant difference between the basic psychological needs of the students in the experimental and control groups in the baseline test (pre-test) (t= -0.498, $p > 0.05$). A 2 × 2 repeated measures ANOVA on basic psychological needs revealed a significant group main effect, [F(1,198) = 19.256, $p < 0.001$, Partialη2 = 0.089]; students' basic psychological needs in the experimental group were significantly higher than those in the control group;

and there was a significant main effect of time, [F(1,198) = 87.616, p < 0.001. Partialη2=0.307]; and a statistically significant effect of the group × time interaction on basic psychological needs [F(1,198)=39.309, p < 0.001, Partialη2=0.166]. Before the intervention, there was no statistical difference between the basic psychological needs of students in the control group (4.79 ± 0.69) and the experimental group (4.74 ± 0.67) (p > 0.05). After the intervention, there was a statistical difference between the basic psychological needs of students in the control group (4.95 ± 0.63) and the experimental group (5.59 ± 0.41) (p < 0.001). There is a statistical difference (p < 0.001) between the basic psychological needs before the intervention (4.74±0.67) and after the intervention experiment (5.59±0.41). From Table 18 and Figure 12, it can be seen that the intervention had a positive effect on the basic psychological needs of university students.

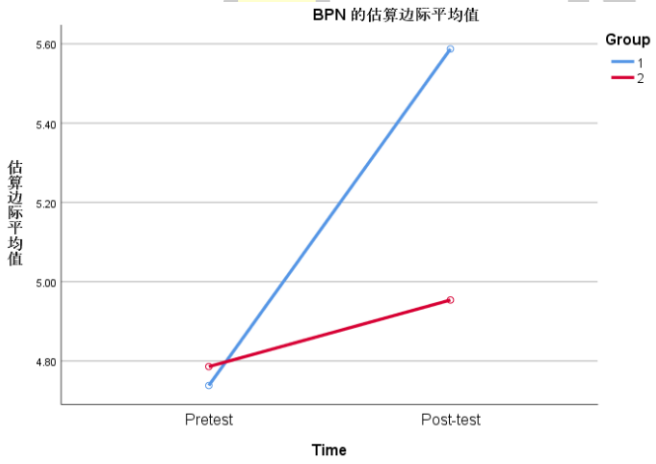

Figure 12 The Basic Psychological Needs (BPN) of the experimental group and control group

1.4 Analysis of intervention effects on autonomous motivation

The results of the independent samples t-test showed that there was no significant difference between the autonomous motivation of the students in the experimental and control groups in the baseline test (pre-test) (t= -0.101, p > 0.05). A 2 × 2 repeated measures ANOVA on autonomous motivation revealed a significant main effect of group, [F(1,198) = 16.946, p < 0.001, Partialη2 = 0.079]; students in the experimental group had significantly higher autonomous motivation than those in the control group; and a significant main effect of time, [F(1,198) = 25.743, p < 0.001.

Partialη2 = 0.115]; and a statistically significant effect of the group × time interaction on autonomous motivation [F(1,198) = 18.159, $p < 0.001$, Partialη2 = 0.084]. Before the intervention, there was no statistical difference ($p > 0.05$) between the autonomous motivation of students in the control group (35.97 ± 21.73) and the experimental group (35.66 ± 21.67). After the intervention, there was a statistical difference in the motivation for autonomy between the control (37.62 ± 22.45) and experimental (54.62 ± 14.19) students ($p < 0.001$). There is a statistical difference ($p < 0.001$) between autonomous motivation before intervention (35.66±21.67) and autonomous motivation after intervention experiment (54.62 ± 14.19). As can be seen in Table 18 and Figure 13, the experimental intervention had a positive effect on the autonomous motivation of university students.

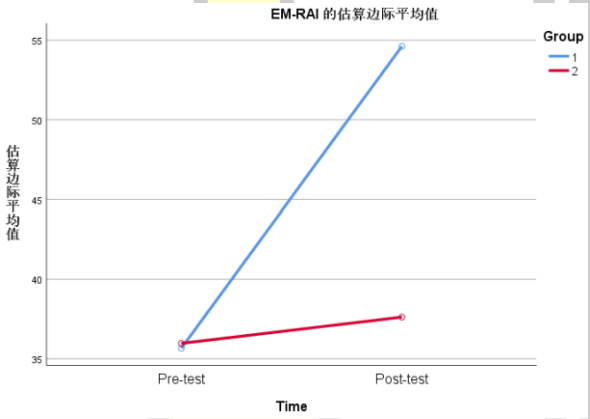

Figure 13 The Exercise Motivation (EM-RAI) of the experimental group and control group

1.5 Analysis of intervention effects on exercise behavior

The results of the independent samples t-test showed that there was no significant difference between the exercise behavior of the students in the experimental and control groups in the baseline test (pre-test) (t= -0.023, $p > 0.05$). A 2 × 2 repeated measures ANOVA on exercise behavior revealed a significant main effect of group, [F(1,198) = 27.232, $p < 0.001$, Partialη2 = 0.121]; students' exercise behavior in the experimental group was significantly higher than that of the control group; and there was a significant main effect of time, [F(1,198) = 31.797, $p < 0.001$. Partialη2 = 0.138]; and a statistically significant effect of the group × time interaction on exercise behavior [F(1,198) = 34.913, $p < 0.001$, Partialη2 = 0.150]. Before the

intervention, there was no statistical difference ($p > 0.05$) between the exercise behavior of students in the control group (35.97 ± 21.73) and the experimental group (35.66 ± 21.67). After the intervention, there was a statistical difference between the exercise behavior of students in the control group (54.62 ± 14.19) and the experimental group (37.62 ± 22.45) ($P < 0.001$). There was a statistical difference ($p < 0.001$) between the exercise behavior before the intervention (35.66 ± 21.67) and the exercise behavior after the intervention experiment (37.62 ± 22.45). As can be seen in Table 18 and Figure 14, the experimental intervention had a positive effect on the exercise behavior of college students.

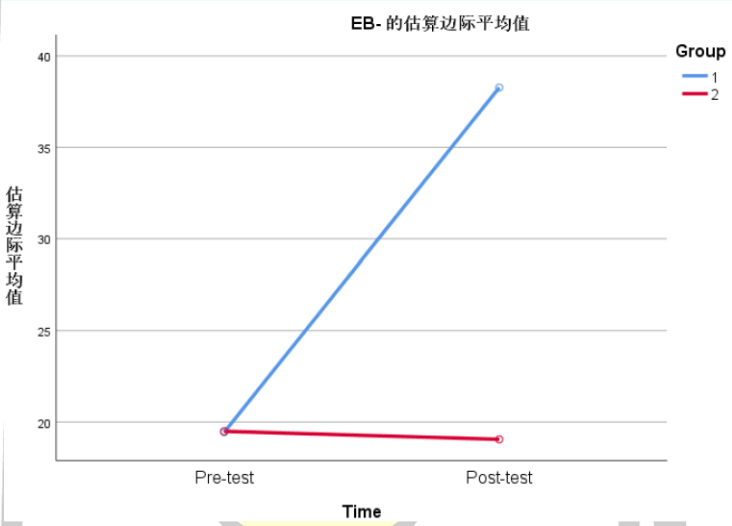

Figure 14 The Exercise Behavior (EB) of the experimental group and control group

2. Summary

Phase 3 adopted a longitudinal research design, and the research hypotheses were supported, reflecting the impact of an exercise autonomy-supported intervention on college students' basic psychological needs, autonomous motivation, and exercise behavior. It also provided supportive evidence for the effectiveness of the exercise autonomy-supported intervention approach on college students' exercise behaviors, and to a certain extent supported the reasonableness of the assumptions of the self-determined exercise behavior model. The above findings supported hypothesis H3.

CHAPTER V

Conclusion, Discussion, and Suggestions

The final chapter discusses the findings in light of the objectives of this study, including: the direct predictive role of autonomy support on college students' exercise behavior; the mediating effect of basic psychological needs and autonomy motivation; the analysis of the chain mediating effect of basic psychological needs and autonomy motivation, and the applicability of an intervention model of exercise behavior based on SDT to a group of Chinese college students.

Discussions

The results of the study indicate that the theoretical model of self-determined exercise behavior based on SDT can well predict and explain the exercise behavior of college students, and the intervention approach of exercise autonomy support based on the exercise behavior model of SDT is effective in intervening the exercise behavior of college students. Therefore, the results supported our research hypothesis.

This chapter mainly discusses the questionnaire related to this research, based on the theoretical research and research hypotheses of domestic and international literature, integrating the domestic mature scale as the initial scale. Pre-survey, reliability and validation factor analysis are conducted on the basis of the initial scale. The constructed prediction model of self-determined exercise behavior was validated and revised using structural equation modeling, and the results of the study showed that the reliability of the scales was good and the overall structural validity of the prediction model of self-determined exercise behavior was good. Research hypothesis 1 was supported, i.e., the prediction model of self-determined exercise behavior is applicable to the college student population in China.

The structural equation model constructed on the basis of the dimensional variables can effectively explain the inputs of the psychological need for progeny and autonomous motivation of college students in the process of promoting exercise behavior. After validation, the structural equation model is characterized by stability and invariance, which indicates the validity of the dimensional measures. It also indicates that external support, basic psychological needs, and autonomous motivation

are important constituent factors in college students' promotion of physical exercise.

1. Analysis of the direct predictive effect of autonomy support on college students' exercise behavior

Regression analysis found that teacher autonomy support can significantly and positively affect exercise behavior, β= 0.235, p< 0.01, and autonomy support can explain 6% of the variance in exercise behavior, the results of the study support the research hypothesis H2, which is consistent with the results of SDT autonomy support environment-related study. Xu Zhenqin's (2021) results showed that physical education teachers' autonomy support, self-efficacy, and physical exercise engagement all had a significant positive effect on college students' physical exercise behavior. Raabe et al.'s (2019) study concluded that teacher autonomy support can significantly increase students' exercise participation, can positively predict students' value perceptions of learning and practicing tasks, so that students can have positive beliefs about competence, place more importance on the task, and show adaptive behaviors, reinforcing students' effects of subject depth perception. Yoo's (2015) study showed that when students perceived higher levels of autonomy support from their teachers, they were more inclined to attribute their participation in physical exercise to being of their own volition, and were willing and eager to engage in physical exercise. Autonomy support leads to more perseverance in athletic performance. Persistence, high effort, high commitment, high self-efficacy, the ability to feel higher affective experiences, and a greater tendency to use deep cognitive strategies.

Autonomy support provided by physical education teachers has a positive predictive effect on the exercise behavior of university students, indicating that the more autonomous choices physical education teachers give to their students during the teaching process, and the more opportunities they give to students to independently explore problems and exercises, the more initiative students take to perform physical exercises in physical education classes, and the more conducive it is to the development of their exercise behavior. In this regard, it has been suggested that support for students' autonomy in learning improves their motivation and perceptions of their abilities (Wulf & Lewthwaite, 2016). It has also been argued that autonomy support allows learners to adapt the exercise environment to meet their individual needs and preferences and can facilitate deeper processing of relevant information

(Laughlin et al., 2015). On the contrary, autonomy support is antagonistic to teacher control, which is characterized by not giving students sufficient time for learning and practicing, ignoring students' viewpoints and suggestions, not giving students the right to make their own choices, forcing students to act in accordance with the teacher's rules, and students' passive thinking, which seriously hinders students' experience of autonomy, and makes it difficult to produce actual skill development results when students are always in a state of executing with passive control. Therefore, physical education teachers should give students meaningful choices as much as possible during physical education teaching (e.g., the choice of task practice stations), provide students with differentiated instruction that meets their motor abilities (e.g., different requirements for the same practice tasks according to gender), and improve the learning efficiency of students' basic motor skills.

In summary, the autonomy support of the external environment for college students can regulate the negative impact of unfavorable factors on individuals, help to improve the individual's attitude and motivation to exercise, promote exercise behavior and enhance the effect of exercise, it can be seen that the higher the level of college students' perception of the autonomy support of physical education teachers, the greater the motivation to actively participate in physical exercise and self-discipline. Therefore, physical exercise interventions must take action to increase teacher autonomy support, promote autonomy-supportive teaching practices and reduce controlling teaching behaviors during the teaching process, encourage students to feel positively about their beliefs and control of their own physical domains in the physical exercise environment, and continue to deepen the benefits and significance of engaging in physical exercise so as to motivate college students to consciously participate in physical exercise.

2. Analysis of the mediating role of basic psychological needs

The results of this study showed that the predictive effect of autonomy support on exercise behavior was no longer significant due to the intervention of basic psychological needs, and the regression coefficient of autonomy support on exercise behavior changed from 0.235 to 0.040 and was reduced to a non-significant level ($p >$ 0.05), explaining 11.0% of the variance, indicating that the basic psychological needs play a role in the process of autonomy support of physical education teachers

influencing exercise behavior of college students. fully mediating effect, and hypothesis H2 of this study is valid. Cronin et al. (2020) conducted a study by examine the longitudinal associations between teacher autonomy support, students' basic psychological need satisfaction and life skills development in physical education. Teacher's autonomy support will satisfy the students' basic psychological need, which will make the students more engaged in the learning of physical education skills, and the resultant learning outcomes will perform better. The autonomy support provided by physical education teachers can have a facilitating effect on students' basic psychological needs fulfillment, which further validates previous studies (Zhu & Yin, 2017; Tilga et al., 2020; Tang et al., 2021).

