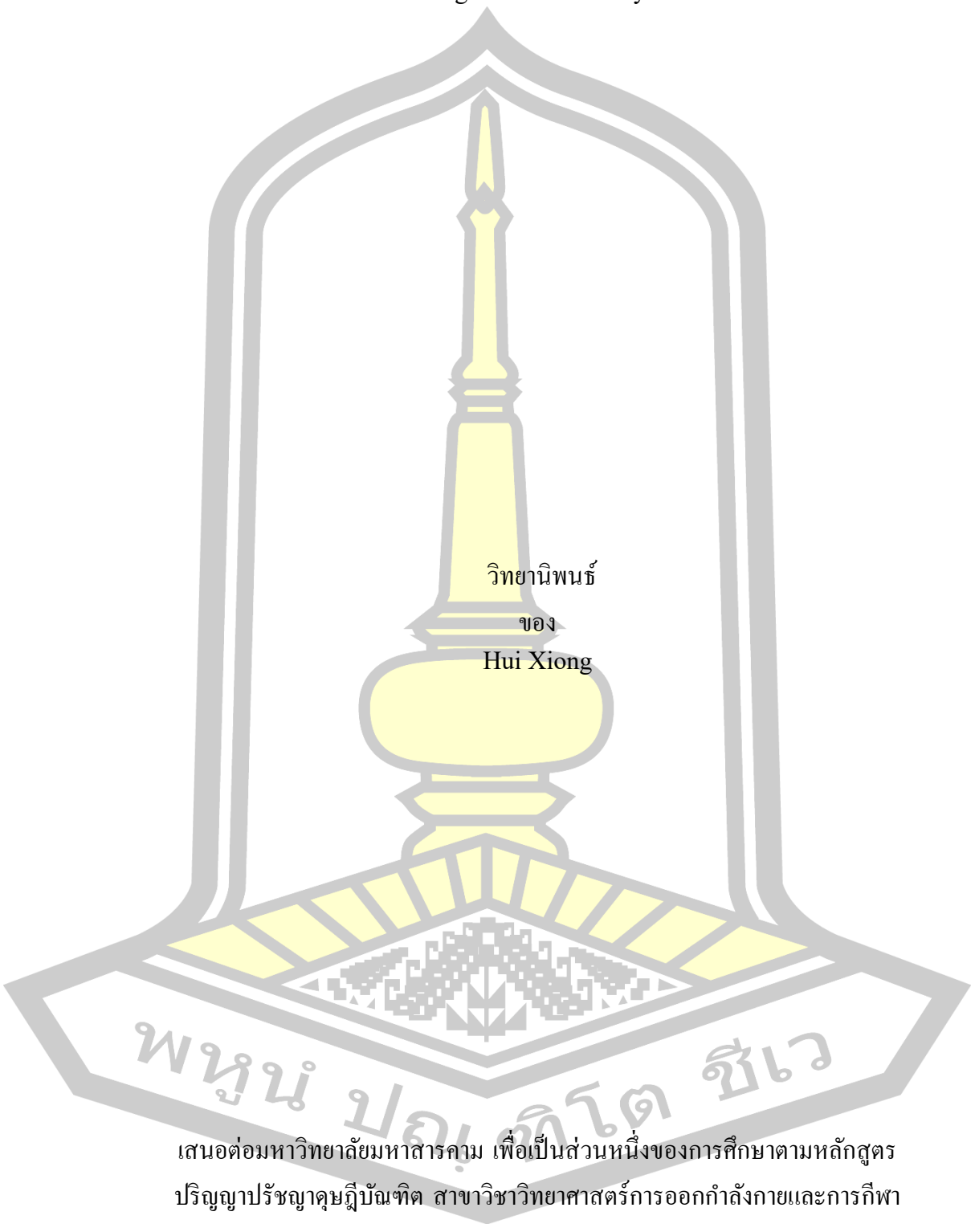
The Effect of Functional Physical Training on Improving Sports Performance of College Basketball Players

Hui Xiong

A Thesis Submitted in Partial Fulfillment of Requirements for
degree of Doctor of Philosophy in Exercise and Sport Science
October 2024

The Effect of Functional Physical Training on Improving Sports Performance of College Basketball Players



วิทยานิพนธ์

ของ

Hui Xiong

เสนอต่อมหาวิทยาลัยมหาสารคาม เพื่อเป็นส่วนหนึ่งของการศึกษาตามหลักสูตร

ปริญญาปรัชญาดุษฎีบัณฑิต สาขาวิชาวิทยาศาสตร์การออกกำลังกายและการกีฬา

ตุลาคม 2567

The Effect of Functional Physical Training on Improving Sports Performance of College Basketball Players

Hui Xiong

A Thesis Submitted in Partial Fulfillment of Requirements

for Doctor of Philosophy (Exercise and Sport Science)

October 2024

The examining committee has unanimously approved this Thesis, submitted by Mr. Hui Xiong , as a partial fulfillment of the requirements for the Doctor of Philosophy Exercise and Sport Science at Mahasarakham University

Examining Committee

.....Chairman
(Asst. Prof. Rojapon Buranarugsa , Ph.D.)

.....Advisor
(Asst. Prof. Yada Thadanatthaphak , Ph.D.)

.....Committee
(Asst. Prof. Chairat Choosakul , Ph.D.)

.....Committee
(Asst. Prof. Napatsawan Thanaphonganan , Ph.D.)

.....Committee
(Asst. Prof. Chamnan Chinnasee , Ph.D.)

Mahasarakham University has granted approval to accept this Thesis as a partial fulfillment of the requirements for the Doctor of Philosophy Exercise and Sport Science

.....
(Assoc. Prof. Chowwalit Chookhampaeng , Ed.D.)
Dean of The Faculty of Education

.....
(Assoc. Prof. Krit Chaimoon , Ph.D.)
Dean of Graduate School

TITLE The Effect of Functional Physical Training on Improving Sports Performance of College Basketball Players

AUTHOR Hui Xiong

ADVISORS Assistant Professor Yada Thadanatthaphak , Ph.D.

DEGREE Doctor of Philosophy **MAJOR** Exercise and Sport Science

UNIVERSITY Mahasarakham University **YEAR** 2024

ABSTRACT

Functional physical training is a multi-dimensional and all-round targeted training designed on the basis of special sports characteristics and athletes' physical evaluation results. Basketball is a high-intensity, intermittent and adversarial sport, and its physical training is crucial to technique and tactics.

The purpose of this study is two: (1) To compare the effects of functional physical training on between groups physical fitness: body shape, body function and sports quality; (2) To compare the effects of functional physical training on physical fitness in each within group: body shape, body function and sports quality.

The study subjects were two college basketball players (12 in each team, aged 18-25) who were preparing for CUBAL. The experimental group used functional physical training and the control group used traditional physical training for 10 weeks, 3 times a week, 90 minutes each time.The functional physical training of the experimental group was divided into three training stages: the first stage (1-3 weeks) : Basic motor function development stage of the body; The second stage (4-7 weeks) : General motor function development stage; Stage 3 (8-10 weeks) : Specific motor function development stage.

In this study, literature, induction and deduction, experiment and mathematical statistics were used to evaluate the effects of the two training methods by measuring athletes' height, weight, BMI, body fat percentage, vital capacity, heart rate change and sports quality indicators (such as strength, power, speed, endurance, agility, flexibility, etc.).

The results show:

(1) Comparison between groups: Functional physical training is superior to traditional training in terms of fat loss and muscle gain and heart rate recovery after exercise, and performs better in terms of strength, flexibility and anaerobic endurance, but there is no significant difference in speed and agility.

(2) Comparison within group: both training methods can effectively reduce body fat percentage, improve cardiopulmonary function and exercise quality, and functional physical training is better than traditional training in improving strength, speed, anaerobic endurance and other aspects.

Keyword : Functional physical training, College basketball players, Sports performance

ACKNOWLEDGEMENTS

As I am about to finish my doctoral studies, I am filled with endless gratitude and emotion. Looking back on this long and profound academic journey, every step has condensed the care and help of too many people, without them, I can not imagine that I can smoothly go to today. Here, I would like to express my sincere gratitude to all those who have given me selfless support and help during the research process.

First of all, I would like to extend my highest respect and gratitude to my advisor, the Distinguished Asst. Prof. Yada Thadanatthaphak, Ph.D. Her profound knowledge, rigorous academic attitude and keen academic insight have illuminated my way forward like a beacon. When I encountered a bottleneck in my research, it was her patient guidance and encouragement that made me regain my confidence and continue to explore the unknown field. Her words and deeds not only benefit me academically, but also serve as an example in my life. This kindness, I will remember in my heart, never forget.

I would like to thank Asst. Prof. Chairat Choosakul, Ph.D., for his academic guidance and help in my life. He is knowledgeable, tireless and approachable. He took us to various universities in Thailand for exchange and study, and invited us to his home for dinner on weekends, which made me feel very warm in a foreign country. I wish him good health and a happy life.

I would like to thank Asst. Prof. Rojapon Buranarugsa, Ph.D., Assoc. Prof. Vorapoj Promasatayaprot, Ph.D., Asst. Prof. Napatsawan Thanaphonganan, Ph.D, Asst. Prof. Chamnan Chinnasee,Ph.D., and Guo Xikui, Li Jing and others gave me a lot of support and help in the process of writing my thesis and put forward good suggestions for revision. I would like to express my sincere thanks here.

I would like to thank my friend Lecturer Kritchapol Arsapakdee, and all the staff at the School of Sport and Sports Science for everything they have done for my studies and life at Maha Sarakan University. Thanks to all my classmates, those days of fighting side by side will become the most precious memories in my life.

I would like to thank the team teachers and students who participated in the data collection, and the coaches and athletes who participated in the experiment. Your cooperation and participation are very important for my research.

In addition, I would like to especially thank my wife and family for their understanding, support and silent efforts, which have built the most solid backing for me on my long road to study. Your encouragement and expectations are the source of motivation for me to keep moving forward. Without your support, I can't imagine how I could have made it to this moment. Please accept my deepest gratitude and love.

Finally, I would like to thank the Faculty of Education, MahaSarakham University for providing a comfortable learning environment for our Chinese students.

Hui Xiong

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

LIST OF FIGURES

Page

CHAPTER I

INTRODUCTION

Background

In competitive sports, a complete training system consists of physical fitness training, technical training, tactical training, and psychological training. Physical fitness is one of the important factors in the overall structure of athletes' competitive ability and is the foundation of competitive ability elements (Yan Qi, 2013). In other words, the technical performance and tactical completion of athletes are built on the foundation of good physical fitness. Physical fitness is the physical ability required to serve competitive sports, achieve the implementation of techniques and tactics, and establish a good psychological environment (Chi Tianshu, 2010).