The basic hypothesis framework of SDT assumes that the external environment can satisfy basic psychological needs, that basic psychological needs are the basic conditions that stimulate intrinsic motivation in an individual, and that they are the internal drive that promotes an individual's continued participation in an event, and that individuals have positive behavioral performance when their basic psychological needs are satisfied. Physical education teachers who provide autonomy support go out of their way to cultivate students' intrinsic motivational resources during physical education, use non-controlling language, and show patience in order to provide students with enough time for them to learn at their own pace and at their own will, and students participate in more decision-making in an autonomy-supportive teaching and learning environment, experiencing more self-exploration, ample opportunities for autonomous choices, and enjoying their own personal growth, factors that somehow fulfill students' need for autonomy (Fin et al., 2019). In summary, the higher the level of perceived teacher autonomy support by students, the more conducive it is to the fulfillment of students' basic psychological needs. Autonomy support has been shown to not only allow students to perceive higher levels of autonomy, but also helps students to more easily perceive teachers' competence support and emotional support, and to obtain higher satisfaction of basic psychological needs, which leads to stronger motivation to learn autonomously and more positive motor participation behaviors.

The test results proved the mediating role of basic psychological needs between autonomy support and exercise behavior; the results indicated that physical education teachers can satisfy students' basic psychological needs for autonomy, competence,

and emotion in physical exercise by providing various types of autonomy-supportive teaching strategies such as choice, positive feedback, and emotional care, which will in turn enhance students' persistence and engagement in exercise behaviors, and ultimately improve students' basic motor skill performance. In conclusion, the satisfaction of basic psychological needs is an important medium for autonomy support to play a role in the exercise behavior of college students.

3. Analysis of the mediating role of autonomous motivation

The results of the study showed that the regression coefficient of autonomy support on exercise behavior decreased from 0.235 to 0.081 ($p < 0.01$) due to the intervention of autonomous motivation, explaining 24.8% of the variance, indicating that autonomous motivation plays a partly mediating role in the process of autonomy support acting on college students' exercise behavior. Abula et al. (2020) used a cross-sectional survey to examine 681 college students' perceptions of autonomy support in physical education classes and motivation for autonomy inside and outside the classroom, and the results indicated that autonomy support provided by the instructor had a significant positive effect on students' motivation for autonomy inside and outside the classroom. It can be seen that autonomous motivation plays an important role in promoting college students' exercise behavior, and Hypothesis H2 of this study was verified, further validating the results of previous studies (Li Yan, 2022; Zhu & Zhang, 2016).

SDT suggests that an individual's intrinsic motivation and self-determination will be higher when the social environment supports and satisfies the individual's three basic psychological needs. Teachers provide an autonomy-supportive environment that prevents students from being restricted by“musts”and “shoulds”in their various learning and exploratory activities, which makes individuals feel that their behaviors are autonomous, and avoids interfering with their curiosity about learning, and their desire to challenge and be competent in their learning will be higher. It also prevents students' curiosity about learning from being interfered with, and their desire for challenge and competence in learning becomes stronger, which is conducive to the development of a more autonomous motivation for learning, and thus sustained engagement in learning (Deci and Ryan, 2000).

In the university stage, the individual's self-consciousness and self-will are

greatly developed, some students like to exercise with a strong will, and show great enthusiasm for physical education learning, while there are some students who do not have a strong will to exercise, and their psychological state after performing exercise may also be negative. Students' independent choice is the biggest feature of college students' learning at this stage, and according to the theory of self-determined motivation, different motivational states have different effects on individuals' participation in learning. Therefore, due to the high autonomy that college students have, when participating in physical exercise, they are more motivated by their own exercise habits and internal factors (Niemiec and Ryan, 2009), i.e., autonomous motivation has a significant positive effect on college students' exercise behavior

When students have higher autonomous motivation, they show greater effort, persistence, and participation because this participation without any external pressure and fun leads students to perceive their physical exercise and exercise performance as more effective. Therefore, it is important for physical education teachers to provide students with as much comprehensive support for their needs as possible as a way to help them gradually develop more stable autonomous motivation so that they can achieve a better exercise experience during their participation in physical exercise.

4. Analysis of the chain mediating role of basic psychological needs and autonomous motivation

SDT suggests that there is a complex mediation process for the role of autonomy supportive environment in influencing exercise motivation and exercise behavior, which was confirmed by structural equation modeling in this study. The results of the study showed that the chain mediation effect of basic psychological needs-autonomous motivation was significant, and autonomy support indirectly influenced exercise behavior through the chain complete mediation effect of basic psychological needs satisfaction-autonomous motivation. The path of autonomy support→basic psychological needs→autonomous motivation→exercise behavior, had an indirect effect of 1.825, 95% CI [1.354, 2.322] indicating a significant chain mediation effect. The goodness of fit of the chain-mediated effect model was constructed using structural equation modeling: x^2 = 290.724, df = 40, x^2/df = 7.268, GFI = 0.953, NFI = 0.978, TLI = 0.974, IFI = 0.981, CFI = 0.981 (> 0.9), and RMSEA = 0.067 <0.08. Basic The chain model of psychological need-autonomous motivation had a

predictive power of 26% for exercise behavior.

Autonomy, competence and relationship are the basic psychological needs of the individual, when the needs are satisfied, it can promote the will of self-determination and the ability of the individual to participate in exercise, in this process extrinsic motivation is positively transformed into values recognized by the individual, and autonomous motivation is formed, which enhances the internal drive for the development of exercise behavior. The research results show that autonomy support has a significant positive effect on basic psychological needs, basic psychological needs have a significant positive effect on autonomous motivation, and autonomous motivation has a significant effect on exercise behavior. Based on this, physical education teachers should focus on developing their own autonomy-supportive teaching strategies in physical education and clarify the chain role of basic psychological needs and autonomous motivation in the development of autonomy support and exercise behavior. Xiang Mingqiang (2013) found that autonomy support, specific psychological needs satisfaction, and autonomous motivation could positively predict adolescent physical exercise through regression analysis. Li Deguo's (2022) findings found that coaches' autonomy-supportive behaviors can positively influence athlete engagement directly or indirectly through the chain mediation of competence needs, relatedness needs, and sport autonomy motivation to positively influence young athlete engagement. Hypothesis H2 of this study was verified and the findings were consistent with previous studies (Ulstad et al., 2019; Leyton-Román et al., 2020).

Basic psychological needs have a significant positive effect on autonomous motivation, and SDT suggests that satisfying an individual's basic psychological needs is a mechanism that triggers the formation of an individual to generate autonomous motivation, which should promote the individual's enjoyment of the activity and autonomy self-regulation behavior. For example, when people are free to choose an activity (autonomy needs), individuals are more likely to be intrinsically motivated. Basic psychological needs and autonomous motivation act as chain mediators between autonomy-supportive and exercise behaviors, and the Hierarchy of Motivation Model suggests that social-environmental variables can have an impact on the basic psychological needs for autonomy, competence, and affect, while the basic

psychological needs influence the formation of different types of motivation, and the motivation ultimately influences the individual's outcome.

Basic psychological needs not only motivate autonomous physical exercise participation behaviors such as effort, persistence, and active participation, but also prompt individual students to pursue goal orientations that are generally accepted by the student body and influence students' self-regulatory strategies, which in turn influence their autonomous motivation. Intrinsic autonomous motivation is the strongest predictor of sport participation. Individuals with a high level of autonomous motivation tend to be better able to transform external environmental stimuli into internal needs, to have a stronger interest in participation, enjoyment, and desire for exploration and challenge, and tend to participate in sports more actively, frequently, and persistently in order to satisfy their multidimensional and multi-level internal psychological needs, and to be more autonomous, persistent, and focused on sports participation. This suggests that autonomy support can influence sport participation through the chain-mediated effects of basic psychological needs and autonomous motivation.

In summary, satisfying students' basic psychological needs for autonomy, competence, and affectivity moderates the relationship between students' perceived socio-environmental factors (autonomy support, competence support, and affective support) and autonomous motivation during physical exercise, and autonomous motivation further produces positive outcomes. The results of this study confirm that basic psychological needs and autonomous motivation are recursively mediated. For this reason, in the path of promoting college students' participation in physical exercise, it is not only important to consider the autonomy support environment to promote the satisfaction of college students' basic psychological needs, but also more importantly, to satisfy the basic psychological needs to promote the autonomy of extrinsic motivation, to form the autonomous motivation, and ultimately to maintain long-lasting physical exercise behaviors.

5. Experimental Intervention

A longitudinal research design was used in Phase 3 to better validate the validity of the Self-Determined Exercise Behavior Prediction Model in practice, as well as to provide further supporting evidence for the structure of the model. Therefore, college

students were selected as research participants for this study and divided into experimental and control groups to examine the effects of an exercise autonomy support intervention on college students' basic psychological needs for exercise, motivation for exercise autonomy, and exercise behavior. The results of repeated measures ANOVA showed that the intervention had a good promotion effect on college students' exercise basic psychological needs, exercise autonomous motivation and exercise behavior. On the basis of refining the existing theories of exercise behavior intervention, it provides a feasible solution for the intervention of exercise behavior. The findings supported research hypotheses H3. Ding, Wei-Wei (2016) conducted a 14-week longitudinal experimental intervention for middle school students, and the results of the study showed that an intervention based on a prediction model of self-determined exercise behaviors could increase the basic psychological need for exercise, motivation to exercise, and engagement in exercise behaviors among middle school students. The results of the experimental intervention were consistent with previous studies (Chang, et al. 2016; Moustaka, et al. 2012).

This study uses the autonomy support provided by physical education teachers as an intervention means to reflect the encouragement, guidance, support and guidance for college students, through WeChat, face-to-face and other ways to enhance the students' confidence in the understanding of the value of exercise and self-realization, in accepting the guiding advice provided by the teacher, and through the design and arrangement of the task plan of the autonomy to increase the awareness of the initiative to participate in physical exercise, and autonomy, competence, and relational needs to be met and the autonomous motivation is increased to promote the level of exercise behavior.

Social support interventions are a good way for educators to stimulate students' intrinsic motivation and to keep internalizing the extrinsic value system. After a 10-week intervention trial, the autonomy-supportive behaviors of physical education teachers in the experimental group were significantly higher than those of the control group. The basic psychological needs, autonomous motivation and exercise behaviors of students in the experimental group were not significantly different from those of the control group at the baseline test, but were significantly higher than those of the control group at the end of the intervention. This suggests that an increase in

autonomy-supportive teaching behaviors facilitates better satisfaction of students' basic psychological needs, promotes autonomous motivation, and increases exercise behavior; i.e., students who perceived higher levels of autonomy-supportive teaching behaviors tended to report higher levels of satisfaction of basic psychological needs and autonomous motivation formation; SDT suggests that an individual's motivational orientation may be affected by the context of the environment and that an individual wants to move across the motivational continuum toward more autonomously motivated behaviors, three basic psychological needs of individuals need to be satisfied.

After the intervention in the experimental group, the participants' autonomous motivation was significantly improved, and they could adhere to physical exercise more autonomously, and accomplishing the set goals could also increase the students' beliefs and attenuate the negative influence of external motivation on students' performance of exercise. The use of autonomy-supportive interventions to stimulate college students' autonomous motivation to exercise is significantly effective, especially in favor of college students' motivation internalization, so that external motivation is transformed into internal motivation. Most of the motivation of college students to participate in physical exercise is highly arbitrary, and there is no clear purpose for physical exercise. The self-support intervention with higher autonomy gives college students more opportunities for independent development, stimulates the motivation to participate in physical exercise independently after satisfying their basic needs, and facilitates the adherence to the exercise behavior, which is meaningful for the cultivation of college students' motivation to participate in exercise and the development of lifelong sports habits. It is meaningful to improve college students' motivation to participate in exercise and the formation of lifelong sports habits.

The purpose of autonomy support strategies implemented by physical education teachers is to promote student autonomy in learning. Autonomous learning serves as a learning style that fully emphasizes students' emotional experience, focuses on their needs, and reinforces their subjectivity. A series of studies have conducted empirical research on the relationship between teachers' adoption of autonomy-support teaching strategies and students' motivation and learning behavior. The study concluded that when students perceive teachers' autonomy support, it is conducive to students'

identification with physical exercise, and better enables students to perceive attention, understanding, trust, and respect, which in turn promotes students' positive learning emotions, and shows more effort and persistence in their learning behaviors. From the results that the basic psychological needs and autonomous motivation of students in the experimental group were significantly higher than those of students in the control class, and in combination with the mediating role of the two between autonomy-supportive teaching and exercise behavior in the cross-sectional survey, it suggests that an increase in autonomy-support teaching behaviors will indeed have a beneficial effect on college students' exercise behavior.

Conclusions

The exercise behavior prediction model based on SDT is applicable to the Chinese college student population.

The SDT Chinese college students' physical exercise model can effectively predict and explain the exercise behavior.

Teacher autonomy support has a significant positive effect on college students' physical exercise behavior.

The specific path of teacher autonomy support's influence on exercise behavior is through satisfying basic psychological needs, and then helping students to form positive autonomous motivation, which ultimately has a facilitating effect on exercise behavior.

The autonomy support intervention program constructed was proved to be an intervention model that can effectively promote students' exercise participation, which is useful for other specialties to conduct research.

Given that the autonomy support provided by physical education teachers can have a positive effect on college students' basic psychological needs, autonomous motivation and exercise behavior. It is suggested that physical education teachers should firstly correctly recognize the importance of the influence of autonomy-supportive teaching strategies on students' physical education learning from the ideological perspective, and improve their demand-supportive teaching ability as much as possible, adopt autonomy-supportive teaching methods as much as possible in their teaching practice, and create a motivating learning atmosphere so as to better

satisfy the students' basic psychological needs, cultivate the students' motivation for autonomy, and enhance the exercise behavior of college students. Behavior.

In order to better promote college students' participation in extracurricular physical exercise and satisfy their basic psychological needs for exercise, it is necessary to stimulate college students' stronger autonomous motivation. The present study concluded that the use of exercise autonomy support is more effective than a controlling approach in stimulating college students' motivation to exercise. It is recommended that educators use autonomy-supportive exercise interventions as much as possible to establish correct cognitive appraisals of exercise and to promote the formation of autonomous motivation among college students. It is recommended that educators focus on increasing improvements in ways to meet autonomy and competence needs when motivating college students to exercise. Physical exercise for college students should be strengthened through a variety of ways to enrich physical health cognition, enhance exercise identity, stimulate participation interest and enthusiasm, and cultivate good exercise will quality and behavioral habits.

Suggestions

The study used a combination of theoretical and empirical, cross-sectional and longitudinal research design to analyze the relationship between autonomy support provided by physical education teachers and students' basic psychological needs, autonomous motivation, and exercise behaviors, to propose a prediction model for college students' exercise behaviors based on the SDT, and to conduct a longitudinal intervention study on the theoretical model, which provided theoretical and practical guidance for college students' physical exercise level promotion . How to enable physical education teachers to provide social contexts that satisfy students' basic psychological needs in teaching is always an important part of implementing teaching concepts and promoting lifelong sports.

1. The exercise behavior in this study was in the form of self-reporting, and there may be errors in the measurements. Future studies try to adopt a combination of multiple measurements to objectively measure the exercise behavior, such as accelerometers, Polar scales, and other objective measurement tools, to improve the accuracy of the measurements.

2. Given that autonomy support provided by physical education teachers can have a positive effect on college students' basic psychological needs, autonomous motivation and exercise behavior. Future research should also consider the effects of other social contextual supports, such as competence support and relational support provided in teachers' motivational styles, to create conditions for the full satisfaction of college students' basic psychological needs and the development of autonomous motivation.

3. The structure of the self-determined exercise model was further tested by changing the group of study participants to combine the effects of individual personality traits on basic psychological needs in order to verify the stability and applicability of the model's structural relationships.

4. Longitudinal intervention by applying the theoretical model can effectively improve the exercise behavior of college students, but the improvement is not significant. Future research needs to further consider multi-channel and long-time interventions for longitudinal and long-term tracking.

5. Policy Recommendations: advocate for including autonomy-supportive exercise programs in college curricula to improve the physical and mental health of college students. Provide autonomy supportive training to help educators create a stimulating exercise environment. Promote SDT interventions as regular health program within the universities.

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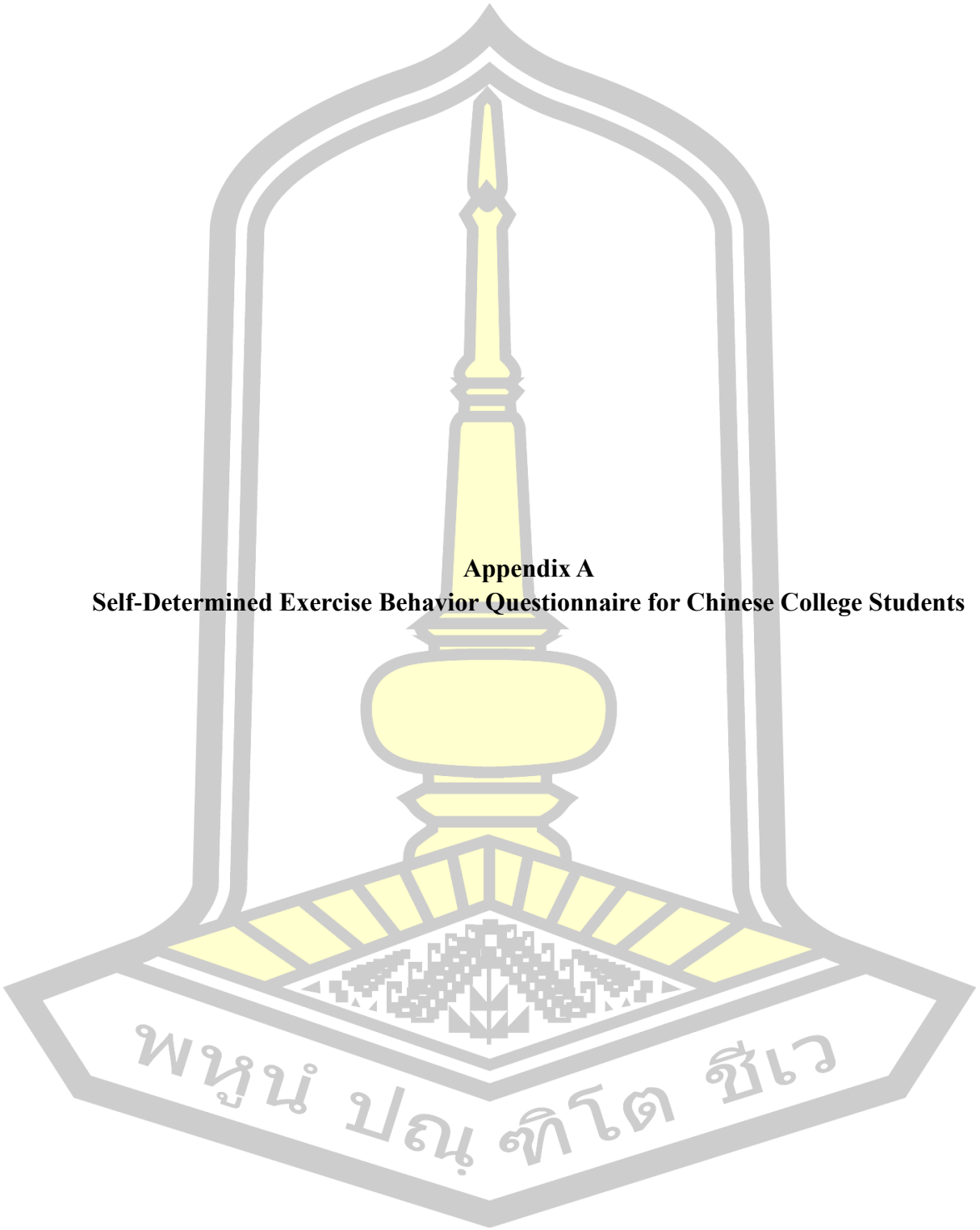
APPENDIX



Appendix A
Self-Determined Exercise Behavior Questionnaire for Chinese College Students

Questionnaire

Honourable participants:

Hello!

Thank you very much for taking time out of your busy schedule to complete this questionnaire, your information will be an important source of data for this study. Please read the following carefully before you decide whether or not to participate in this study.

The content of this questionnaire will be used for academic research aimed at understanding the relationship between Exercise Autonomous Support, Exercise Motivation and Exercise Behavior. This questionnaire contains 5 sections, please choose the most appropriate one in each question option according to your real situation and thoughts, there is no right or wrong answer to the questions.

This questionnaire will take anonymous form, not for individuals to do any analysis, will not have any impact on the individual, you participate in the process of this survey all personal data will be kept strictly confidential, you are free to decide whether to participate in this questionnaire, at any time you have the right to withdraw.

If you have any questions queries or suggestions about the above or the questionnaire, feel free to contact the director of this study.

Tel: 18553736260

Email: wenjuanbsu@126.com

I have read and fully understood the above information note about this questionnaire, and agree and voluntarily participate in this research and co-operate in completing the survey.Thank you very much for your participation and support!

Sincerely,

Signature:

Date:

Part I- Information on demographic variables

Dear Participant:

Greetings! In order to better grasp your perception of exercise autonomous support, exercise motivation and exercise behavior, we need your support and help. The results of this survey are for academic research only, please answer the questions based entirely on your own perceptions and realities, there are no right or wrong answers, and your support is truly appreciated!

For the following questions, please put a "√" in front of "□" for the option that corresponds to your actual situation.

Basic information

1. Name: _____(It is only used as a code, please feel free to fill in)
2. University:
3. Major:
4. Student ID:_____(It is only used as a code, please feel free to fill in)
5. Sex: Male ☐ Female ☐
6. Age:
7. Years level study:

Freshman ☐ Sophomore ☐ Junior ☐ Senior ☐ Graduate ☐

Part II- Exercise Autonomy support Scale

Dear Student: The following questions are about how supportive your significant other is of your exercise. The numbers in the question represent the degree to which they are true for you, with "1" meaning "not at all", "7" meaning "completely compatible", and "2" through "6" meaning somewhere between "not at all" and "completely". Please select the numbers that match your situation in order of importance. Cross them out with a "√".

Item	7	6	5	4	3	2	1
1.I feel that my PE teacher gives me a lot of choice and freedom of choice in terms of exercise.	7	6	5	4	3	2	1
2.I feel that my teacher of PE in terms of exercise is very understand me.	7	6	5	4	3	2	1
3.My PE teacher gives me confidence in exercise and makes me believe that I am capable of doing well.	7	6	5	4	3	2	1
4.My PE teacher encouraged me to ask questions in terms of exercise.	7	6	5	4	3	2	1
5.My PE teacher listens carefully to what I plan to do when it comes to exercise.	7	6	5	4	3	2	1
6.My PE teacher would always get my thoughts and opinions first when suggesting a new approach in terms of exercise.	7	6	5	4	3	2	1

Part III- Exercise Motivation Scale

Dear Student: Why do you participate in extracurricular physical activity? We are interested in the reasons why you choose to participate, or not to participate, in extracurricular physical activity, as well as your personal feelings about participating in extracurricular physical activity. Please select the number of entries below that is appropriate for you.

ONE OF THE FIVE ALTERNATIVES

Note: 0=Strongly Disagree, 1= Disagree, 2=Neither Agree nor Disagree, 3= Agree, 4=Strongly Agree

Item	4	3	2	1	0
1. Regular exercise is important to me.	4	3	2	1	0
2. I don't understand why I have to exercise.	4	3	2	1	0
3. I exercise because it's fun.	4	3	2	1	0
4. If I don't exercise, I'll feel guilty.	4	3	2	1	0
5. I exercise because it aligns with my life goals.	4	3	2	1	0
6.I exercise because other people say I should.	4	3	2	1	0
7.I value the benefits that exercise will bring.	4	3	2	1	0
8.I don't understand why I have to work so hard to exercise.	4	3	2	1	0
9. I enjoy the exercise.	4	3	2	1	0
10. I feel ashamed when I miss a chance to exercise.	4	3	2	1	0
11. I think exercise is part of myself.	4	3	2	1	0
12. I take part in exercise because my friends/family/partner says I should exercise.	4	3	2	1	0
13.I think it's important to try hard to get regular exercise.	4	3	2	1	0
14. I don't understand the value of exercise.	4	3	2	1	0
15. I find exercise to be enjoyable activity.	4	3	2	1	0
16. If I don't exercise for a while, I feel like I'm doing something wrong.	4	3	2	1	0
17. I think exercise is an important part of my.	4	3	2	1	0
18. I exercise because if I don't, other people won't like me.	4	3	2	1	0

Item	4	3	2	1	0
19. If I don't exercise regularly, I become impatient.	4	3	2	1	0
20.I think exercise is a waste of time.	4	3	2	1	0
21. I get happiness and satisfaction from participating in exercise.	4	3	2	1	0
22. If I don't take time to exercise, I'll feel is not good enough.	4	3	2	1	0
23. I think exercise is consistent with my values.	4	3	2	1	0
24. I feel pressure from my friends/family to exercise.	4	3	2	1	0

Part IV-Basic Psychological Needs Scale

Dear Student: This questionnaire contains questions about your exercise experience, so please read it carefully. The numbers in the questionnaire represent the degree of conformity with your real situation, Please indicate the degree of compliance with your situation by ticking the appropriate number.

ONE OF THE FIVE ALTERNATIVES

Note: 1=Strongly Disagree, 2=Disagree, 3= Slightly Disagree, 4=Slightly Agree, 5= Agree, 6=Strongly Agree .