Basketball is a high-intensity, multi-interval and long duration item. In a basketball game, the players need to get rid of the opponent or seize a favorable position in the area 28 m long and 15 m wide within 40 minutes by rushing to start, stop, change direction, jump, etc., and compete fiercely for the ball in the air and on the ground. Frequent physical contact, more collisions and high confrontation intensity require not only athletes to have a strong body, but also good explosive power, antagonistic strength, endurance, flexibility and sensitive coordination, etc., to provide guarantee for the rational use of techniques and tactics (Liu Xinzheng, 2006). If the event is intensive, in addition to the above abilities, athletes should also have good physical reserve and recovery ability, so that they can maintain sufficient physical strength in each game and lay a good foundation for the play of skills and tactics. Studies have shown that high-intensity movement only accounts for about 15% of the effective time in a game (medium intensity accounts for 50%, low intensity accounts for 35%), and it is this 15% of high-intensity movement time that carries the completion of key technical actions and plays a crucial role in the play of athletes' technical and tactical abilities (Ben Abdelkrim et al., 2007).At the same time, athletes should have the ability to recover quickly during breaks in competition or low-intensity exercise, so as to maintain the ability to efficiently complete repeated high-intensity exercise during competition (Liu Jun et al., 2012).

Basketball belongs to the skill driven category of the same field adversarial event group, which has high intensity, intermittency, and adversarial characteristics, which puts high requirements on the physical fitness of athletes. Only by possessing excellent physical reserves can athletes demonstrate their best technical and tactical abilities in competitive competitions. For basketball players, good physical fitness is an important condition to support an athlete to complete the game. Good physical fitness and its scientific training methods will not only help improve their competitive ability, but also help their body to coordinate development in all aspects and avoid sports injury, thus extending their sports life (Kong Wanlong, 2021).

At the 18th Asian Games in 2018, Chinese basketball won four gold medals. The men's and women's basketball teams won all the gold medals, and both the men's and women's teams in the three-player basketball team won the gold medals. Men's basketball physical fitness coach Ye En attributed part of the winning factors to physical training. In basketball games, it is often necessary to accelerate, slow down, stop and start quickly, change direction, turn back, rebound, and physical confrontation, which consumes a lot of athletes' physical energy, The men's basketball team has specially combined the characteristics of basketball in their daily physical training, scientifically drawing on advanced functional training concepts from abroad, and formulated different physical training plans for players in different positions, especially for some players with injuries. An excellent basketball player needs to possess qualities such as strength, speed, endurance, agility, flexibility, technical tactics, and psychology to help him execute the tactics assigned by the coach on the field. Physical fitness training focuses on strengthening the athlete's physical level to help him complete the tasks assigned by the coach. Technology and tactics are the manifestation of the characteristics of the project itself, and physical fitness is the basic prerequisite for supporting the development of technology and tactics (Deng Fen, 2019).

Good physical fitness can better ensure the normal or superior performance of technical and tactical skills and can also compensate for the disadvantages when technical and tactical skills are low. From this, it can be seen that a basketball player's physical fitness and technical and tactical level are the key factors that directly affect the outcome of the game. If his physical fitness is more abundant and his technical

and tactical application is more appropriate, the team has a greater chance of winning the game (Hu Sheng, 2016).

The Chinese University Basketball Association League (CUBAL) is very influential in China, and the college basketball players in this study refer to the college basketball players who participate in CUBAL. The league is divided into male and female groups, consisting of a first level league, a second level league, and a third level league. Each year, more than 1600 teams participate in the three levels, covering 32 provinces, cities, and autonomous regions in China. The Chinese University Basketball Association is the top amateur league in China's sports industry in terms of game scale, competition level, talent incubation and other aspects. The league continues to precipitate the sports cultural atmosphere of Chinese university students through the games. Now it has become the basketball shrine in the minds of more than 40 million college students nationwide. Every year, more than 1 billion people watch the live broadcast of the game “. Asugh television and the network, and more than 2 million people watch the game on the spot, Its influence is second only to that of the Chinese Basketball Association, and it is truly the Chinese version of "NCAA".As of 2023, CUBAL has held 25 sessions, with over 1000 college student teams participating in each session, and its influence is increasing day by day(Zhuo Ran, 2022).

CUBAL has become one of the channels of talent transfer for the China Basketball Association (CBA) and the national team, in the past 8 years, CUBAL has sent 57 basketball players to the CBA, and some have even been selected to the Chinese men's basketball team, representing the national team to participate in the Asian Cup and Olympic trials (Li Yuanchun, 2021). However, the research shows that the CUBAL players in the CBA is actually very low, only a few players in the CBA league foothold, physical fitness is an important reason affecting the development of college basketball players in the CBA. Wang Mudi's research results show that CUBAL athletes have good endurance and speed endurance, but poor lower limb strength, especially poor ankle joint strength, insufficient jumping and flexibility, and slow response. These factors restrict the performance of basketball players in CUBA (Wang Moudi, 2006). According to a study by Bao Yong et al., CUBAL players have strong upper and lower limb strength and weak core strength, which, in addition to

age factors, indicates that the training methods and means of physical training for CUBAL athletes are relatively backward (Bao Yong, 2013).

Through literature review, it can be seen that CUBAL athletes have a significant difference from the average of CBA players in terms of basic physical fitness indicators such as height, weight, and Ketolet index, as well as physical fitness, as well as the average hit rate in competitions (Miao Xinyu et al., 2021).

Jiang Xingjia analyzed the CUBAL men's first tier league and found that teams with higher rankings have shown certain advantages in terms of physical fitness, mainly in terms of body shape and sport quality (Jiang Xingjia, 2022). Through on-site inspections of CUBAL matches and interviews with coaches, it was found that athletes exposed many shortcomings in high-intensity and fast-paced matches. Firstly, their physical fitness level was insufficient, their physical confrontation ability was weak, and their basic skills were not solid; Secondly, physical fitness issues have a significant impact on the outcome of a match in a close match and at the final critical moments of the match(Li Lijian, 2010); Thirdly, fatigue brings some adverse effects and potential injuries to athletes' bodies; Fourthly, most universities do not have professional physical fitness coaches, and both technical and tactical training and physical fitness training are handled solely by the head coach. Coaches often prioritize technical and tactical training while neglecting physical fitness training (Zhang Liyue, 2014).

With the continuous application of new science and technology in sports training, the theory of sports training has developed faster. The research on physical fitness training by European and American sports powers has become more in-depth. On the basis of more systematic and in-depth research on the methods, testing methods, and evaluation methods of physical fitness training, more attention has been paid to the balanced development of various physical fitness elements, and many new concepts of physical fitness training have been proposed. Functional physical training is one of them, and it has become a hot research field in international physical fitness training.

Functional physical training is a means of conducting physical fitness training based on the actual condition of physical function and the specific characteristics of

the participating sports events (Santana. J.C, 2004). The action mode of functional training involves acceleration, deceleration, and stability of multiple joints and planes. It refers to the training of partial chains and connections in the human motion chain, including completing specific target actions, including acceleration and deceleration of multi-dimensional motion trajectories, and stability training activities that meet specific target action characteristics (Gary Cook, 2012).

A comparative study by Mark Verstegen et al. (2009) showed that after training, the strength increase in the functional training group was 58% higher than that in the control group, the balance ability was 196% higher than that in the control group, and joint pain was reduced by 30%. Tomljanovic et al. (2011) conducted a group of comparative experiments on 23 male intermediate training athletes aged 22-25 for 5 weeks, 3 times a week. The research results showed that hexagonal jumping, standing medicine throwing, high jump and explosive power were significantly improved, and functional physical training was significantly better than traditional physical training. A Shaikh and DS Mondal randomly selected 19 male college students aged between 19 and 25 years for functional training 3 times A week for 8 weeks, and found that their speed, endurance, muscle strength and explosive power, flexibility and sensitivity were significantly improved (Shaikh A et al., 2012).

In recent years, experts and scholars represented by Dr. Yan Qi, a researcher at the General Administration of Sport of China, have conducted in-depth research on functional physical training, which has been applied in high-level events such as diving, table tennis, volleyball, hockey, boxing, and wrestling for the Chinese national team. However, this advanced physical fitness training method is rarely used in basketball training in Chinese universities. Therefore, college basketball teams should keep up with the pace of the times and popular trends, improve the physical fitness level of athletes through scientific physical training methods, and thereby improve the execution ability and competitive ability of basketball players' technical and tactical levels deliver basketball talents to the country.

To sum up, physical fitness is one of the main factors affecting the development of college basketball players to a higher basketball platform. The lack of physical fitness leads to the inability of basketball players to adapt to strong physical

confrontation in the game, and the inability to complete the attack and defense with high quality at the last critical moment of the game. CUBAL athletes lack scientific physical training methods. As a new training method (Feito et al., 2018), some studies have confirmed that functional physical training can improve speed (Alonso-Fernandez et al.,2017; Keiner et al., 2020), Muscle strength (Oliver and Brezzo, 2009; Elbadry, 2014), power (Alonso-Fernandez et al., 2017; Yildiz et al., 2019; Keiner et al., 2020), agility (Tomljanovi ´ c et al., 2011; Yildiz et al., 2019) and muscle endurance (Oliver and Brezzo, 2009), it is different from traditional physical training, it is a training means for the purpose of enhancing specific athletic ability (Pacheco et al., 2013). This paper will study the effectiveness of functional physical training to improve the athletic performance of college basketball players from two angles of theoretical methods and practical application, aiming at improving the competitive level of college basketball players, in order to contribute to the development of college basketball functional physical training.

Research Problem

(1) College basketball players have insufficient physical fitness, weak physical confrontation ability, and weak basic skills; In a close match and at the final critical moment, physical fitness issues have a significant impact on the outcome of the game.

(2) Functional physical training is an advanced physical training method, but it is seldom used and studied in Chinese college basketball training, and the evaluation system and training method are not perfect.

Research Objective

(1) To compare the effects of functional physical training and traditional physical training on between groups physical fitness: body shape, body function and sports quality.

(2) To compare the effects of functional physical training and traditional physical training on within group physical fitness: body shape, body function and sports quality.

Hypothesis of Research

(1) Functional physical training can effectively improve the physical fitness of college basketball players: body shape, body function and sports quality.

(2) Compared with the control group, functional physical training can effectively improve the physical fitness of college basketball players: body shape, body function and sports quality.

Significance of Research

Theoretical significance

(1) There are few researches on functional physical training of college basketball players. This study analyzed and summarized relevant literatures on functional physical training, and sorted out relevant theories on functional physical training of college basketball according to the characteristics of basketball projects.

(2) Systematically explain how to use the theory and practice of functional physical training to improve the competitive level of college basketball players, so as to provide reference standards and ideas for future research.

Practical significance

(1) The physical fitness test index system of college basketball players has been established to make basketball training more directional and enrich the means of college basketball physical training.