Item	6	5	4	3	2	1
1. I feel that I am able to complete the exercise tasks that are challenging for me.	6	5	4	3	2	1
2. I feel free to exercise in my own way.	6	5	4	3	2	1
3. I think I like my exercise partners a lot because they accept me as well.	6	5	4	3	2	1
4. When the people who is important for me to join me in exercise, I feel I am in sharing with them.	6	5	4	3	2	1
5. I feel confident enough to do the most challenging exercises.	6	5	4	3	2	1
6. Going with exercise partners, I feel that I can experience a sense of mutual help and solidarity.	6	5	4	3	2	1
7. I am very sure and confident in my ability to participate in those challenging exercises.	6	5	4	3	2	1
8. I feel very close to my partners who have overcome difficulties together in exercises.	6	5	4	3	2	1
9. I feel like I have the freedom to decide my own exercise plan.	6	5	4	3	2	1
10. I feel like I'm able to complete challenging exercises.	6	5	4	3	2	1

11. I feel like I'm deciding my own exercise program.	6	5	4	3	2	1
12. I fell that I have the ability to do the most challenging exercises.	6	5	4	3	2	1
13. I feel like I have a say in choosing my own exercise program.	6	5	4	3	2	1
14. I felt comfortable with the partners I was exercising with.	6	5	4	3	2	1
15. I often feel that I can do those challenging exercises well.	6	5	4	3	2	1
16. I feel like I can get along with the people I interact with when we exercise together.	6	5	4	3	2	1
17. I feel free to choose the exercise programs that I participate in.	6	5	4	3	2	1
18. I feel like it's up to me to decide how I want to do my own exercise.	6	5	4	3	2	1

Part V- Exercise Behavior

Dear students: This questionnaire measures the intensity, time and number of times you participated in exercise per week on average in the past month, there are three questions, each question has five options for you to choose, please put a "√" on the option that most closely matches your real situation (single choice).

1.The intensity of your physical exercise is

① Such as walking, doing radio exercises, playing goalball and other light exercise;

② Such as recreational volleyball, table tennis, jogging, tai chi and other small intensity less intense sports;

(iii) Light exercise such as cycling, running, and playing tai chi for recreational purposes;

③ Such as cycling, running, playing table tennis moderate intensity of the more intense persistent exercise;

④ Such as playing badminton, volleyball, basketball, tennis, soccer, and other breathing, sweat a lot of high-intensity, but not lasting sports;

⑤ High-intensity, sustained exercise (e.g., running, aerobics routines, swimming, etc.) that involves rapid breathing and profuse sweating.

2. You perform the above intensity of physical activity, each time you continue to be

① Less than 10 minutes

② 11 to 20 minutes

③ 21 to 30 minutes

④ 31 to 59 minutes

⑤ More than one hour

3. The number of times you do the above physical exercise is

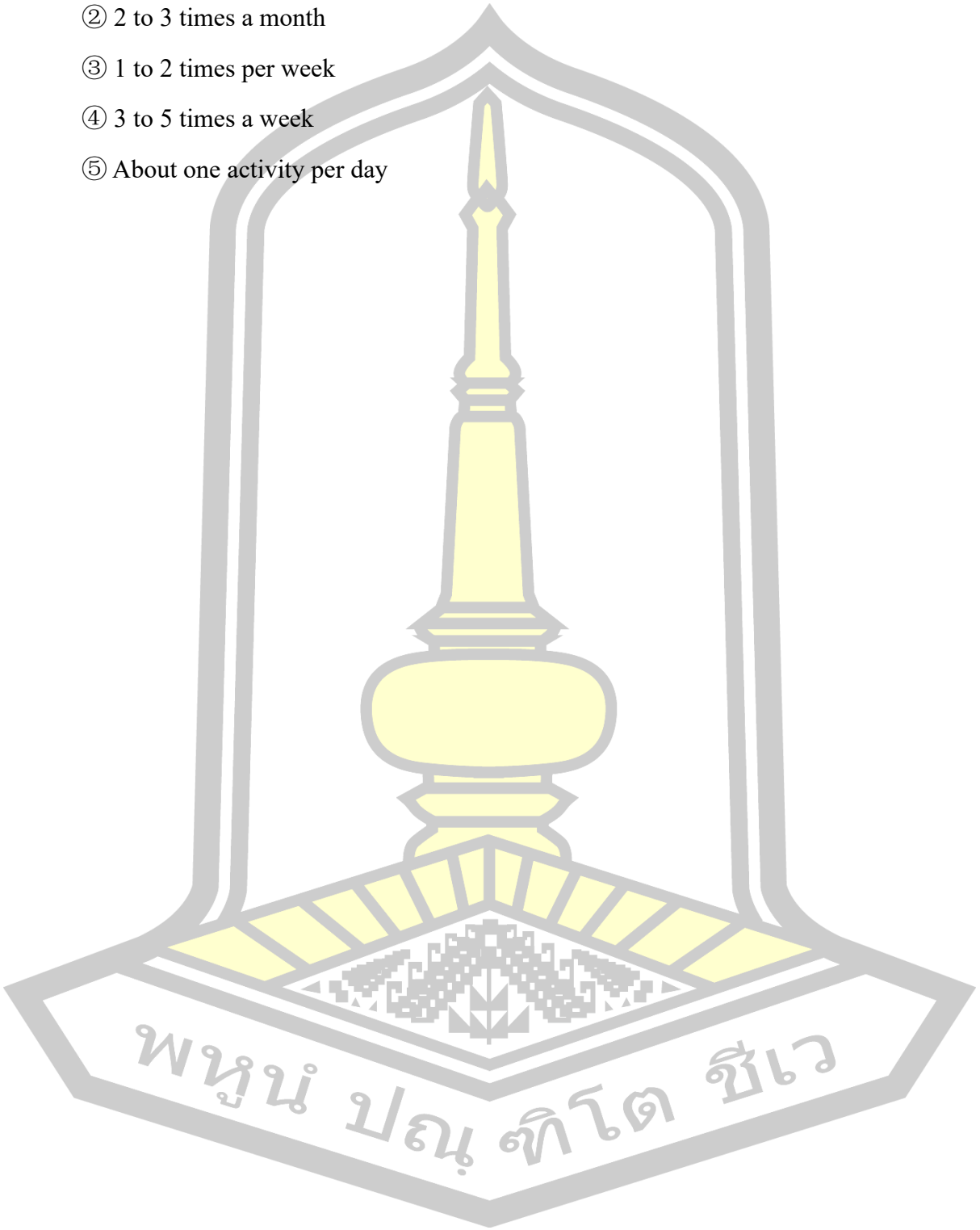
① Less than once a month

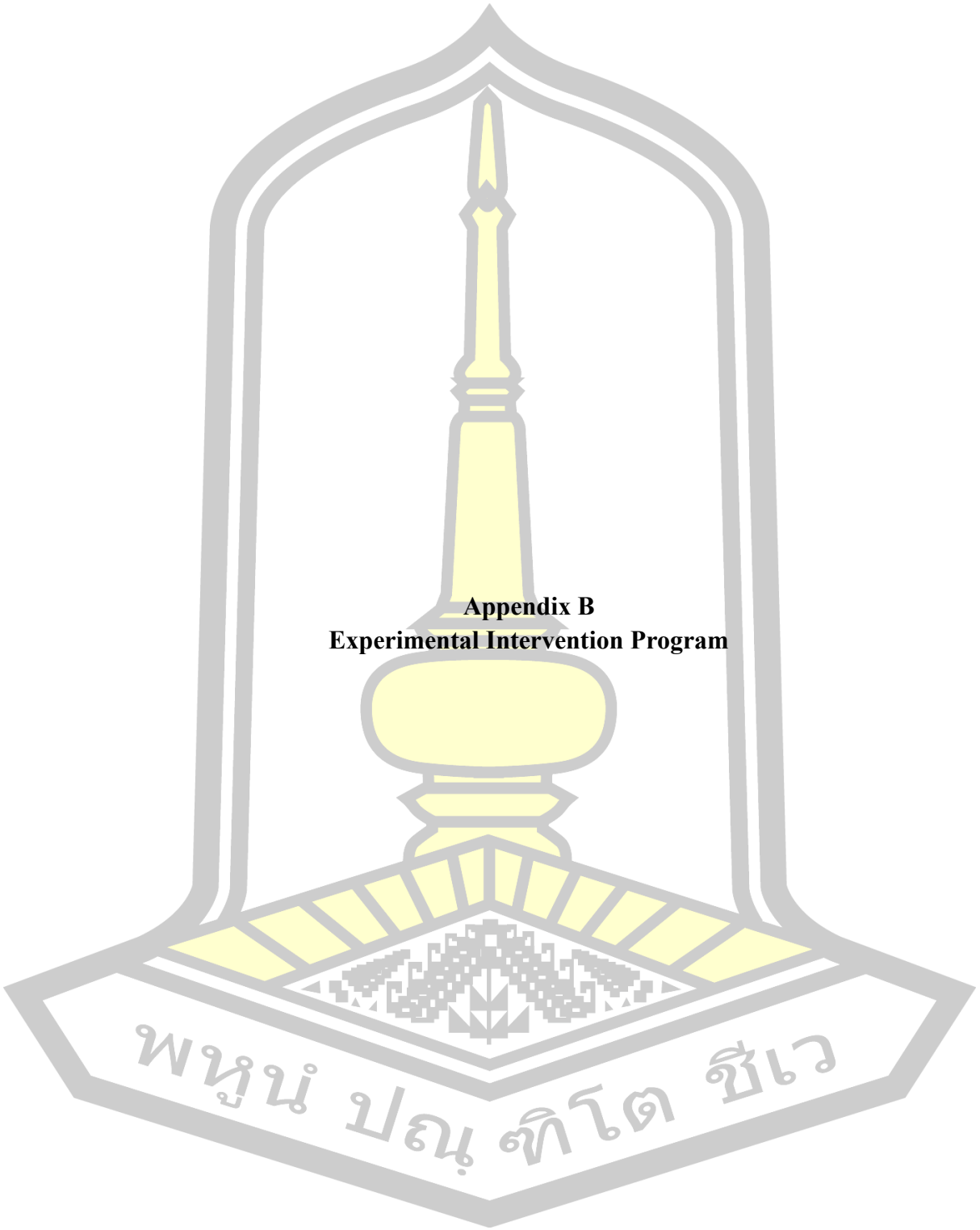
② 2 to 3 times a month

③ 1 to 2 times per week

④ 3 to 5 times a week

⑤ About one activity per day





Appendix B
Experimental Intervention Program

Intervention Process

weekly	Intervention Forms	Intervention content
Week 1	Baseline tests (experimental group 1; control group 2)	None
Week 2	Experimental group: 1. Live face-to-face in PE class 2. 2-3 text messages per week (QQ/WeChat group) Control group: No intervention, only some common sense information about life	Physical education teachers provide knowledge of students' self-determined exercise behaviors; 1. knowledge of the purpose, meaning, and value of physical exercise. 2. knowledge of exercise interests, needs, and abilities. 3. learning the content of physical exercise instruction manuals. 4. online encouragement for students to engage in self-determined exercise and exercise apps.
Week	Experimental group: 1. Live face-to-face in PE class 2. 2-3 text messages per week (QQ/WeChat group) Control group: No intervention, only some common sense information about life	1. knowledge of how to establish exercise expectations and goals that meet one's exercise interests and needs. 2. Knowledge of how to make choices, decisions, and plans to achieve one's exercise goals and expectations. 3. Answer students' questions and give guidance on the spot; share physical exercise experiences. 4. Discussions and interactive answers with students online. 5. Send videos about physical exercise and fitness.
Week 4	Experimental group: 1. Live face-to-face in PE class 2. 2-3 text messages per week (QQ/WeChat group) Control group: No intervention, only some common sense information about life	1. provide students with knowledge of how to assess the effectiveness of exercise programs and behaviors. 2. knowledge of how to adjust the exercise program to achieve goals and meet needs. 3. answer students' questions and give guidance on the spot. 4. interact effectively with, praise, and encourage students online.
Week 5	Experimental group: 1. Live face-to-face in PE class 2. 2-3 text messages per week (QQ/WeChat group) Control group: No intervention, only	1. improve students' skills in executing self-determined exercise behaviors. 2. improve the student's ability to express his/her exercise interests, needs, abilities, and deficiencies rather than being influenced by others. 3. improve the student's ability to make exercise choices, decisions, and plan to achieve their goals rather than be influenced by others.

	some common sense information about life	4. answer students' questions and give guidance on the spot. 5. interact effectively with, praise, and encourage students online. 6. send videos of relevant physical exercise and fitness.
Week 6	Experimental group: 1. Live face-to-face in PE class 2. 2-3 text messages per week (QQ/WeChat group) Control group: No intervention, only some common sense information about life	1. improve the student's ability to assess the effectiveness of exercise programs and behaviors. 2. increase the student's ability to adopt exercise behaviors to successfully complete an exercise program. 3. increase students' perceptions of their knowledge and ability to perform self-determined exercise behaviors. 4. answer students' questions and give guidance on-site. 5. interact effectively with, praise, and encourage students online.
Week 7	Experimental group: 1. Live face-to-face in PE class 2. 2-3 text messages per week (QQ/WeChat group) Control group: No intervention, only some common sense information about life	1. increase the student's confidence and sense of freedom to express his/her exercise interests, needs and abilities expectations, and goals. 2. increase students' confidence in adopting exercise behaviors to successfully complete an exercise program. 3. increase students' motivation to assess the effectiveness of their exercise behaviors. 4. Increase students' willingness to adjust their exercise program to achieve goals and meet needs. 4. Answer students' questions and provide guidance on-site. 5. Interact effectively with, praise, and encourage students online.
Week 8	Experimental group: 1. Live face-to-face in PE class 2. 2-3 text messages per week (QQ/WeChat group) Control group: No intervention, only some common sense information about life	1. provide opportunities for students to develop self-determined exercise behaviors 2. provide opportunities for students to identify expectations and goals for meeting their exercise interests, needs, and abilities at school. 4. answer students' questions and give instruction on site. 5. interact effectively with, praise, and encourage students online. 6. send videos of relevant physical exercise and fitness.
Week 9	Experimental group: 1. Live face-to-face in	1. increase the student's willingness to adjust the exercise program to achieve goals and meet

	PE class 2. 2-3 text messages per week (QQ/WeChat group) Control group: No intervention, only some common sense information about life	needs. 2. Increase student perception of knowledge and ability to perform self-determined exercise behaviors. 3. answer students' questions and give guidance on the spot. 4. interact effectively with, praise, and encourage students online.
Week 10	Experimental group: 1. Live face-to-face in PE class (10 minutes) 2. 2-3 text messages per week (QQ/WeChat group) 3. Completion of 2nd test (experimental group 1; control group 2) Control group: No intervention, only some common sense information about life	1. increase students' confidence in adopting exercise behaviors to successfully complete an exercise program. 2. Increase students' motivation to assess the effectiveness of their exercise behaviors. 3. Answer students' questions and give guidance on the spot. 4. Interact effectively with, praise, and encourage students online. 5. Complete the 2nd test.