(2) Through the application and research of functional physical training for college basketball players, a more refined, systematic and targeted functional physical training method is designed, which breaks through the traditional mode of basketball physical training and provides reference for college basketball players' training and competition.

Related Concepts and Definitions

1. Functional Physical Training

According to the characteristics of special sports and the results of athletes' physical fitness assessment, the multi-dimensional and all-round targeted training is designed for the weak links of athletes' bodies and based on the characteristics of body movement functions. This study is based on the pyramid model of functional physical training proposed by Yan Qi (2012) and divides the functional physical training of college basketball players into three training stages: basic motor function training (1-3 weeks), general motor function training (4-7 weeks) and special sports function training (8-10 weeks).

2. Physical Fitness

Physical fitness refers to the comprehensive ability of the human body to adapt to the environment. This study adopts Wang Jiaming's (1999) theory of physical fitness composition in competitive sports, which divides physical fitness into three aspects: body shape, body function, and sports quality, with the aim of improving athletes' sports performance.

2.1 Body shape: Refers to the external shape and characteristics of the human body, is the most basic and important sign to measure the level of human growth and development, to a certain extent reflects the growth and development of the human body and the health of the body. Body shape indicators are generally represented by overall indicators (height, weight and chest circumference), length indicators, width indicators and circumference indicators and their relationships. The body shape measure indexes in this study mainly included height, weight, BMI, percentage of body fat, standing touch height etc.

2.1.1 BMI (Body Mass Index): Body mass index, referred to as body mass index, is a standard commonly used in the world to measure the degree of body fat and fitness. The formula is BMI= weight ÷ height ^{2}. (Weight unit: kg; Height in meters). In this study, Visbody will be used to measure BMI of basketball players.

2.1.2 Percentage of body fat: Refers to the proportion of body fat in the total body weight, reflecting the amount of fat content in the body, and has guiding

significance for health. In this study, Visbody will be used to measure the body fat percentage of basketball players.

2.2 Body function: Refers to the whole human body and its constituent organs and systems of life activities. Body functions reveal the phenomena, processes, basic laws and mechanisms of normal functional activities of the human body from the whole level, organ and system level, cell and molecular level, and clarify the influence of internal and external environmental changes on life activities. This study is mainly evaluated from the aspects of vital capacity and heart rate. Heart rate includes quiet heart rate, maximum heart rate and exercise heart rate during 17 turns back run.

2.2.1 Vital capacity: It refers to the amount of gas that a person can exhale with maximum exhalation after inhaling deeply. In this study, TZCS-3 electronic Vital capacity tester (China) will be used to measure the vital capacity of basketball players.

2.2.2 Heart rate: It refers to the number of beats per minute of the human heart. In this study, Polar H10 Heart rate monitor (China) will be used to measure the exercise heart rate of basketball players.

2.3 Sports quality: It refers to the various motor abilities displayed by the body during exercise. Includes the muscle strength, power, speed, endurance, agility, flexibility and other abilities exhibited by the human body during sports, which is the foundation for mastering sports techniques and improving sports performance.

2.3.1 Muscular strength: Refers to the ability of the human body or a muscle in a certain part of the body to overcome resistance when working. In this study, bench press 1RM was used to measure the maximum upper limb strength of basketball players, and squat 1RM was used to measure the maximum lower limb strength of basketball players.

2.3.2 Power: Explosive power, refers to the ability to exert force during an explosive action or a group of powerful sudden movements, mainly generated by rapid muscle contraction. In this study, the explosive power of the upper limbs of basketball players is measured by both hands' chest pass gravity ball, and the

explosive power of the lower limbs is measured by standing long jump, Vertical jump height with both feet and Jump height on one leg in the run-up.

2.3.3 Speed: Refers to the ability of the human body to move rapidly. In this study, the speed of basketball players was measured by sprint run in 3/4 basketball court.

2.3.4 Endurance: Refers to the ability of the human body to carry out muscle activities for as long as possible, endurance can also be seen as the ability to fight fatigue. Endurance quality refers to the ability of the body to maintain a specific intensity load or movement quality for a certain period of time.

2.3.4.1 Aerobic endurance: Refers to the ability to perform aerobic energy supply work for a long time. Its load intensity is 75% to 85% of the maximum load intensity of the human body, and the heart rate is generally 110 to 150 times/minute. The time is at least 5 minutes, usually more than 15 minutes. The physiological factors that determine the aerobic endurance of the body are mainly the oxygen supply factors and the glycogen content as energy substances during exercise.In this study, the anaerobic endurance of basketball players was measured by 17 turn back run on the basketball court.

2.3.4.2 Anaerobic endurance: Refers to the working ability of muscle contraction to supply energy for a long time under the condition of hypoxia. It is often carried out by the method of repetitive exercise with short duration, maximum exertion and short rest. In this study, 3200 meters were used to measure the aerobic endurance of basketball players.

2.3.4.3 Muscular endurance: Refers to the ability of muscles to overcome resistance for a long time. The evaluation of strength and endurance often adopts the method of repeatedly completing simulated actions in competitions and is evaluated based on the number of repetitions performed by athletes. In this study, 90 seconds bench press is used to measure the upper body strength endurance of basketball players, and 90 seconds squat is used to measure the lower body strength endurance of basketball players.

2.3.5 Agility: refers to the ability of the human body to quickly, harmoniously, nimbly and accurately complete actions under a variety of suddenly changing conditions. It is the comprehensive performance of people's motor skills, neural responses and various physical qualities. In this study, T-test and hexagon jump were used to measure the agility of basketball players.

2.3.6 Flexibility: refers to the range of motion of each joint of the human body and the stretching ability of soft tissues such as muscles, tendons and ligaments. Good flexibility can reduce the chance of muscle and ligament damage to a certain extent. In this study, the flexibility of basketball players was measured by sit and reach.

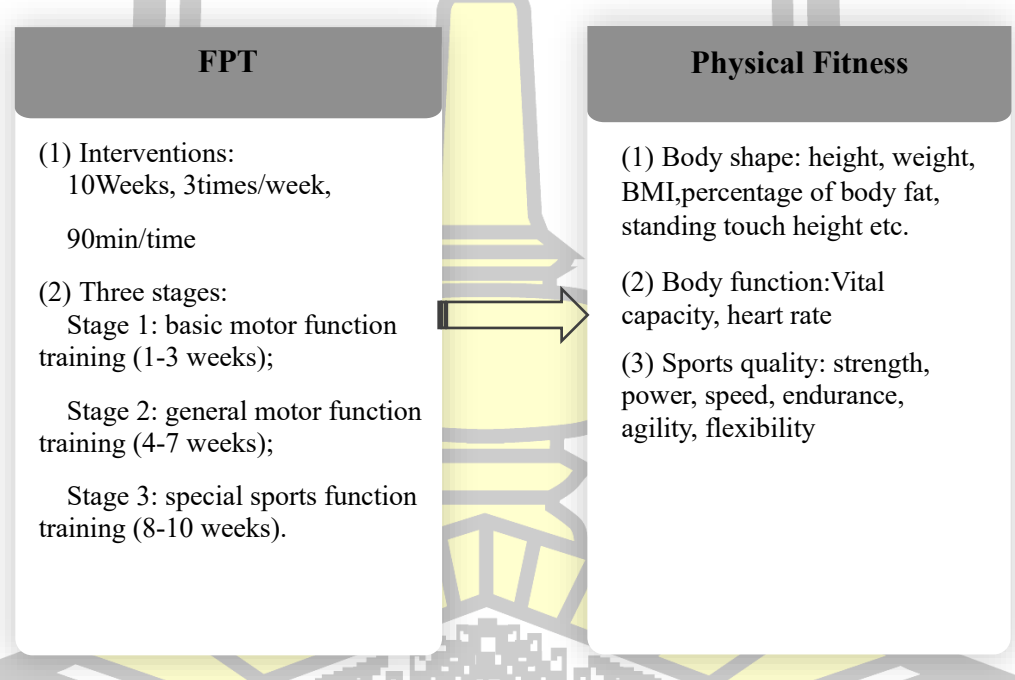


Figure 1 Research framework

CHAPTER II
REVIEW OF RELATED LITERATURE

The main purpose of this chapter is to sort out literatures related to physical fitness, physical characteristics of basketball players, physical evaluation indicators of basketball players, functional physical training, etc., apply the functional physical training pyramid model (Yan Qi, 2013), and combine the training methods of functional physical training in different fields with the physical characteristics of college basketball players. To design a set of functional physical training methods suitable for college basketball players.

1. Research on Physical Fitness

Through the Document retrieval and analysis of CNKI literature and Web of Science core collection, it is found that the research on physical fitness training is mainly concentrated in the United States, Australia, Britain, Germany and other countries and regions, and physical fitness research in colleges and universities is the forefront. As early as 1978, the United States established a non-profit physical fitness training and education institution, the American Physical Fitness Association, with members in 62 countries and regions around the world. Germany is also a country that attaches great importance to physical fitness training. They regard physical fitness training as a precise and refined system engineering, placing it in an important position.

Gong Yilin (1995), a Taiwan scholar, believes that physical fitness can be divided into competitive physical fitness and healthy physical fitness. Competitive physical fitness refers to the physical (fitness) ability required by athletes to pursue excellent athletic results in competitive competitions. Physical fitness is the physical fitness required to promote health, prevent disease and improve the efficiency of daily life and work, including cardiorespiratory endurance, muscle strength, muscle endurance, flexibility, and body fat percentage.

According to Wang Jiaming (1999), physical fitness is the comprehensive ability of human body in the Adapted process to the environment. Physical fitness includes two levels: healthy physical fitness and competitive sports physical fitness. Healthy

physical fitness refers to the body's ability to adapt, exercise, and function states, with the goal of improving health and basic living abilities. Competitive sports physical fitness refers to the comprehensive qualities required by athletes to complete competitions, including body shape, body function, and sports quality. It aims to improve sports skills and create excellent sports results.

American Exercise physiologists W. Larry Kenney, Jack Wilmore and David L. Costill (2004) talk about the relationship between physical fitness and body composition in Physiology of Sport and Exercise. William A. Kraemer and David R. K. L. (2013) et al., Exercise Physiology: Integrating Theory and Application further discusses the relationship between physical fitness and body composition in exercise physiology, concluding that excessive body fat may have a negative impact on physical fitness, and optimizing body composition is crucial to improve physical fitness level.

Physical fitness is the basic athletic ability of the human body manifested through physical qualities such as power, speed, endurance, coordination, flexibility, and agility, and is an important component of an athlete's competitive ability. The level of physical fitness is closely related to the morphological and functional characteristics of the human body. The morphological characteristics of the human body are the qualitative basis of its physical fitness, while the functional characteristics of the human body are the biological functional basis of its physical fitness (Tian Maijiu, 2012).

Hartman, a famous German training expert, and others believed that physical strength is a kind of exercise ability that is based on the energy metabolism activities of the human body and is displayed through the nerve Muscular system. From a biochemical perspective, the physical fitness of athletes depends on their ability to integrate energy supply, transfer, and utilization during the exercise process.

In sports, physical fitness, that is, physical competitive ability, is one of the most important structures in the overall structure of athletic ability. General physical ability refers to the physical state manifested by different dimensions such as the athlete's body shape, body function and sports quality. The narrow sense of physical fitness, also known as special physical fitness, refers to the athlete's ability to bear load and

adapt to environmental changes in sports, and is the comprehensive embodiment of the athlete's body shape, body function, sports quality and health level (Zhao Zifu, 2022).

To sum up, this study selects Wang Jiaming (1999) 's physical constitution theory of competitive sports, which divides physical fitness into three aspects: body shape, body function and sports quality (figure 2), with the purpose of improving athletes' sports performance.

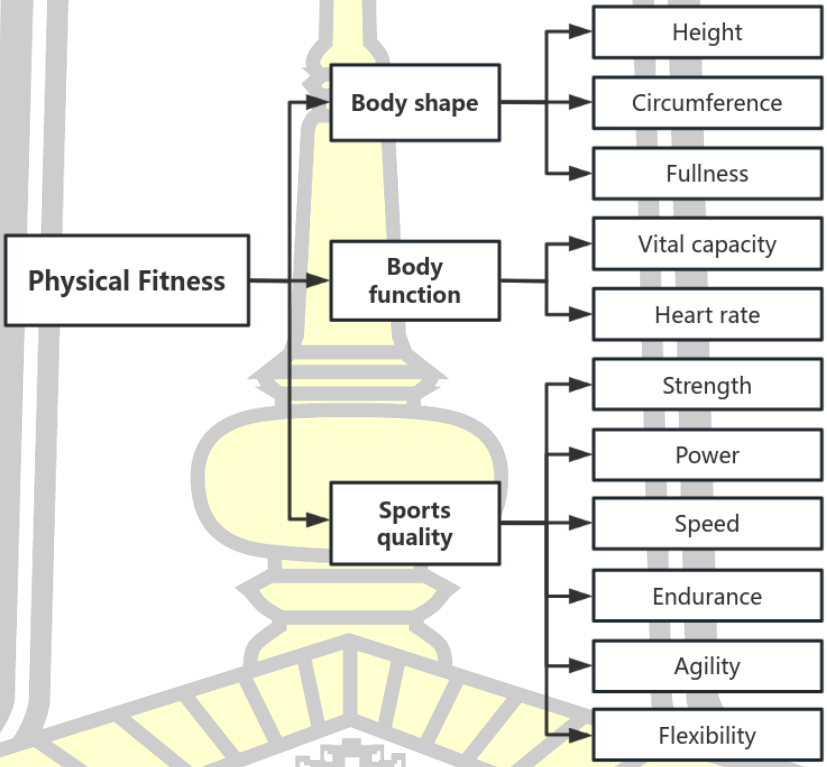


Figure 2 Composition of physical fitness

2. Research on physical fitness of basketball players

Basketball is a sport of high intensity, short interval and long duration (Liu Xinzheng, 2006). In modern basketball games, the players have frequent physical contact and collision, and the physical confrontation is strong, and the competition for the ball right is particularly fierce in the air and on the ground. This puts higher demands on athletes' physical fitness (Narazaki K, Berg K, Stergiou N, et al., 2009).

2.1 Characteristics of Basketball Sports

Basketball is a sport with high intensity, short intervals, and a longer duration (Liu Xinzheng, 2006). In modern basketball games, athletes have frequent physical contact, frequent collisions, and high physical intensity. The competition for ball rights is particularly fierce both in the air and on the ground, which puts higher demands on athletes' physical fitness (Narazaki K, Berg K, Stergiou N, et al., 2009). Basketball differs from other sports in that it is a dual line competition between space and ground, as well as time and speed, centered around the hoop in the air. Its important characteristics are high-altitude, instantaneous, adversarial, versatile, three-dimensional, and ornamental (Yang Hua, 2001). Basketball is a speed, strength, adversarial physical fitness, and skill-based event aimed at shooting and scoring, with fast and varied attack and defense (Wang Baocheng, 2001). This article analyzes the project characteristics of basketball from several aspects, such as time characteristics, spatial characteristics, and energy supply characteristics, based on the needs of studying physical fitness training.

2.1.1 Time characteristics

When the human body is exercising, energy metabolism and recovery are closely related to exercise time. From the perspective of physical training, the time characteristics of basketball are mainly reflected in the following aspects.

Firstly, the certainty of the total competition time and the uncertainty of the segment time. According to the basketball rules of the International Basketball Federation, a basketball game has a net time of 40 minutes, divided into 4 sections, with 10 minutes for each section, 2 minutes for interval breaks, and 15 minutes for halftime breaks. If there is a draw, an extra time game will be played, with 5 minutes for each extra time game. These times are relatively certain, and it takes about 90 minutes to complete a game. But there are too many segments of time, such as pauses, substitutions, violations, fouls, and rule restrictions of 3 seconds, 5 seconds, 8 seconds, and 24 seconds. Every whistle from the referee must be stopped, and the time of these game segments is uncertain, ranging from a few seconds to a few minutes.

Secondly, the instantaneous nature of technical and tactical application. In basketball games, the transition between attack and defense is fast, and physical confrontation is strong. In the game, the development of the situation is fast changing, and the best time for attack and defense is often fleeting. The strategies of both attack and defense are constantly changing, all of which determine the instantaneous nature of basketball technical and tactical application.

Thirdly, the mobility of athletes' playing time. The number of substitutions in basketball matches is unrestricted, and modern basketball games are becoming increasingly fierce. Full participation and frequent substitutions have become important features of modern international basketball games. At the same time, the role of core players is becoming increasingly prominent, and the playing time has specific mobility.

2.1.2 Spatial characteristics

The spatial characteristics of sports events determine their requirements for the physical form of athletes. For example, weightlifters need to be shorter in height and have slightly shorter limbs; Volleyball players need to be tall and have long limbs. From the perspective of physical training, the spatial characteristics of basketball are mainly reflected in the following aspects.

Firstly, confront the three-dimensional nature of space. The height of the 3.05 meter hoop determines the position of high-altitude advantage in basketball, and techniques such as rebounding, shooting, catching shots, and blocking all require high-altitude advantage. Basketball matches belong to the same competitive event, with frequent physical contact and intense physical confrontation, which puts forward higher and more comprehensive requirements for basketball players' height, weight, strength, sensitivity, etc.

Secondly, the ambiguity of players' positions on the field. Due to the limitations of the size of the basketball court, although athletes have a division of positions before entering the game, their positions on the court are relatively blurred during actual matches. In modern basketball games, we often see inside players pulling to the outside to attack, and outside players breaking through to the inside to attack. These

put forward higher requirements for basketball players' movement speed, starting speed, movement speed, and endurance.

2.1.3 Energy supply characteristics

Famous American basketball coach Bob Knight believes that basketball is a highly anaerobic sport, with 85% of energy consumption mainly coming from the anaerobic system (Bob Knight et al., 1998). Mclnnes et al. further pointed out that in basketball, the glycolytic system function accounts for a larger proportion. He believes that in basketball games, short duration actions such as fast break layups, jumps, shots, dribbles, and rebounds mainly rely on ATP conversion to CP function. However, this energy supply system can only supply 10-15 seconds and will be used up. During continuous offensive and defensive conversion, the glycolytic system function is mainly relied on. The metabolism of competitive ball games such as football and basketball is based on the anaerobic decomposition and aerobic re synthesis of high phosphate compounds, with non-lactic acid anaerobic metabolism and aerobic metabolism as the main characteristics (Tian Maijiu, 1998).

2.2 Sports quality requirements for basketball

Sports quality plays an important role in physical fitness and is the ability exhibited by athletes in sports. In a fierce competition, athletes must constantly run, get rid of, slide, jump, and steal the ball quickly, and complete difficult technical movements under complex conditions. Therefore, excellent basketball must comprehensively develop strength, bounce, speed, endurance, agility, and flexibility. Whether athletes can complete competitions and achieve victory in a fast-paced and high-intensity competitive environment depends on their own physical fitness (Wang Weixing, 2003).

2.2.1 Strength

Strength is the ability of muscles to contract and overcome resistance, including maximum strength, explosive power, and strength endurance. Strength is a direct reflection of the physical fitness of basketball players (Chen Jixin, 2019). Basketball techniques are divided into offensive and defensive techniques. The core quality of basketball strength training is explosive power, which is suitable for upper limb strength exercises such as forward push, backward pull, lift, and pull down. The

kicking strength of the lower limbs is particularly important for basketball specific techniques (Liao Kaikai, 2018).

Maximum strength is the ability of muscles to overcome extreme load resistance during maximum contraction. The center forward requires a relatively advantageous position in the narrow space of the three second zone, and often needs to compete with the opposing player for absolute strength. Most of the world's top centers are tall and burly. Except for the center forward, players in other positions also need varying degrees of absolute strength to increase their own adversarial ability. Research has confirmed that there is a positive correlation between the size of body strength and body weight (Iatridis P. G., 1991).

Fast power refers to the ability of muscles to quickly exert their strength in a short period of time, and power is a common manifestation of rapid strength. In basketball, the vast majority of technical and tactical movements are completed with speed, such as breakthroughs, jumps, jump shots, and quick stops, all of which belong to the category of explosive power. The control of the load and intensity of strength training is crucial for improving explosive power. If expressed as a percentage of maximum force, it is generally believed that the load intensity of fast force should be 60% to 75% of the maximum load weight, the load of maximum force should be 80% to 100% of the maximum load weight, and the load of strength endurance should be 40% to 50% of the maximum load weight (Tian Maijiu, 2000). If expressed in RM, the appropriate load intensities for developing rapid strength, maximum strength, and strength endurance are 10-15RM, 1-5RM, and 20-30RM, respectively (Li Shiming, 2006).

Strength endurance refers to the ability of muscles to resist resistance contraction for a long time. It includes both the duration of the athlete's sustained contraction against a certain resistance and the maximum number of repetitions to repeat a certain load. In addition, whether the strength and speed of muscle contraction can be better maintained after fatigue is also a reflection of strength and endurance qualities. The average movement of world-class basketball players per game is 5000m, and the average movement distance of outstanding power forwards who play the entire game can reach 6000m, while the shooting guard is around 6400m. Players in each position

move at an average of 50 - 80% of their maximum speed during the game. The takeoff frequency of outstanding athletes on the field ranges from 1.6 - 2.2 beats per minute (Mi Jing, 2008). Under this intensity of stimulation, the fatigue of the athlete's sports system occurs earlier than that of the respiratory and nervous systems, and the degree of fatigue is deeper. Insufficient strength and endurance can lead to a decrease in athletic ability and deformation of technical movements in the second half of the competition, resulting in missed victories.