Instruction Manual: Behavioral Intervention Materials for Physical Exercise for College Students Content

1. Regular physical exercise

Physical exercise refers to social activities that use physical activity as the main means to develop the body, improve health, enhance physical fitness, regulate the spirit and enrich cultural life.

Physical exercise not only strengthens the body and promotes physical and mental health, but also helps to improve learning efficiency and enhance the quality of life.

2. How to exercise regularly

A large number of scientific studies have found that aerobic metabolic exercise has the best effect on improving human body functions. Aerobic exercise must have three conditions: 1, the energy needed for exercise is mainly provided by oxidizing body fat and sugar; 2, most of the muscle groups in the body (more than 2/3) are involved in exercise; 3, the intensity of exercise is between low and medium, and the duration is 15-40 minutes or longer.

Types of exercise include: 1. Aerobic exercise: refers to activities in which the large muscle groups of the body are repeatedly engaged in rhythmic contractions that can be sustained over a long period of time. Such as jumping rope, cycling, swimming, jogging, badminton, etc. 2. anaerobic exercise: to maximize a variety of activities in a short period of time. Such as sprinting, weight lifting, short distance swimming, etc..

Therefore, compared with other forms of exercise, aerobic thank exercise has the following several chemical points: 1, consuming fat and sugar means reducing body fat, good effect on weight reduction, it means that can not have to excessive dieting; 2, most of the muscles of the whole body are involved in the activities during the exercise, it means that most of the muscle groups have been silver refining, which can

make the muscle line become more perfect; 3, the intensity of the exercise is in the low to medium between, it means that most people can stick to it for a long time.

Aerobic exercise should be done at least five days a week for 30 minutes or more per day for optimal results. For college students, it is optimal to maintain a heart rate of about 120-130 beats per coincidence when exercising, depending on the location and the amount of effort involved.

3. Impact of insufficient or sedentary physical exercise on physical health

Do you know what sedentary and insufficient sports are? A large amount of survey data found that college students spend 95% of their time in a seated position, and during their leisure time, due to Internet surfing, reading books, playing cell phones and so on take up a lot of time, resulting in a sedentary and less active state of greater than 4 hours; young people (20-30 years old) do not participate or less participate in physical exercise accounted for 78.8%.

This state of being physically inactive and sedentary puts you at risk for health problems, and longitudinal studies have found that a sedentary lifestyle is the number one factor contributing to the highest mortality rates, and leads to physical illnesses such as chronic heart disease and certain mental health disorders. College students are in the transition from school to work, and developing good health behaviors will have a profound impact on their future work and life.

4. Cultivating a sense of independent physical exercise - setting clear goals

Students should be clear about the goals they hope to achieve through physical exercise, which can be to strengthen their physical fitness, improve their motor skills, and improve their physical fitness. Clear goals help to stimulate their own motivation and enthusiasm, making them more conscious of physical exercise.

5. Establishing Exercise Habits

It is vital for students to develop the habit of regular exercise. You can incorporate exercise time into your daily life planning, set up a regular weekly exercise time, such as every morning or afternoon, and gradually form a good

exercise habit without giving up easily.

6. Finding exercise partners

Doing physical exercise with friends or classmates, supervising and motivating each other, and making progress together can not only increase the fun and challenge of exercise, but also enhance friendship and team spirit. The presence of an exercise partner can make physical exercise more fun.

7. The benefits of regular physical exercise on physical health

Understand the benefits of physical exercise on physical health, pay attention to health information, and constantly improve the awareness of and attention to physical exercise. This helps to strengthen one's awareness of physical exercise and increase the importance of health.

Appropriate physical exercise, especially aerobic exercise, can enhance physical strength, shape the body, improve also vascular function, and reduce the risk of disease; the most important benefit embodied in physical exercise can reduce weight and prevent obesity.

The most important benefit of physical exercise is that it can reduce weight and prevent obesity. The health of the mind is fundamental to the health of the body, and physical exercise can make the mood better, improve the sleep cycle, slow down the pressure, and enhance self-confidence. It has also been found that moderate-intensity aerobic exercise can halve the state of depression. The main mechanism is that exercise increases serotonin concentrations, which depletes the body of stress-inducing substances such as adrenaline, helping the body to relax and effectively helping people to boost positive moods.

8. Making personal plans

According to one's own situation and time schedule, make a physical exercise plan that meets one's own needs, including the content, duration and frequency of exercise, and constantly adjust and optimize it according to the actual situation.

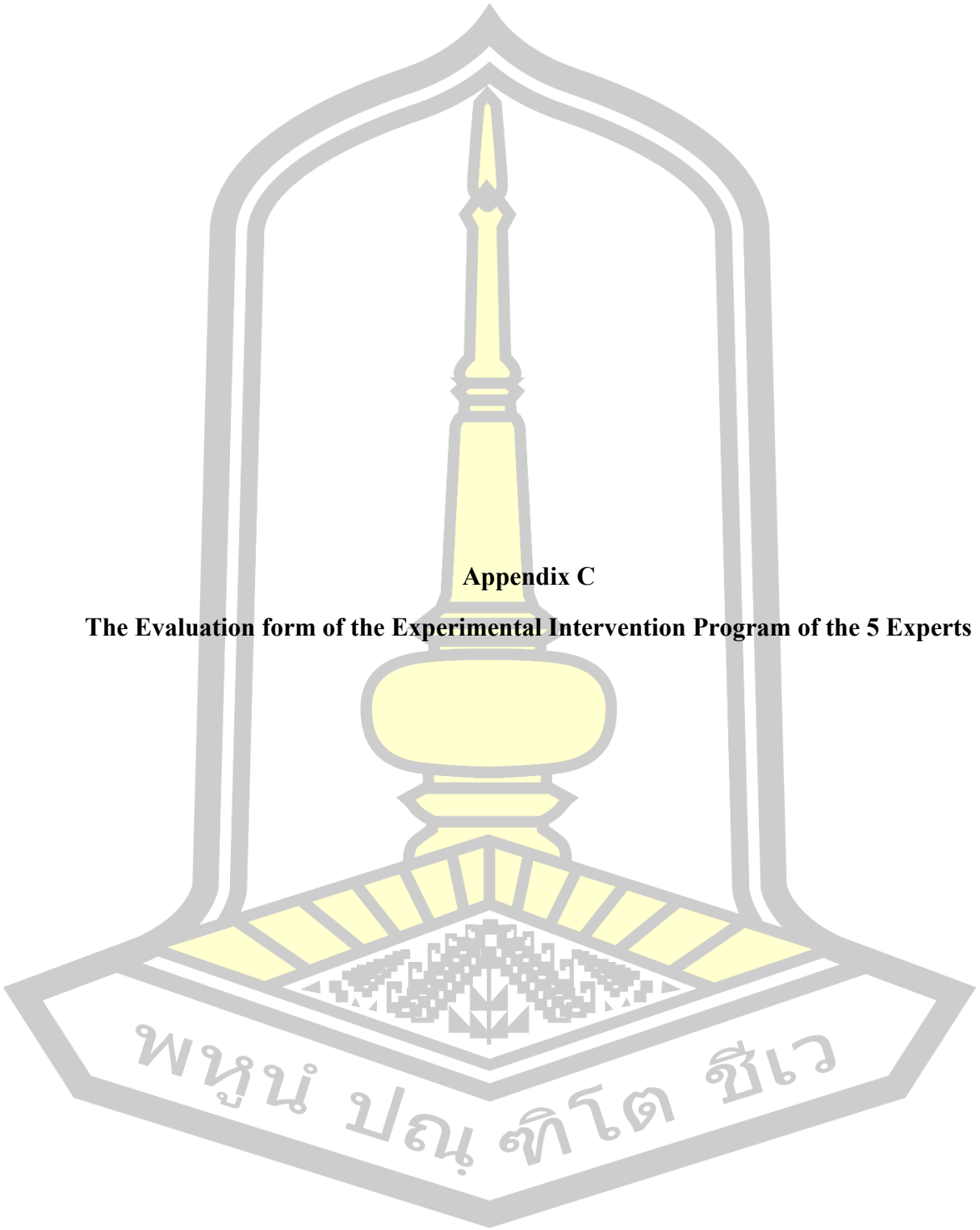
Everyone's physical condition and rhythm of life are different, so it is necessary to make a personal plan that suits you for better physical exercise.

In order to encourage and discipline yourself, it is necessary to make a practical plan: create a schedule, write down clearly the time, place and name of the program to go for physical exercise; to ensure that the plan is feasible, ask your classmates to supervise it together; in case of bad weather or other temporary matters, you can revise the plan appropriately to ensure that you have more than 30 minutes of physical exercise more than three times a week.

9. Precautions in physical exercise

To pay attention to several aspects of the content: 1, loose and comfortable sportswear and sports shoes is very important, which will increase the amplitude of physical activity and comfort, but also reduce the chance of injury, 2, the initial best not to do the initial intensity of the movement is too large, the first do a good job of warming up, to be the heart to keep up with the mobilization of the muscles, and then activities are better. 3, after the exercise, especially after the intense exercise, do not sit down or immediately stop moving, easy to cause gravity shock. Stop, easy to cause gravity shock, the correct practice is, in situ activities for a few minutes, to be the heart rate tends to quiet state and then rest.

In conclusion, by setting up clear goals, establishing exercise habits, finding exercise partners, paying attention to health information and making personal plans, students can independently cultivate a good sense of physical exercise, enjoy the benefits of physical exercise, and maintain their health and vitality. We hope that all students will pay attention to physical exercise, maintain a healthy body, meet challenges and create a better future.



Appendix C

The Evaluation form of the Experimental Intervention Program of the 5 Experts

Expert evaluation questionnaire on strategies to promote exercise behavior among Chinese university students

Dear experts:

Hello!

I am (Ms.Wenjuan Zhang, PhD Student Health and Sport Science. Faculty of Education, Mahasarakham University) under the advisor of Chairat Choosakul, Ph.D, now doing on research name "Self-Determination Theory-Based Promotion Intervention for Physical Exercise Behavior among Chinese College Student". This experimental procedure was designed according to the dissertation research in order to understand the impact of teacher support provided by physical education teachers on college students' exercise behaviors, so as to explore its relationship with exercise motivation and exercise behaviors.

You are a senior expert with rich knowledge and experience. I sincerely ask for your guidance and help. I hope you can give me guidance and evaluation in your busy schedule and put forward your valuable opinions and suggestions.

Thank you very much for your support and help.

Student name: Wenjuan Zhang

Advisor: Dr. Chairat Choosakul

Email: wenjuanbsu@126.com

Mahasarakham University, Thailand

Please fill in the following personal information:

Expert's name:

Professional title:

Work unit:

The following is the experimental intervention process of this study. Please score in the IOC score for the expert column (**-1 is not suitable, 0 is general, 1 is suitable** between "√"), and give relevant modification suggestions in the Items that need to be modified. Thank you for your guidance and evaluation in the help.