When analyzing the shooting accuracy rate, Li Hang conducted upper limb strength training with instruments or bare hands on the experimental group. The results showed that upper limb strength training can improve the shooting accuracy rate, proving that upper limb strength training can have an impact on the shooting accuracy rate (Li Hang, 2006).

Strength quality is a fundamental quality in basketball, playing an important role in the development of specialized techniques and abilities such as shooting range and jumping height. When basketball players have good specialized strength quality, they can gain the upper hand in fierce confrontations, and thus complete technical movements to gain competitive advantages (Liu Jinbo, 2005). At the same time, the improvement of strength quality can drive the development of other qualities, strengthen muscle rigidity to reduce the risk of sports injuries, and also enhance athletes' confidence, helping them better display their technical and tactical skills on the field (Hu Faxin, 2011).

2.2.2 Speed

Speed refers to the ability of the human body to move rapidly. The specific speed qualities of basketball players include running speed without the ball and holding the ball, displacement, attack defense conversion, and retreat defense (Dong Yilin, 2020).

In a series of actions such as attacking and defending, speed plays a crucial role. By adopting effective speed, basketball players can occupy advantageous positions and effectively capture the ball. From this, it can be seen that speed occupies an indispensable position in basketball. Unlike the sprint speed of track and field athletes, the specialized sprint speed of basketball players not only needs to pay attention to breaking through the defender, but also needs to pay attention to keeping

up with the attacker. Therefore, basketball players should always pay attention to the opponent's movements during the sprint and make accurate responses according to the situation (Dong Wenqi, 2015).

2.2.3 Endurance

Endurance refers to the ability of the body to maintain a specific intensity load or movement quality for a certain period of time, which includes aerobic endurance and anaerobic endurance. A basketball game requires athletes to be able to perform offensive and defensive transitions, continuous foot movements, and multiple jumps in a short period of time, as well as maintain high performance from the beginning to the end in a 40 minute game, such as stability in shooting, accuracy in passing, and suppressive defense. This places high demands on the endurance of basketball players (Zheng Gongying, 2022).

In modern basketball games, players need to have good, specialized endurance due to their long playing time, fast offensive and defensive transitions, intense confrontations, and small playing fields. The speed endurance of repeated short distance sprints or sprints with irregular intervals. Basketball sports contain a large number of actions that can be completed under extreme sports intensity, such as accelerating breakthroughs, grabbing rebounds, making quick stops and jumping shots, and pressing defense, all of which require good anaerobic endurance. In endurance training, anaerobic endurance should be combined with aerobic endurance, which is the foundation for training anaerobic endurance. To arrange the training sequence reasonably, prioritize the development of aerobic endurance, and on this basis, focus on improving the level of anaerobic endurance (Liu Qingshan, 2004).

2.2.4 Agility

Agility refers to the ability of the human body to quickly, coordinate, agile, and accurately complete movements under various sudden changes. It is a comprehensive expression of human motor skills, neural responses, and various physical qualities. In basketball games, athletes need to make timely judgments based on the situation on the field, adjust their body position and direction of movement quickly, and choose reasonable technical actions to adapt to the constantly changing environment on the

field. Therefore, basketball players need to possess sufficient agility in order to gain an advantage in the game.

The specific characteristics of basketball specialized agility are as follows: athletes can make quick and reasonable responses to their position, direction, and route of movement based on the specific situation on the field in a timely manner; Be able to flexibly apply various skills and utilize one's own advantages to gain initiative on the field (Pan Liping, 2000). Sensitivity training can improve the level of side running and sliding running in basketball footstep movement, as well as improve the speed of retreat and turning (Wang Guoqing, 2015). Good agility can improve athletes' physical control and responsiveness in both offense and defense. Sensitivity is an important supplement to strength and speed, and the agility of athletes should develop together with strength and speed.

2.2.5 Flexibility

Flexibility refers to the range of motion of various joints in the human body and the stretching ability of soft tissues such as muscles, tendons, and ligaments. Good flexibility can to some extent reduce the likelihood of muscle and ligament damage. When athletes perform specialized technical movements, the standardization and degree of stretch of the movements are influenced by their flexibility. At the same time, a low level of flexibility will restrict the development of athletes' other qualities and also bring a high risk of sports injuries (Wang Daocheng, 2018).

Basketball specific flexibility training can help athletes improve their performance level, expand the range and amplitude of their movements, refine their movements, strengthen various physical fitness, improve muscle recovery efficiency (Huang Zongwei, Liu Runling, 2009), and also protect muscles, ligaments, joints, and their structures from damage under heavy loads.

In summary, a high-intensity, fast-paced basketball game requires athletes to possess excellent specialized qualities and physical reserves.

2.3 Physical fitness characteristics of basketball players in different positions

The characteristics of modern basketball, such as fast pace of attack and defense conversion, strong physical confrontation, and long shooting distances, further

highlight the development trend of "higher, faster, and stronger". Basketball players must possess core competitive qualities such as skills, physical fitness, tactics, psychology, intelligence, and highly coordinated development in order to maximize their technical and tactical abilities.

The physical fitness of basketball players is based on the three major energy supply systems as the foundation of energy metabolism activities, and the exercise ability displayed through the activities of skeletal muscles. The level of physical fitness of athletes is determined by three aspects: body shape, body function, and sports quality. Body shape and body function are the material foundation, and sports quality is the external manifestation of physical fitness. At present, research on the physical fitness structure characteristics of basketball players is mainly conducted from three aspects: athlete body shape, body function, and sports quality, revealing the characteristics of basketball player physical fitness structure through specific indicators (Liu Qingshan, 2004).

The basketball game is jointly completed by five players on the court, divided by position, including guard (point guard (PG), Shooting guard (SG)), forward (small forward (SF), power forward (PF)), center (C). Each position has a different division of labor, which not only performs its own duties, but also cooperates with each other to complete the offensive and defensive tasks in the basketball game, so as to win the game for the team.Each team member's position on the field is different, and their body shape, competition load, body function, and sports quality requirements are also different. So in basketball specialized physical training, it is necessary to systematically arrange according to the position characteristics of athletes on the field, have a clear understanding of the physical needs of basketball players in different positions, and improve them targeted during the training process in order to better improve the physical training level of basketball players and create excellent game results (Sun Lekun, 2017).

2.3.1 Body shape characteristics of basketball players in different positions

Body shape refers to the external shape and characteristics exhibited by a person during their growth and development. Indicators that reflect external shape characteristics include height, sitting height, arm length, hand length, leg length,

muscle circumference, etc., while indicators that reflect internal shape characteristics include longitudinal diameter of the heart, bone age, muscle shape, etc. (Zhao Yanping, 2012). Body shape is closely related to sports performance, and different events have different requirements for body shape. Body shape to some extent reflects the level of body function and competitive ability, and to some extent affects the development of sports quality (Yang Shiyong, 2013). Height, weight, and Kleto index can reflect the body's physical structure, growth and development level, as well as the body's fullness. Jin Huijuan, Zhang Song, and others analyzed the body shape of men's basketball players in different positions at the 29th and 30th Olympic Games. It can be seen that the body shape of outstanding basketball players in the world today has positional characteristics. The height, weight, and Krato index of center forward players are higher than those of forward players, while the height, weight, and Krato index of forward players are higher than those of guard players (Jin Huijuan et al., 2009; Zhang Song et al., 2014).

The "Event Group Training Theory" edited by Mr. Tian Maijiu describes the morphological characteristics of basketball players in the same field against ball events as "tall, robust, with slender and elastic muscles, thin fat layer, tight and adducted buttocks muscles, small ankle circumference, clear Achilles tendons, and high arches". Basketball is a game of giants, and height is a very important condition for basketball players to join the world's top teams, and height also plays an important role in games (Shen Changgeng, Shen Fu, 2007). Jin Huijuan et al. conducted statistics on the height of athletes from the top 8 countries in men's basketball at the 29th Olympic Games and found that the average height of athletes reached 201.3cm (Jin Huijuan et al., 2009).

The position of the center forward is mainly concentrated in the area under the basket, with the highest intensity of confrontation and the most intense competition for ball rights. Therefore, an excellent center must have a tall physique, strong body, and even a more agile pace, reasonably lean on the opponent's players and limit their shots during defense, make reasonable blocks and picks for their own team members during attack, and make shots during close defense by the opponent. Therefore, broad shoulders and well-developed shoulder, back, and buttocks muscles are essential physical conditions for an excellent center (She Yanli, 2013). Research has shown that

the average height of center players in the top 8 men's basketball teams at the 29th Olympic Games reached 211.7cm, while the average height of center players in the top 8 women's basketball teams also reached a height of 195.1cm. Defenders are the soul figure on the basketball court. An excellent defender needs to possess comprehensive offensive and defensive skills, as well as excellent command and organizational skills. Defenders are generally lower in height than centers and forwards. Chen Qingwei conducted statistics on the height of defenders participating in the men's basketball team at the 29th Olympic Games. There were a total of 58 guards from 12 teams participating in the competition, ranging in height from 1.80 to 2.05m (Chen Qingwei, 2009).

Body shape is the foundation of physical factors such as physiological function and athletic fitness, and basketball players in different positions have different needs for their body shape. The analysis of the body shape of basketball players in different positions can fully understand the body shape characteristics of different positions, which is of great significance for the selection of athletes and the improvement of their sports quality.

2.3.2 Body function characteristics of basketball players in different positions

A series of physiological changes in the human body during exercise are an objective response of the body to the exercise load it bears. Therefore, the analysis of basketball players' physiological functions should be based on the characteristics of game load. The position and role of basketball players on the court are different, and the load they bear in the game has obvious position characteristics. In a fiercely contested game, the average moving distance of the defender is greater than that of the forward, and the forward is greater than the center. Moreover, there are differences in the movement speed and intensity of players from different positions in the game. The maximum speed of defenders in the game can reach around 8 m/s, which is significantly higher than that of forwards and centers. The proportion of high intensity movement of centers is significantly lower than that of forwards and guards (McInnes S., 1995).

The role of basketball players on the field is significantly related to the region, and the regional characteristics of the game load show positional differences. The guard moves the most frequently throughout the court, and bears an average amount of exercise load in various positions throughout the court; The main load-bearing area of the center is in the three second zone, which is related to the high-intensity confrontation under the basket; The forward is between the inner and outer lines and bears a heavy load near the three-point line (Ning Qingxin, 2011). Competition load is the sum of various stimuli exerted on the athlete's body by the synthesis of various relevant factors in the competition. Competition load is an important content that reveals the essential characteristics of the competition, and also objectively reflects the physiological needs of athletes in the competition (Sun Lekun, 2017).

Related studies have shown that there is a certain linear correlation between heart rate and exercise intensity. Vaquera's study on the heart rate response of athletes in five matches of LEB Club in the Spanish league showed that athletes from different positions showed obvious positional characteristics in the change of game center rate. Both the maximum and average heart rates show that the defender is greater than the center forward, and the center forward is greater than the forward. The heart rate of the center forward is higher than that of the forward, which may be related to the center's high-intensity confrontation under the basket in the game (Vaquera, 2008). Heart rate varies greatly among individuals, so it is often measured to reflect the intensity of exercise.

Rodriguez Alonso et al. studied the heart rate characteristics of Spanish national women's basketball players (including point guards, forwards, and centers) in ten matches. The results showed significant differences in heart rate characteristics among players from three positions. The guard has 185 ± 5.9 beats per minute, the forward has 175+11 beats per minute, and the center has 167 ± 12 beats per minute. Compared to the three positions, the guard has the highest load intensity (Rodriguez Alonso et al., 2003).

Dionne Matthew et al. studied the heart rate characteristics of elite female basketball players during competition, using them as subjects. The results showed that throughout the total time of the competition, the average heart rate was 165 ± 9 beats

per minute (89.1% of the maximum heart rate); Within the effective competition time (live time), the average heart rate is 170 ± 8 beats/minute (92.5% of the maximum heart rate). It was also found that the average heart rate in the first half was significantly higher than that in the second half ($P<0.05$).

Although measuring heart rate values can estimate intensity and energy expenditure, there are also other factors that can affect the accuracy of the results. Because heart rate is not only influenced by exercise intensity and duration, but also by many psychological factors (arousal and anxiety) (Xu Jianhua, 2011).

Blood lactate is a commonly used indicator for evaluating anaerobic metabolic capacity and exercise intensity. Understanding the changes in blood lactate of athletes in basketball matches is of certain significance in reflecting exercise intensity and energy metabolism. Rodriguez Alonso, Ben Abdelkrim, and Castagna conducted research on the placement of female and male players (defenders, forwards, and centers), respectively. The results showed significant differences in blood lactate levels among the three positions, with the average blood lactate levels of defenders significantly higher than those of centers (Rodriguez Alonso et al., 2003, Ben Abdelkrim (2010), and Castagna et al. (2006)).

The maximum oxygen uptake reflects the body's ability to inhale, transport, and utilize oxygen, and is one of the important indicators for evaluating the body's aerobic working ability. Audrius Gocentas conducted VO2max tests on 144 players in the Belgian Serie A league, and the results showed significant differences in different positions. The maximum oxygen uptake of defenders was higher than that of forwards, while the maximum oxygen uptake of forwards was higher than that of centers (Audrius Gocentas, 2011). Yusuf Kokl ü et al. tested the maximum oxygen uptake of athletes at different positions in the Türkiye professional league, and the results showed that the guard was greater than the forward and center, and there was a significant difference ($P<0.05$) (Yusuf Kokl ü, 2011).

The energy metabolism characteristics of basketball players in different positions also vary. Basketball is intermittent, indicating that it is an aerobic and anaerobic mixed energy supply sport. Bob Knight, a famous American basketball coach, believes that basketball is a high-intensity Anaerobic exercise, and 85% of the energy

consumption mainly comes from the anaerobic metabolic system. Mclnnes et al. further pointed out that the anaerobic glycolysis system accounts for a larger proportion of energy supply in basketball. He believes that in basketball games, key actions with short duration such as fast layups, jumps, shots, dribbles, and rebounds mainly rely on CP conversion to ATP for energy supply; But this energy supply system can only supply for 10-15 seconds and will be used up. During continuous offensive and defensive transitions, it mainly relies on the sugar anaerobic fermentation energy system for energy supply (Mc lnnes et al.,1995)

The energy supply of basketball is mainly the ATP CP system, assisted by Glycolysis system and aerobic oxidation system. The original phosphate system has a short energy supply time (6-8s) and high output power. In basketball, in intense one-leg confrontations, marking defense, offense, fast break layups, and even dunks are all done by the body through explosive force in a short period of time, high intensity, and speed. This single round high-intensity exercise fully integrates the energy supply characteristics of the phosphate system. At the beginning of extreme exercise, the Glycolysis system (lactic acid energy system) can participate in energy supply, and the maximum power can be reached in about 30s, which can be maintained for 1~1.5min. In the fierce competition, the fast and continuous attack and defense conversion and full court press will exceed 15s, at this time, the Glycolysis system is required to supply energy. In a game, athletes rely on aerobic oxidation to provide energy by using tactics such as slow or fast running, moving back to defense, etc. The aerobic oxidation system is the main energy source for long-term exercise, with the time up to 1-2 hours, and the power is only half of that of the Glycolysis system.

The energy metabolism characteristics of basketball players in different positions also vary. Basketball games have the highest requirements for the glycolytic energy supply ability of defenders, while forwards have high requirements for anaerobic endurance. Training can improve the energy supply ability of forwards during high-intensity short distance movements, while centers need to strengthen their aerobic metabolism training (Sun Lekun, 2017).

Based on the intermittent characteristics of basketball, during the game, players' standing, walking, and jogging activities during effective time, as well as game

interruptions caused by fouls, substitutions, pauses, etc., are in the recovery stage. The most obvious sign is a significant decrease in heart rate and oxygen consumption. At this stage, the oxygen debt owed by the organization is promptly replenished, and the ATP and PC consumed in the body will also be quickly restored (Xu Jianhua, 2011).

In a word, basketball players from different positions have different roles as guards, forwards, and centers on the field, resulting in differences in their game load and physiological functions. The proportion of energy supply varies among different methods. Therefore, in training, it is necessary to differentiate between their positional differences and personality characteristics, and then conduct targeted training.

2.3.3 Sports quality characteristics of basketball players in different positions

When conducting specialized physical training for basketball players in different positions, the following principles should be followed: treating different court positions differently (guard, forward/forward, inside/center); Treat different training parts and different power generation modes differently (upper limbs, lower limbs, core, etc.); Treat different physical conditions differently (height, weight, arm span, etc.).

In basketball games, the center is generally located in the area under the basket where there is a high intensity of offensive and defensive confrontation, frequent collisions, and intense competition. In order to gain inner line position and aerial advantage, an excellent center must have a strong, tall, sturdy body, sufficient strength, and flexible foot movements in order to occupy a favorable position when competing for rebounds, squeeze the opponent in defense, and reasonably limit their takeoff movements, accurately shoot while closely pressing in the attack (She Lihua, 2013). Research has shown that world-class center forward players need to jump more than 100 times on average and run around 5500 meters in a game (Liu Xinzheng, 2006), which is a huge test for the lower limb strength, physical energy supply, and neural endurance of tall individuals. Therefore, from the perspective of the main attack and defense areas and technical application characteristics of the center, it is necessary to possess explosive power of short distance movement and continuous takeoff, as well as the ability to complete technical and tactical coordination in strong

confrontations, and even the speed ability to participate in fast attacks and rapid defense.

The offensive and defensive range of a forward in a game is relatively large, requiring a movement of about 6000 meters to complete the entire game, with explosive jumps of over 100 times. Among them, the power forward takes off about 50% of the time in a confrontation (Chi Jian et al., 2007). Excellent forward players require comprehensive skills, fast speed, and the ability to attack and defend well. When the intensity of attack and defense is high, some technical and footwork movements can be completed quickly, and sensitive reactions, explosive power, and adversarial ability become the key to winning.

The height of the guard is generally lower than that of the forward and center. In terms of body function and athletic ability, the guard should have quick adaptability, explosive force, frequent short distance acceleration, direction change and sudden stop. And the guard is the soul of the Basketball court, not only to have comprehensive offensive and defensive skills and tactics, excellent organization and command ability. In a game, a defender, compared to a forward or center, has a larger range of movement, the farthest movement distance, and a higher frequency of shifting and changing direction.The study by Chi Jian et al. on the movement characteristics of male athletes at the World Championships shows that excellent attacking defenders need to move around 6400 meters throughout the entire field in matches of comparable strength, The maximum movement speed of an excellent center forward can reach around 7.3m/s, the maximum movement speed of a forward can reach around 7.6m/s, and the maximum movement speed of a defender can reach around 8m/s. During the playing time, the takeoff frequency of excellent athletes ranges from 1.6～2.2 times per minute. (Chi Jian et al., 2007). Ben Abdelkrim et al.'s Studied the matches of Tunisian elite youth players, and the results showed that players move once in an average of 1.7 seconds, while all players move an average of (1050 ± 51) times, while defenders reach (1103 ± 32) times (Ben Abdelkrim et al., 2007).

Zeng Sanming studied the characteristics of basketball sports and the structure of basketball players' specialized qualities. Based on different positions of athletes

(defenders, forwards, and centers), he developed a scoring table for the importance of basketball players' sports qualities (as shown in Table 1), believing that basketball players must possess sports qualities such as strength, explosive power, and coordination (Zeng Sanming, 2000).

Table 1 Weighted values of various physical qualities in basketball

Team Position	Strength	Speed	Power	Endurance	Coordination	Flexibility	Agility	Accuracy
Point Guard	5	5	5	5	5	4	5	5
Shooting Guard	5	5	5	4	5	4	5	5
Small Forward	5	5	5	4	5	4	5	5
Power Forward	5	4	5	4	5	4	4	5
Centre	5	3	5	4	5	4	3	5

2.4 Research on physical fitness evaluation indicators of basketball players

Scientific physical fitness testing and evaluation indicators provide a good reference basis for athlete selection and specialized training. RW Latin surveyed 473 male athletes participating in the NCAA first tier league to investigate their height, weight, body composition, strength, speed, flexibility, aerobic ability, and explosive power. The test items include height, weight, percentage of body fat, maximum 1-RM bench press, maximum 1-RM square, 40 foot sprint, agility, and 1 mile run. Using one-way ANOVA and multiple analyses, the results showed significant positional differences in all indicators except for bench press and 1 mile run. The defender is the shortest in height, lightest in weight, best in bounce, and has the best speed and relative strength; The center forward has the highest percentage of physical fitness but has the worst flexibility and sprint; The forward has the best lower limb strength (RW Latin, 1994).

Yu Shaoyong and Zhao Yinghui used Delphi method, principal component and factor analysis, R-type clustering analysis, and professional logic analysis to qualitatively and quantitatively screen the physical fitness testing methods of CUBA male basketball players designed in the article "Research on Physical Fitness Testing

Methods and Testing Indicators of CUBA Male Basketball Players". Research suggests that the design of physical fitness measurement items and methods should have greater inclusivity and comprehensiveness in the physical fitness to be reflected and should also better reflect the characteristics of basketball sports. They have developed 12 test items as indicators to evaluate the athletic quality of CUBA male athletes, including speed quality: 30m starting run; Half-field turn back running with broken steps; Sensitivity: 5.8m × 6 turn back runs; Run around the pole; Flexibility: orthostatic forward bending; Strength and quality: Upper limbs: sitting posture, hands in front of the chest, passing distance; Waist and abdomen: one minute Sit-up with legs bent; Lower limbs: Standing three level frog jump; Bouncing quality: Run up with one foot jumping to touch high, and jump with both feet in place to touch high; Endurance quality: Speed endurance: Multiple sets of variable distance turn back runs; General endurance: 3200m run. After scientific testing, it was found that the measurement reliability coefficients were all above 0.86, and the effectiveness coefficients were above 0.80 (Yu Shaoyong and Zhao Yinghui, 2005).