Intervention Process

weekly	Intervention Forms	Intervention content	Score for the expert						RESULTS
			Exp1	Exp2	Exp3	Exp4	Exp5	Total	
Week 1	Baseline tests (experimental group 1; control group 2)	None							
Week 2	Experimental group: 1. Live face-to-face in PE class 2. 2-3 text messages per week (QQ/WeChat group)	Physical education teachers provide knowledge of students' self-determined exercise behaviors; 1. knowledge of the purpose, meaning, and value of physical exercise. 2. knowledge of exercise interests, needs, and abilities. 3. learning the content of physical exercise instruction manuals. 4. online encouragement for students to engage in self-determined exercise and exercise apps.							
Week 3	Experimental group: 1. Live face-to-face in PE class 2. 2-3 text messages per week (QQ/WeChat group)	1. knowledge of how to establish exercise expectations and goals that meet one's exercise interests and needs. 2. Knowledge of how to make choices, decisions, and plans to achieve one's exercise goals and expectations. 3. Answer students' questions and give guidance on the spot; share physical							

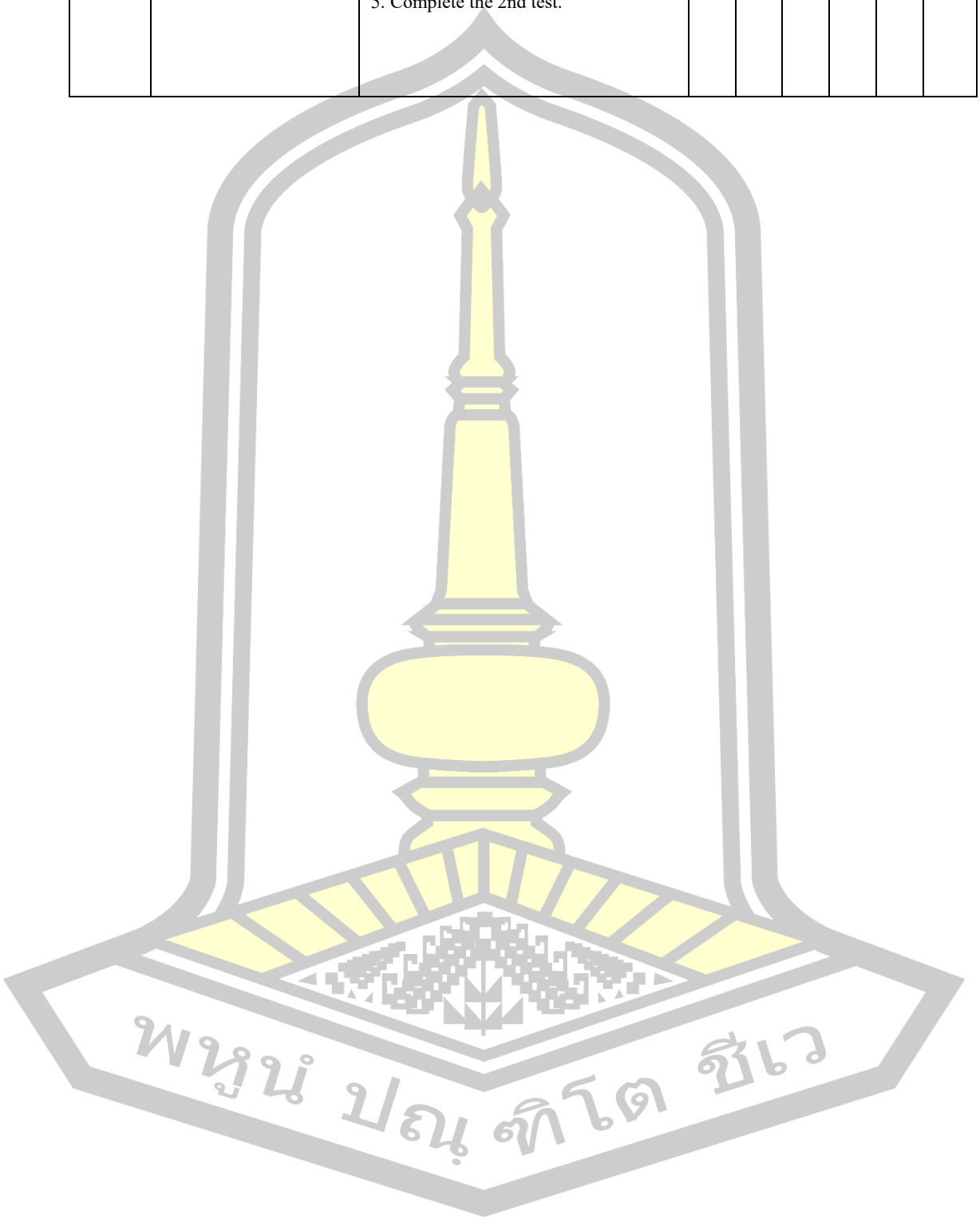
		exercise experiences. 4. Discussions and interactive answers with students online. 5. Send videos about physical exercise and fitness.							
Week 4	Experimental group: 1. Live face-to-face in PE class 2. 2-3 text messages per week (QQ/WeChat group)	1. provide students with knowledge of how to assess the effectiveness of exercise programs and behaviors. 2. knowledge of how to adjust the exercise program to achieve goals and meet needs. 3. answer students' questions and give guidance on the spot. 4. interact effectively with, praise, and encourage students online.							
Week 5	Experimental group: 1. Live face-to-face in PE class 2. 2-3 text messages per week (QQ/WeChat group)	1. improve students' skills in executing self-determined exercise behaviors. 2. improve the student's ability to express his/her exercise interests, needs, abilities, and deficiencies rather than being influenced by others. 3. improve the student's ability to make exercise choices, decisions, and plan to achieve their goals rather than be influenced by others. 4. answer students' questions and give guidance on the spot. 5. interact effectively with, praise, and encourage students online. 6. send videos of relevant physical exercise and fitness.							
Week 6	Experimental group: 1. Live face-to-face in PE class 2. 2-3 text messages per week (QQ/WeChat group)	1. improve the student's ability to assess the effectiveness of exercise programs and behaviors. 2. increase the student's ability to adopt exercise behaviors to successfully complete an exercise program. 3. increase students' perceptions of their knowledge and ability to perform self-determined exercise behaviors. 4. answer students' questions and give guidance on-site. 5. interact effectively with, praise, and encourage students online.							
Week 7	Experimental group: 1. Live face-to-face in PE class 2. 2-3 text messages per week (QQ/WeChat group)	1. increase the student's confidence and sense of freedom to express his/her exercise interests, needs and abilities expectations, and goals. 2. increase students' confidence in adopting exercise behaviors to successfully complete an exercise program. 3. increase students' motivation to assess the effectiveness of their exercise behaviors. 4. Increase students' willingness to adjust their exercise program to achieve goals and meet needs. 4. Answer students' questions and provide guidance on-site. 5. Interact effectively with, praise, and encourage students online.							
Week 8	Experimental group: 1. Live face-to-face in PE class 2. 2-3 text messages per	1. provide opportunities for students to develop self-determined exercise behaviors 2. provide opportunities for students to identify expectations and goals for meeting their exercise interests, needs, and abilities at school.							

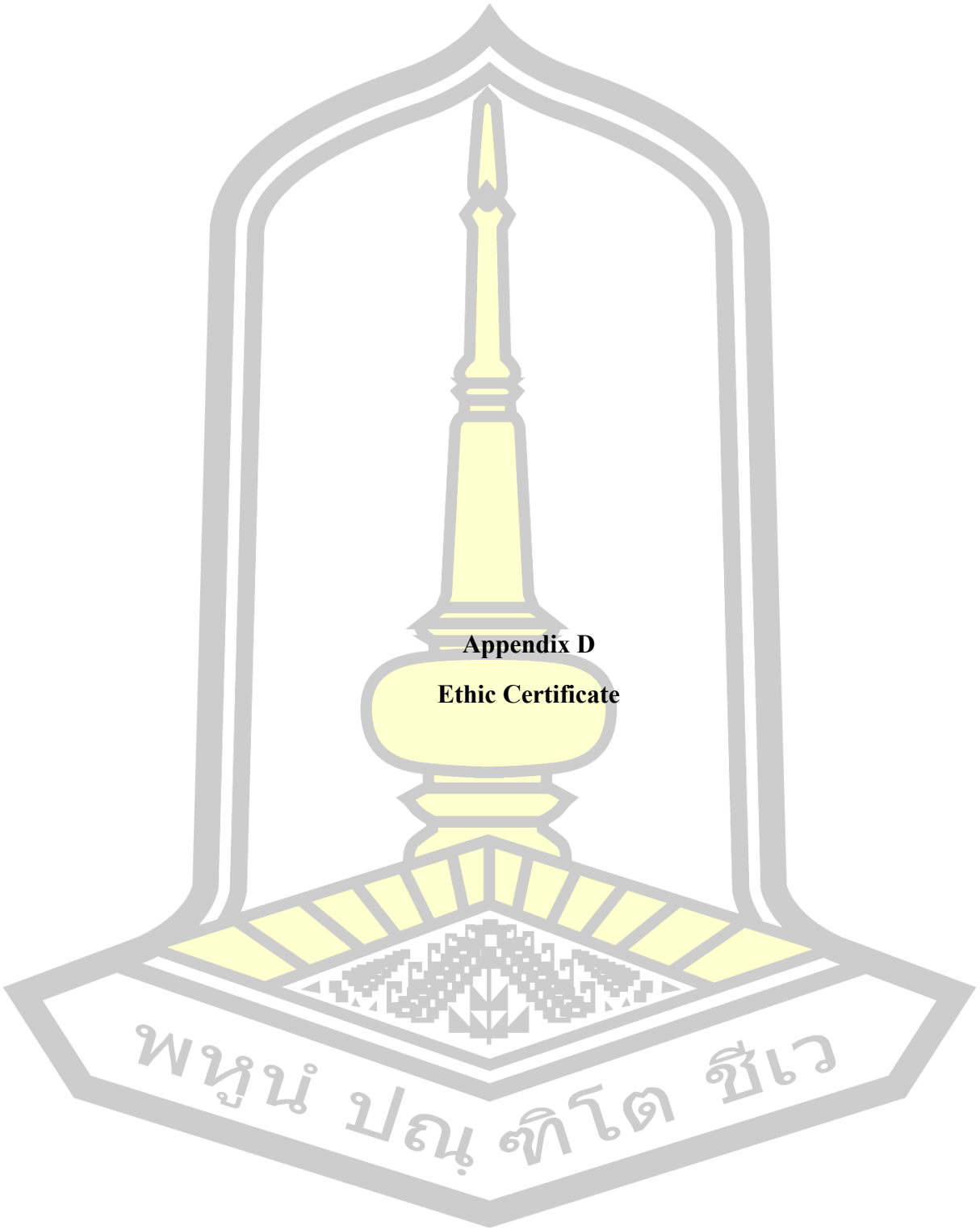
	week (QQ/WeChat group)	4. answer students' questions and give instruction on site. 5. interact effectively with, praise, and encourage students online. 6. send videos of relevant physical exercise and fitness.							
Week 9	Experimental group: 1. Live face-to-face in PE class 2. 2-3 text messages per week (QQ/WeChat group)	1. increase the student's willingness to adjust the exercise program to achieve goals and meet needs. 2. Increase student perception of knowledge and ability to perform self-determined exercise behaviors. 3. answer students' questions and give guidance on the spot. 4. interact effectively with, praise, and encourage students online.							
Week 10	Experimental group: 1. Live face-to-face in PE class (10 minutes) 2. 2-3 text messages per week (QQ/WeChat group) 3. Completion of 2nd test (experimental group 1; control group 2)	1. increase students' confidence in adopting exercise behaviors to successfully complete an exercise program. 2. Increase students' motivation to assess the effectiveness of their exercise behaviors. 3. Answer students' questions and give guidance on the spot. 4. Interact effectively with, praise, and encourage students online. 5. Complete the 2nd test.							

weekly	Intervention Forms	Intervention content	Score for the expert					
			Exp 1	Exp 2	Exp 3	Exp 4	Exp 5	Total
Week 1	Baseline tests (experimental group 1; control group 2)	None	1	1	1	1	1	1
Week 2	Experimental group: 1. Live face-to-face in PE class 2. 2-3 text messages per week (QQ/WeChat group) Control group: No intervention	Physical education teachers provide knowledge of students' self-determined exercise behaviors; 1. knowledge of the purpose, meaning, and value of physical exercise. 2. knowledge of exercise interests, needs, and abilities. 3. learning the content of physical exercise instruction manuals. 4. online encouragement for students to engage in self-determined exercise and exercise apps.	1	1	0	1	1	0.8
Week 3	Experimental group: 1. Live face-to-face in PE class 2. 2-3 text messages per week (QQ/WeChat group)	1. knowledge of how to establish exercise expectations and goals that meet one's exercise interests and needs. 2. Knowledge of how to make choices, decisions, and plans to achieve one's exercise goals and expectations. 3. Answer students' questions and give guidance on the spot; share physical exercise experiences. 4. Discussions and interactive answers with students online. 5. Send videos about physical exercise and fitness.	1	1	1	0	1	0.8
Week 4	Experimental group: 1. Live face-to-face in PE class 2. 2-3 text messages per week (QQ/WeChat group)	1. provide students with knowledge of how to assess the effectiveness of exercise programs and behaviors. 2. knowledge of how to adjust the exercise program to achieve goals and meet needs. 3. answer students' questions and give guidance on the spot. 4. interact effectively with, praise, and encourage students online.	1	1	1	1	1	1
Week 5	Experimental group: 1. Live face-to-face in PE class 2. 2-3 text messages per week (QQ/WeChat group)	1. improve students' skills in executing self-determined exercise behaviors. 2. improve the student's ability to express his/her exercise interests, needs, abilities, and deficiencies rather than being influenced by others. 3. improve the student's ability to make exercise choices, decisions, and plan to achieve their goals rather than be influenced by others. 4. answer students' questions and give guidance on the spot. 5. interact effectively with, praise, and encourage students online. 6. send videos of relevant physical exercise and fitness.	1	1	1	1	1	1

Week 6	Experimental group: 1. Live face-to-face in PE class 2. 2-3 text messages per week (QQ/WeChat group)	1. improve the student's ability to assess the effectiveness of exercise programs and behaviors. 2. increase the student's ability to adopt exercise behaviors to successfully complete an exercise program. 3. increase students' perceptions of their knowledge and ability to perform self-determined exercise behaviors. 4. answer students' questions and give guidance on-site. 5. interact effectively with, praise, and encourage students online.	1	1	1	1	1	1
Week 7	Experimental group: 1. Live face-to-face in PE class 2. 2-3 text messages per week (QQ/WeChat group)	1. increase the student's confidence and sense of freedom to express his/her exercise interests, needs and abilities expectations, and goals. 2. increase students' confidence in adopting exercise behaviors to successfully complete an exercise program. 3. increase students' motivation to assess the effectiveness of their exercise behaviors. 4. Increase students' willingness to adjust their exercise program to achieve goals and meet needs. 4. Answer students' questions and provide guidance on-site. 5. Interact effectively with, praise, and encourage students online.	1	1	1	1	1	1
Week 8	Experimental group: 1. Live face-to-face in PE class 2. 2-3 text messages per week (QQ/WeChat group)	1. provide opportunities for students to develop self-determined exercise behaviors 2. provide opportunities for students to identify expectations and goals for meeting their exercise interests, needs, and abilities at school. 4. answer students' questions and give instruction on site. 5. interact effectively with, praise, and encourage students online. 6. send videos of relevant physical exercise and fitness.	1	1	1	1	1	1
Week 9	Experimental group: 1. Live face-to-face in PE class 2. 2-3 text messages per week (QQ/WeChat group)	1. increase the student's willingness to adjust the exercise program to achieve goals and meet needs. 2. Increase student perception of knowledge and ability to perform self-determined exercise behaviors. 3. answer students' questions and give guidance on the spot. 4. interact effectively with, praise, and encourage students online.	1	1	1	1	1	1
Week 10	Experimental group: 1. Live face-to-face in PE class (10 minutes) 2. 2-3 text messages per week (QQ/WeChat group) 3. Completion of 2nd test (experimental group 1; control group	1. increase students' confidence in adopting exercise behaviors to successfully complete an exercise program. 2. Increase students' motivation to assess the effectiveness of their exercise behaviors. 3. Answer students' questions and give guidance on the spot.	1	1	1	1	1	1

	2)	4. Interact effectively with, praise, and encourage students online. 5. Complete the 2nd test.						





Appendix D

Ethic Certificate

MAHASARAKHAM UNIVERSITY ETHICS COMMITTEE FOR
RESEARCH INVOLVING HUMAN SUBJECTS

Certificate of Approval

Approval number: 270-072/2024

Title : Self-Determination Theory-Based Promotion Intervention for Physical Exercise Behavior among Chinese College Students

Principal Investigator : Miss. Wenjuan Zhang
Responsible Department : Faculty of Education
Research site : Jinan City, Shandong Province, China

Review Method : Expedited Review

Date of Manufacture : 25 April 2024 **expire :** 24 April 2025

This research application has been reviewed and approved by the Ethics Committee for Research Involving Human Subjects, Mahasarakham University, Thailand. Approval is dependent on local ethical approval having been received. Any subsequent changes to the consent form must be re-submitted to the Committee.

Ratree S.
.....
(Assistant Professor Ratree Sawangjit)
Chairman

Approval is granted subject to the following conditions: (see back of this Certificate)

ECMSU01-05.03 (English)

Clarification documents for the volunteers who answered the questionnaires
(Respondents must be above 18 years of age to participate in answering the questionnaires.)

To All respondents

I am Ms. Wenjuan Zhang, Ph. D Student of Health and Sport Science, Faculty Education, Maha Sarakham University. Is now doing on research name "Self-Determination Theory-Based Promotion Intervention for Physical Exercise Behavior among Chinese College Students" With the objective:

1) To develop a prediction model of self-determined exercise behavior applicable to the actual situation of Chinese college students' physical exercise.

2) To validate the model of physical exercise of Chinese college students based on SDT; to explore the main factors affecting the motivation and behavior of Chinese college students in participating in physical exercise.

3) Using the quasi experimental method, through a 10-week control experiment, to verify the intervention effect of the theoretical model on Chinese college students' exercise behavior, and to provide theoretical basis for promoting Chinese college students' exercise behavior. The benefits that you will receive from this research are clear understanding of your exercise behavior, and through intervention experiments, you will be able to improve your physical activity level. You may not directly benefit from participating in this research project. But the information obtained will be useful for Academic.

If you decide to participate in the research, the researcher will ask you to answer the questionnaire on exercise behavior which consists of questions for 5 parts in total of 58 items. answer the questionnaire is taking about 15 minutes. Researcher will receive the questionnaire by online questionnaire, or fill it out offline face to face.

If you feel uncomfortable or feel uncomfortable with some questions You have the right to not answer those questions. You have the right to withdraw from this project at any time without prior notice. The refuse of participating in the research or withdrawing from this research project Will not have any effect to does not affect your studies and your health.

The information in your questionnaire will be kept. Not disclosed to the public on an individual basis, only the overall research results will be reported. Researcher will destroy relevant information after the research is completed. In this research, you will not receive any compensation or any fees.

If you have questions about the research Please contact us at Ms. Wenjuan Zhang, Ph. D Student of Health and Sport Science, Faculty Education, Maha Sarakham University, Phone: +8618553736260

If you have not performed as stated or want to know your rights while participating in this research, please contact "Committee on Ethics for Research in Humans Maha Sarakham University Division of Research" Tel. 043-754416, 1758

Sincerely

.....

(Ms. Wenjuan Zhang)

Researcher

67/072

ECMSU01-05.03 (English)

Clarification documents for the volunteers who participate experiment
(Respondents must be above 18 years of age to participate experiment)

To All respondents

I am Ms. Wenjuan Zhang, Ph. D Student of Health and Sport Science, Faculty Education, Maha Sarakham University. Is now doing on research name "Self-Determination Theory-Based Promotion Intervention for Physical Exercise Behavior among Chinese College Students" With the objective:

1) To develop a prediction model of self-determined exercise behavior applicable to the actual situation of Chinese college students' physical exercise.

2) To validate the model of physical exercise of Chinese college students based on SDT; to explore the main factors affecting the motivation and behavior of Chinese college students in participating in physical exercise.

3) Using the quasi experimental method, through a 10-week control experiment, to verify the intervention effect of the theoretical model on Chinese college students' exercise behavior, and to provide theoretical basis for promoting Chinese college students' exercise behavior. The benefits that you will receive from this research are clear understanding of your exercise behavior, and through intervention experiments, you will be able to improve your physical activity level. You may not directly benefit from participating in this research project. But the information obtained will be useful for Academic.

If you decide to participate in the research, the researcher will ask you to answer the questionnaire on exercise behavior which consists of questions for 5 parts in total of 58 items. answer the questionnaire is taking about 15 minutes. Researcher will receive the questionnaire by online questionnaire, or fill it out offline face to face. In addition, researchers will ask you to participate in a 10-week intervention program. The intervention is conducted once a week, and the duration of each intervention is 90 minutes. The content includes an environment that provides autonomy support during physical exercise, exercise lectures, sharing of exercise experiences, exercise records, etc.; to meet the exercise autonomy needs of college students.

If you feel uncomfortable or feel uncomfortable with some questions You have the right to not answer those questions. You have the right to withdraw from this project at any time without prior notice. The refuse of participating in the research or withdrawing from this research project Will not have any effect to does not affect your studies and your health.

The information in your questionnaire and experimental will be kept. Not disclosed to the public on an individual basis, only the overall research results will be reported. Researcher will destroy relevant information after the research is completed. In this research, you will not receive any compensation or any fees.

If you have questions about the research Please contact us at Ms. Wenjuan Zhang, Ph.D Student of Health and Sport Science, Faculty Education, Maha Sarakham University, Phone: +8618553736260

If you have not performed as stated or want to know your rights while participating in this research, please contact "Committee on Ethics for Research in Humans Maha Sarakham University Division of Research" Tel. 043-754416, 1758

Sincerely

.....

(Ms. Wenjuan Zhang)
Researcher

APPENDIX

Informed Consent

Honourable participants:

Hello!

Thank you very much for taking time out of your busy schedule to complete this questionnaire, your information will be an important source of data for this study. Please read the following carefully before you decide whether or not to participate in this study.

The content of this questionnaire will be used for academic research aimed at understanding the relationship between Exercise Autonomous Support, Exercise Motivation and Exercise Behavior. This questionnaire contains 5 sections, please choose the most appropriate one in each question option according to your real situation and thoughts, there is no right or wrong answer to the questions.

This questionnaire will take anonymous form, not for individuals to do any analysis, will not have any impact on the individual, you participate in the process of this survey all personal data will be kept strictly confidential, you are free to decide whether to participate in this questionnaire, at any time you have the right to withdraw.

If you have any questions queries or suggestions about the above or the questionnaire, feel free to contact the director of this study.

Tel: 18553736260

Email: wenjuanbsu@126.com

I have read and fully understood the above information note about this questionnaire, and agree and voluntarily participate in this research and co-operate in completing the survey.Thank you very much for your participation and support!

Sincerely,

Signature:

Date:

ECMSU01-07.10 English 2023

Volunteers Consent Form

(For volunteers over 18 years old)

I (Mr./Miss/Mrs.) ..... Surname ..... Age.....Year.

House number ..... Village No. ..... Sub-district ..... District .....

province.....

Read the explanation from Ms. Wenjuan Zhang, PH.D Student of Health and Sport Science, Faculty Education, Maha Sarakham University. About volunteering in the research project on " Self-Determination Theory-Based Promotion Intervention for Physical Exercise Behavior among Chinese College Students ". The explanatory text consists of Full details about the purpose of the research, details of the research. That I have to do and be treated, the benefits that I may gain from the research and the risks that may arise from participating in the study. Including guidelines for questions that may arise throughout. It has also received an explanation and an answer to any questions from the research project leader.

As well as the testimony from the researcher that will keep my information confidential. In addition, not anonymously or private information individually to the public. The results of the research will be presented in the form of an overview that is a summary of the research results for academic purposes only.

"In participating as a volunteer of this research project I join voluntarily." And I can withdraw from this study at any time. If I wish which will not have any effect and will not lose any rights in study or work that I will receive in the future.

sign..... Volunteer

(.....)

Date.....

sign..... Volunteer parents

(.....)

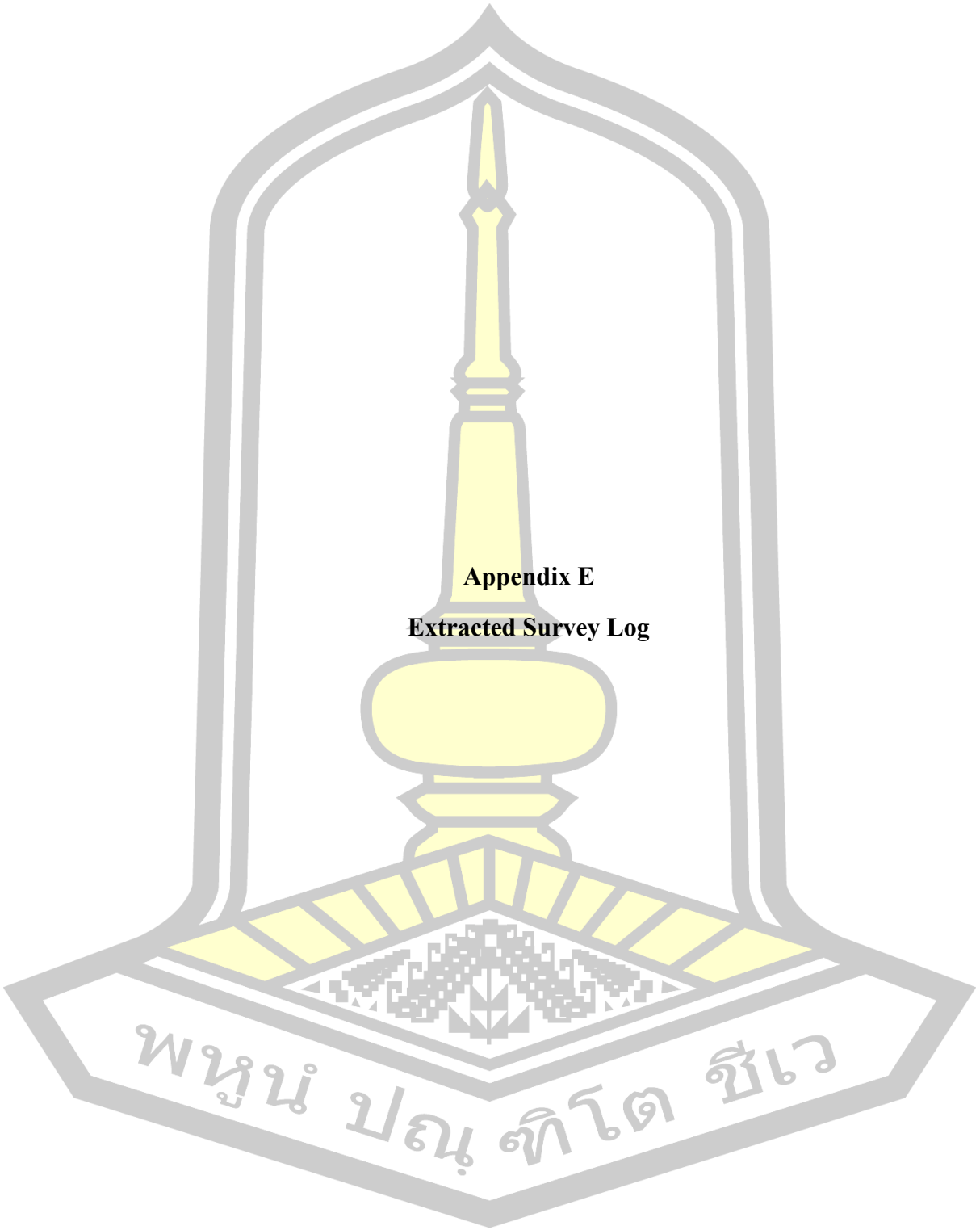
Date.....

sign..... researcher

(Ms. Wenjuan Zhang)

Date.....