Zhou Yong et al. took male college basketball players as subjects, and conducted a Exploratory research on the comprehensive sports quality of college basketball players. Research suggests that the evaluation indicators for athletic fitness include: speed sensitivity, bounce, waist and abdominal strength, speed endurance, aerobic endurance, and takeoff speed. The test methods were half court triangle run, three consecutive vertical jumps, run-up single leg take-off touch height, 1 minute knee flexion Sit-up, multi group full court variable distance turn back run, 3200 m time running (Zhou Yong et al., 2005).

Li Chengliang and Ma Yi believed that the evaluation of basketball players' physical fitness level should focus on the indicators of sports quality, and the athletes' body shape and sports function must be effectively transformed into quality. They also gave six effective indicators of physical fitness, namely, 30 m run, one foot bounce, three-stage frog jump, half court triangle run, variable distance turn back run (Li Chengliang et al., 2007).

Xu Yuanhong and Wang Ge interviewed many experts, scholars and coaches in related fields and analyzed the interview results. They concluded that the best test

items for the special physical fitness of female college basketball players in China were 3200m run, three consecutive vertical jumps to touch the backboard, one foot run-up to touch the height, half court triangle run on the Basketball court, 1min Sit-up, and three groups of full court variable distance turn back runs (Xu Yuanhong et al., 2007).

Lan Yinping selected 3 first level indicators, 9 second level indicators, and 12 third level indicators that effectively reflect the physical fitness level of CUBA women's basketball athletes in her "Research on Physical Fitness Evaluation of CUBA Women's Basketball Players". When conducting physical fitness tests, the selected test indicators mainly include: single and double foot takeoff and touch height; 30 second bench press 20KG barbell; 1 minute Sit-up with bent legs; Full field variable distance turn back running; Run 3200 meters. (Lan Yinping, 2008).

Delextrat, A. Cohen, D et al. explored what physiological factors are the dominant factors affecting the competitive ability of modern basketball players. They tested 8 elite players and 8 regular players in 7 sports qualities. They are vertical jumping; 20 meter sprint; T-type flexibility test; Suicide sprint; 30 second anaerobic test; Equal length contraction force of knee extensor muscles; Maximum horizontal push. The independent sample T-test method was used to analyze the test results of the test data. The results showed that compared with ordinary players, elite players showed significantly better T-test flexibility, maximum peak torque of knee extensor muscles, and maximum bench press, while there was no significant difference in the other three tests. The conclusion is that for modern basketball, players' anaerobic power is much more important than their aerobic metabolic ability. In addition, the author suggests that when carrying out physical training, try not to arrange more than 30 seconds of exercise items, and pay attention to intensity. For example, the sprint distance should be between 5 and 10 meters (Delextrat, A. Cohen, D, etc., 2008).

In order to study the relationship between the position and competitive ability of excellent basketball players, Ben Abdelkrim et al. conducted tests on athletes from three national basketball teams, namely 18 year old, 20 year old, and college students. The test mainly focused on body shape and athletic fitness. The body shape test included height, weight, and body fat ratio tests, while the athletic fitness test included

vertical jumping in place, sprint running, bench press, and other tests that reflected explosive power, jumping power Testing of qualities such as speed and strength (Abdelkrim et al., 2010).

Li Tonghui believes that the first level indicators for evaluating the physical fitness level of national male basketball players include four aspects: physical form, body function, sports quality, and psychological quality; If you want to scientifically evaluate the physical fitness level of basketball players, it should be determined based on the evaluation objectives, training level, and evaluation indicators and weights at all levels (Li Tonghui, 2016).

Long Kun determined specific physical fitness evaluation indicators for college male basketball players based on three indicators: body shape, athletic fitness, and physiological function through questionnaire survey and mathematical analysis, including calf length, upper arm dimension difference, body fat rate, half court triangle running, 1 minute standing and lying support, approach running and touch height, and 10% × 15 meter turn back run, 3m left and right movement × 5 Round trip, Vital capacity/body weight, VO2 max (Long Kun, 2019).

Wang Chenshuang identified 13 test items for physical condition of Beijing CUBA men's basketball players in Comparative Analysis of Physical Condition of Beijing CUBA Men's Basketball Team Players. Body shape test items include height, weight, body fat rate, physiological function test items include Vital capacity and blood pressure, and sports quality test items include 30 meter standing run, weight bearing squat (max), bench press (max), Standing long jump, run-up touch high Sitting posture with forward bending, 1500 meter running, T-test (Wang Chenshuang, 2015). In terms of physical function, the weight of strength is the highest, and flexibility, speed, endurance, and upper limb strength are all important factors affecting physical fitness (Zhao Liang et al., 2020).

American basketball basically represents the highest level of basketball in the world, and the physical fitness testing of various NBA clubs has formed a mature system. Whether it is for the physical testing of rookies or for athletes who recover from injuries during the season, corresponding methods and standards have been developed. The test program includes morphology, biochemistry, genetics, sports

biomechanics, etc. Common indicators include: standard height, standing touch height, weight, body composition (fat%), body circumference (neck, chest, arm), 400m (anaerobic endurance), 2400m run (aerobic endurance), flexibility (sitting forward flexion), muscle strength and endurance (bench press), speed (3/4 court sprint), agility (T-test), explosive force (vertical jump), Basketball court bottom line - bottom line 5 turn back runs (special endurance) The overall explosive power of the body (peak explosive power) and other aspects.After collecting all data, a weight analysis was conducted on the test indicators based on their close integration with the basketball program. High scoring indicators included: body shape test, sensitivity (T-test), speed (3/4 court sprint), and body composition test; The medium quality indicators are: 1 step approach, vertical jump, high touch, overall explosive strength of the body, and 1.5km running; The low-quality indicators include 400m sprint, sitting forward bending, and bench press (Feng Lizheng et al., 2007).

These physical fitness test indicators in the NBA reflect an athlete's most basic athletic ability, and these data play a very important role in athlete selection. At the same time, they have good reference value for the physical fitness evaluation indicators of college basketball players.

In summary, most of the test indicators and methods used in the evaluation of basketball players' sports quality in China are endurance (3200m), speed endurance (variable distance turn back run), psoas and abs (1 min bending Sit-up), lower limb strength (triple breastjump), speed sensitivity (half court triangle run) and bounce (single and double foot bounce); The research indicators for sports quality in foreign countries are more refined and specialized. In summary, there are still shortcomings in the scientific demonstration of physical fitness testing methods for college basketball players in China, and there is a lack of research on distinguishing and evaluating the physical fitness of CUBAL athletes in different positions (defenders, forwards, and centers).

At present, the physical fitness testing of basketball players mainly includes three aspects: body shape, body function, and sports quality. This study combines the characteristics of basketball and previous research, based on the standards of the "Technical and Physical Fitness Testing and Evaluation Manual for Basketball Players

of the China Basketball Association", and referring to the NBA rookie and NCAA physical fitness testing projects, preliminary CUBAL physical fitness testing indicators for this study are proposed, as shown in Table 2

Table 2 Physical fitness testing primary indicators for college basketball players

Level 1 Indicators	Level 2 Indicators	Level 3 Indicators	Testing Instrument
Body Shape	Height	Barefoot height, standing touch height	SGT-A (I) Height and Weight Measuring Instrument (China), measuring ruler.
	Fullness	Weight Koleto index BMI index Percentage of body fat	InBody720 Human Composition Analyzer (Korea)
Body Function	Vital capacity	Forced expiratory volume	TZCS-3 electronic Vital capacity tester (China)
	Heart rate	Quiet heart rate, highest heart rate during YOYO run and 17 turn back run, heart rate immediately after exercise, 1 minute, 2 minutes, and 4 minutes	Polar H10 Heart rate monitor (China)
Sports Quality	Maximum strength	1RM bench press、1RM deep squat	Stopwatch, tape measure, height feeler, barbell combination equipment, box, gravity ball, Yoga mat.
	Power	Standing long jump, Standing triple Jump, Two hands chest pass gravity ball, Vertical jump height with both feet, Jump height on one leg in the run-up	
	Strength endurance	90s bench press,90s deep squat,1 min knee flexion Sit-up, arm flexion plate support	
	Speed	3/4 Basketball court acceleration run, 20m, 30m acceleration run, 28m acceleration run on Basketball court	Brower TCI timing speed tester (USA)
	Anaerobic endurance	Basketball court 17 turn back run, Basketball court see the line turn back run, Basketball court 5.8 m * 6 turn back run, 400 m run	Brower TCI timing speed tester (USA), YOYO Run Test Software
	Aerobic endurance	YOYO Run、3200-meter run	
	Agility and coordination	T-test, 5-10-5 agile running, hexagon jump	Brower TCI timing speed tester (USA), stopwatch
	Flexibility	sit-and-reach, Prone arm lift	Sitting posture forward bending tester

Summary

Basketball is a high intensity sport which is mainly anaerobic, combining aerobic and anaerobic. Basketball players in different positions have different demands on physical fitness. The defender runs the longest distance in the game and needs to have strong explosive power, short-distance acceleration, change direction, emergency stop and so on. The striker jumps the most times and needs to have strong explosive power, reaction ability and confrontation ability. Centers are tall and need to possess great strength and the ability to take off continuously to gain an advantage. The physical fitness measurement indexes of college basketball players mainly include height, fullness, heart rate, vital capacity, upper and lower limb strength, upper and lower limb explosive power, speed, agility, anaerobic endurance, aerobic endurance, upper and lower limb and core strength endurance, flexibility and so on.

3. Research on functional physical training

Functional training originated in the fields of medical rehabilitation and medical research. Therapists train patients by imitating exercise exercises or working from home to help them return to normal life as soon as possible. At present, functional training is gradually penetrating High-performance sport in gyms and rehabilitation centers. In order to be different from other fields, in competitive sport, it is called "functional physical training".

3.1 Definition and connotation of concepts

Gray was the first person to explain the concept of functional training. He pointed out that it is important to emphasize the power chain of the body rather than training certain systems; Physical exercise promotes the improvement of functional exercise patterns and abilities, thereby promoting the improvement of functional skills (Gray Cook ,1997).

Gambetta V. et al. believe that functional training has more forms of training compared to general physical fitness training. The training objectives are based on movements, which can more effectively train specialized sports strength, improve dynamic stability, and enhance overall coordination. Functional training uses a large number of instruments and also combines spinal recovery, yoga, Pilates, gymnastics,

and any other training methods that can have a role, Ultimately, it enables the practitioner to improve core stability, understand and improve motor skills, enhance specialized athletic abilities, and enhance the ability of the energy metabolism system (Gambetta V., 1999).