มหาวิทยาลัยมหาสารคาม Mahasarakham University Ethics Committee For Human Research คณะกรรมการจริยธรรมการวิจัยในคน



Appendix E

Extracted Survey Log

Photos: Data collection, expert consultation, experimental intervention, online discussion, students' independent exercise

Figure 15 Test and intervention pictures

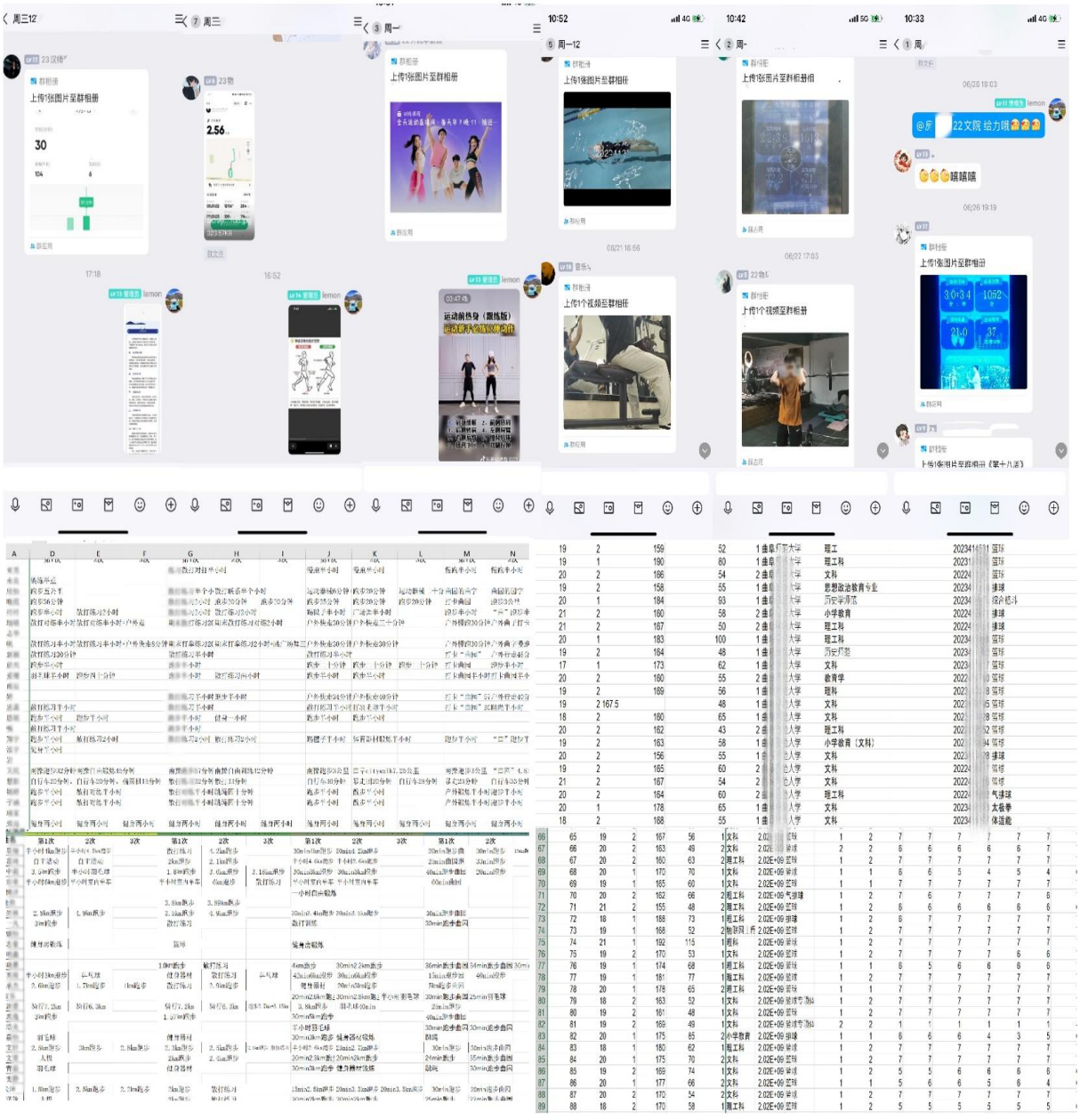
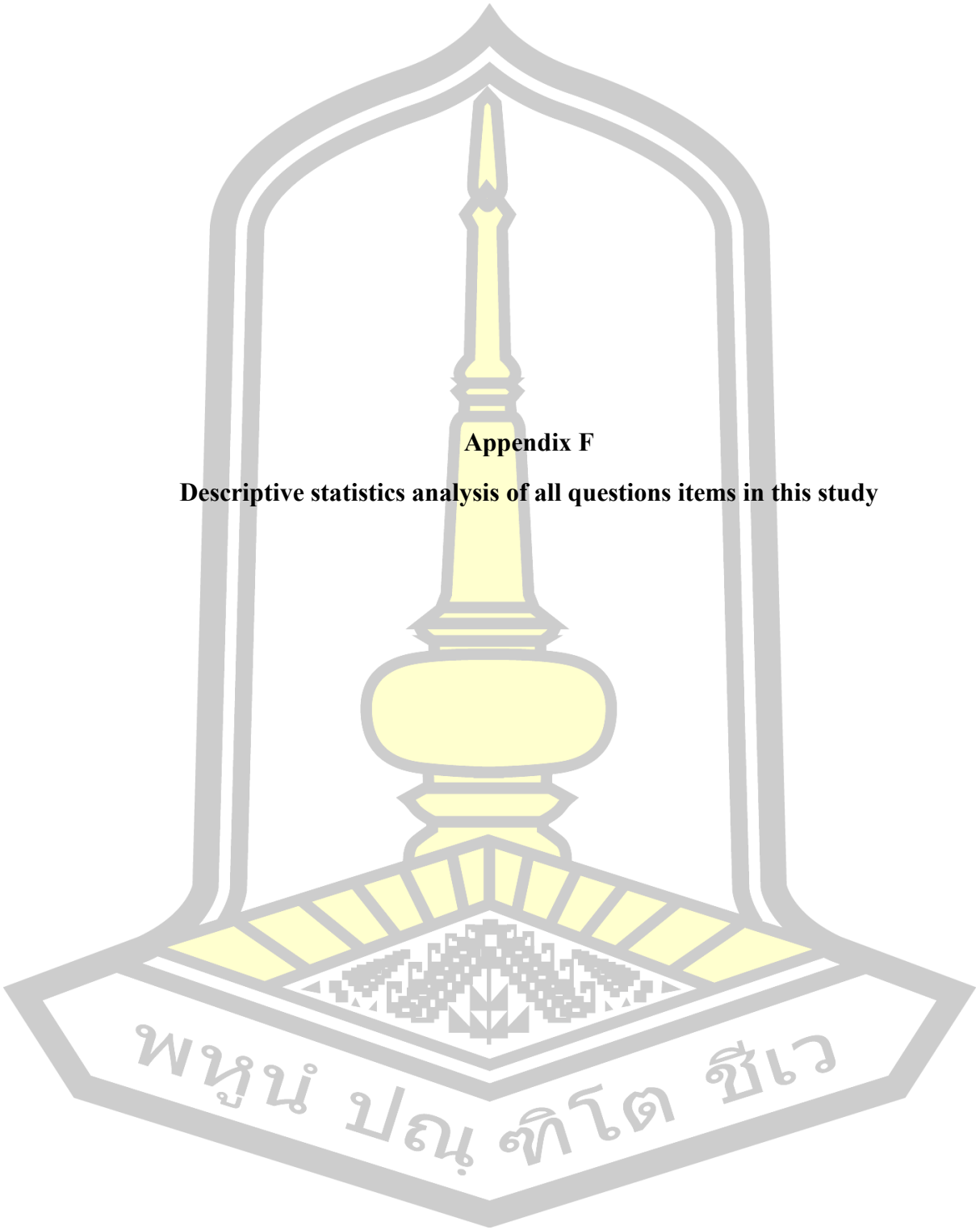


Figure 16 Physical exercise pictures



Appendix F

Descriptive statistics analysis of all questions items in this study

These are the descriptive statistics and normal distribution K-S nonparametric tests for all the questions in this study.

Descriptive Statistics for all questions in the SDT						
variables	**Min**	**Max**	***M***	***SD***	**Skewness**	**Kurtosis**
Autonomy Support (AS)	1	7	6.160	1.034	-1.559	3.344
AS12-1	1	7	6.096	1.146	-1.527	2.902
AS13-2	1	7	6.201	1.075	-1.702	3.788
AS14-3	1	7	6.168	1.098	-1.591	3.088
AS15-4	1	7	6.202	1.090	-1.703	3.702
AS16-5	1	7	6.175	1.115	-1.641	3.182
AS17-6	1	7	6.116	1.159	-1.558	2.795
Basic Psychological Needs (BPN)	1	6	5.013	0.865	-0.781	0.759
BPN33-1	1	6	4.748	1.132	-0.770	0.416
BPN34-2	1	6	4.926	1.030	-0.900	0.888
BPN35-3	1	6	5.111	0.950	-1.115	1.600
BPN36-4	1	6	5.162	0.967	-1.250	1.902
BPN37-5	1	6	4.953	1.076	-0.970	0.741
BPN38-6	1	6	5.152	0.944	-1.210	1.957
BPN39-7	1	6	4.952	1.089	-0.995	0.793
BPN40-8	1	6	5.193	0.885	-1.116	1.596
BPN41-9	1	6	5.015	1.010	-0.930	0.745
BPN42-10	1	6	4.880	1.123	-0.885	0.462
BPN43-11	1	6	4.974	1.028	-0.936	0.842
BPN44-12	1	6	4.740	1.222	-0.840	0.192
BPN45-13	1	6	5.048	0.980	-0.997	1.202
BPN46-14	1	6	5.179	0.885	-0.974	1.086
BPN47-15	1	6	4.896	1.083	-0.875	0.549
BPN48-16	1	6	5.158	0.895	-0.866	0.497
BPN49-17	1	6	5.084	0.952	-1.066	1.526
BPN50-18	1	6	5.074	0.970	-1.028	1.351
Exercise Autonomous Motivation (EM-RAI)	-73	91	28.095	28.464	0.127	-0.850
EM51-1	1	5	4.253	0.843	-1.009	0.730
EM52-2	1	5	2.571	1.395	0.470	-1.057
EM53-3	1	5	3.744	1.071	-0.553	-0.341
EM54-4	1	5	3.031	1.242	0.033	-0.871
EM55-5	1	5	3.595	1.102	-0.376	-0.525
EM56-6	1	5	2.845	1.300	0.185	-0.998
EM57-7	1	5	4.203	0.847	-0.941	0.761

EM58-8	1	5	2.339	1.370	0.729	-0.704
EM59-9	1	5	3.936	0.990	-0.623	-0.120
EM60-10	1	5	3.344	1.229	-0.247	-0.808
EM61-11	1	5	3.797	1.058	-0.545	-0.352
EM62-12	1	5	2.965	1.315	0.072	-1.056
EM63-13	1	5	4.190	0.860	-0.923	0.678
EM64-14	1	5	2.278	1.366	0.766	-0.660
EM65-15	1	5	4.037	0.946	-0.720	0.085
EM66-16	1	5	3.109	1.241	0.002	-0.906
EM67-17	1	5	3.781	1.060	-0.529	-0.351
EM68-18	1	5	2.274	1.371	0.731	-0.734
EM70-20	1	5	2.152	1.343	0.925	-0.372
EM71-21	1	5	4.014	0.914	-0.635	-0.013
EM72-22	1	5	2.972	1.288	0.076	-0.971
EM73-23	1	5	3.844	0.971	-0.435	-0.304
EM74-24	1	5	2.567	1.372	0.422	-1.017
Exercise Behavior (EB)	0	100	22.823	21.621	1.067	0.313
EB75-1	1	5	2.603	1.288	0.146	-1.280
EB76-2	1	5	3.277	1.191	-0.110	-0.878
EB77-3	1	5	3.029	1.012	0.011	-0.235

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