J.C Santana, the founder of "IHP" functional training in the United States, believes that functional training is conducted in a way that is consistent with the body's function or the specificity of the target movement (Santana J.C., 2004). Steven Plisk believes that the sports involved in functional training have a clear purpose, which is to enable people to maintain the movement ability of Activities of daily living, and is related to mechanics, coordination and energy metabolism.

Michael Boyle, the most typical representative figure of functional training, compared the difference between functional training and general training. He believed that functional training is essentially targeted (with clear goals) training, and its principle is mainly to improve the body's athletic ability through training methods. It is aimed at improving athletic performance or improving the quality of daily life. It does not train a single muscle in isolation, but rather enhances the coordination and coordination of all muscles and the body's ability to control them. It targets movements rather than muscles (Boyle M.,2003).

Functional physical training is a means of conducting physical fitness training based on the actual condition of physical function and the specific characteristics of the participating sports events (Santana. J.C, 2004).

The American Council on Exercise points out that functional training includes balance training, stability training, core training, and dynamic exercise training; Gambetta believes that functional training will involve acceleration, deceleration and stability. At the same time, functional training is the compound promotion of multiple joints in multiple planes, which requires the active participation of nerves and Proprioception, and the need to regulate instability, handle gravity, ground reaction force, impulse and other factors at any time in the practitioner; The National Academy of Sports Medicine defines functional training as: functional training involves every joint in the Kinematic chain and acceleration, deceleration and stability actions in different planes (MICHAEL B., 2004).

Craig Breslow (Boston Red Sox) pointed out that Mike Boyle's dynamic physical training method has always led the trend of the industry, and he combined treatment, flexibility, stability, strength and explosive force in training. He once succinctly described the appropriate training required for athletes as "pushing, pulling, and completing tasks with both feet.

Charles Staley describes functional training in his book as "using multiple instruments to create an unstable mechanical environment, thereby exercising more stable and small muscle groups. He believes that functional training advocates the recruitment of small and stable muscle groups, which is the key to determining competitive ability. Although different experts have different definitions of functional training, there are also many similarities (Charles Staley, 2005).

In 2012, Gary Cook redefined functional fitness training, Functional Physical training refers to the training of partial chains and connections in the human motion chain that involves completing specific target actions, including multi dimensional motion trajectory acceleration, deceleration, and stability training activities that meet the characteristics of particular target actions (Gray Cook, 2012). The action mode of functional training involves acceleration, deceleration and stability of multiple joints and planes.

To sum up, functional physical training is defined in this study as multi-dimensional and all-round targeted training designed based on the characteristics of specific sports and the evaluation results of athletes' athletic ability and based on the functional characteristics of body movements.

3.2 Comparison between functional physical training and traditional physical training

Functional physical training and traditional physical training belong to dialectical unity in philosophical principles. The two have certain connections and obvious differences, and under specific conditions, the two can be mutually transformed. There is no universally applicable method for functional physical training, nor is there an absolute meaning for nonfunctional physical training. The difference between all functions and non-functions is only for specific purposes.

3.2.1 Similarities

Firstly, in terms of training objectives, scientific and systematic training is carried out with a purpose and plan to effectively accumulate training cycles and improve athletes' competitive level, thereby achieving ideal results in competitions; Secondly, in terms of expression, it is the exercise ability demonstrated by the human body through the work of skeletal muscles; Third, in terms of capacity metabolism characteristics, they are all based on phosphate system, Glycolysis system and aerobic system metabolism.

3.2.2 Differences

The guiding ideology of traditional physical training in China is based on the training principles of the 1960s, which were "starting from difficulties, strictness, actual competition needs, and high-intensity training". Among them, "starting from actual competition needs" is also the goal pursued by functional physical training. However, the actual training methods of traditional physical training did not closely adhere to this theme. The traditional physical training in Strength training is often based on resistance of equipment, which increases muscle strength through single plane training such as squatting, bench pressing, hard pulling, etc. Long distance running is the main form of endurance training, which has a fixed training concept for repetition and gradual increase of load, and the training method is slightly boring. He likes to weigh the level of physical fitness with Strength training, emphasizing absolute strength, but pays little attention to coordination, balance, sensitivity, neuromuscular control, proprioception and other aspects, ignoring body symmetry and injury prevention (Tian Peng, 2017).

Functional physical training is the process of visualizing a complete motion chain structure in the human body, emphasizing the establishment of high-quality motion patterns and the ability of the nervous system to control the muscles of the human body in unstable states. In terms of training movements, the range of functional physical training movements is flexible and varied, and the movements are complex; Pay attention to multi-dimensional and all-round training positions; In terms of training methods, it is more interesting (Yan Qi, 2012). Based on the above characteristics, functional physical training is more closely combined with specialized

techniques during training, which has a more prominent effect on improving sports performance.

Compared to traditional physical training, functional physical training is more in line with the various characteristics required by the human body's development laws in biomechanics, anatomy, and physiology. The specific differences between the two are shown in Table 3.

Table 3 Differences between traditional physical training and functional physical training

Content	Traditional Physical Training	Functional Physical Training
Practice Format	Isolated Movement Practice	Complete action chain
Practice Method	Emphasize high intensity and high load	Focusing on improving the quality of movements
Range Of Motion	Fixed form	Flexible and versatile
Training Location	Single plane	Multidimensional and all-round
Movement Difficulty	Simple action	Complex movements
Interest	The training methods are relatively dull	The training method has strong interest
Muscle Group	Large muscle group	Deep small muscle groups

Wang Xiong and Liu Aijie believe that specialized training cannot be replaced by functional training. In the functional training system, many specific action modes are designed around specialized training, which helps to achieve breakthroughs in specialized performance. At the same time, traditional training methods cannot be completely negated. The two should be combined to create a training method suitable for every athlete.

In summary, functional physical training and traditional physical training are not contradictory, but rather dialectical and unified. The two have both connections and significant differences and can be combined or exchanged under specific conditions. Many scholars in China have conducted in-depth research on functional training and believe that functional training is superior to traditional training. They are confident in the development of functional training. However, due to insufficient understanding and experience, it remains at a superficial level and requires deeper research in conjunction with specialized projects.

3.3 Theoretical basis for functional training

3.3.1 Specific adaptation to imposed demands (SAID)

The working principle of functional training is based on the body structure and designed according to the required work tasks, so it requires muscles to work in a natural way. The simplest squatting and throwing movements in the human body require the use of multiple muscles, so arm flexion and extension exercises have little practical significance (Haines M., 1988). The adaptation of muscle fibers and muscle strength caused by training has a clear target, indicating that muscle structural adaptation has a high degree of specificity. The changes in muscle structure caused by training will enhance its function, thereby improving overall motor ability. The specificity of muscle training can be utilized in functional training to improve motor performance closely related to daily life (Cress M E, 1996).

The foundation of functional training methods is the Specific adaptation to imposed demands (SAID) (Steven Plisk.). The goal of functional training is the form of exercise rather than independent muscles. The function of muscles is controlled by the brain, which does not recognize individual muscles, but rather the forms of movement that respond to stimuli from the external environment. The function of a muscle largely depends on the environment in which it is activated. As a component of the form of movement, various muscles in the human body can coordinate movement in a specific way; In another form of exercise, muscles engage in another form of exercise. The form of motion is very complex, requiring multiple muscles to interact on all three planes of motion, in order to react to gravity, ground support reactions, and the effects of power. In order to achieve the best training effect, the focus of functional training must be on the interaction of all systems in the body (Spennewyn, K., 2008).

In medicine, specific training refers to providing specific guidance based on the functional attributes of muscles to better meet the physiological and psychological needs of patients (Ran Xiaoli et al., 2022). In sports training, specific training refers to the specific guidance that should be given based on the functional properties of muscles, that is, to get what you practice. It emphasizes that sports training must be specialized in biomechanics, physiological and biochemical adaptation, and basic

physical fitness, and must meet project requirements to ensure optimal sports performance (Ma Jizheng, 2010). The goal of functional training is the form of exercise rather than independent muscles. The function of muscles is controlled by the brain, which does not recognize individual muscles, but rather forms of movement that respond to external stimuli and inputs (Yan Qi, 2013).

3.3.2 Post-Activation Potentiation theory (PAP)

Post-Activation Potentiation (PAP) refers to the situation where a muscle's ability to work increases for a certain period of time due to the production of contraction marks after being subjected to maximum or submaximal resistance stimulation (Liu Xinlan et al., 2000). Alex Harrison studied the mechanism of post activation potentiation effect. When post activation potentiation effect occurs, calcium saturation in muscles prolongs the duration of muscle contraction, enhances the mobilization of the nervous system, and enables more muscle fibers to contract rapidly, resulting in greater muscle tension (Alex Harrison, 2011).

In recent years, many researchers have studied the influencing factors of PAP, and the current research results generally believe that high intensity and small amounts of load stimulation are more likely to induce PAP (Hanson Erik D et al.,2012).According to the fatigue relationship, it is believed that the strengthening effect after conditional contraction occurs simultaneously with fatigue, but fatigue decays at a faster rate. Therefore, after a certain period of time, the strengthening effect is stronger than that during fatigue, resulting in the generation of PAP (Tillin N.A et al. ,2009).

3.3.3 Regeneration and Recovery theory

Regeneration: refers to the process in which organisms self-repair and replace lost structures. Narrowly speaking, it refers to the phenomenon where the remaining parts of an organism grow structures that have the same morphology and function as the original after organ damage. Regeneration in sports training refers to a planned training unit that helps the body recover from intense training.

Regenerative training: refers to a training mode in which active recovery exercises such as massage, changing exercise patterns, stretching and relaxation are

planned during training, and a series of methods such as nutrition and material energy supplementation are used to accelerate the recovery of the body.

The physiological mechanism of recovery and regeneration is to eliminate the adverse effects of muscle tension and to comb and relax soft tissues such as fascia. The regenerative unit in sports training is based on the principle of biological regeneration, which helps the body repair and maintain its proper structural functions through some training methods. Incomplete pathological regeneration (that is, abnormal tissue structure wear, such as severe muscle and ligament strain, fracture fracture, etc.) belongs to the treatment and recovery after Sports injury and is included in regeneration training.

The purpose of recovery and regeneration is the same, both aimed at maintaining, or even enhancing, the functionality of the organizational structure. The difference is that regeneration is more refined to the cell molecular structure, and part of regeneration belongs to recovery, but another part is different from recovery and exists independently.

3.3.4 Sports Science Theory

Mike Boyle pointed out that functional training is ultimately the application of functional anatomy in training. It applies knowledge of functional anatomy and sports biomechanics to select exercises, thereby reducing the incidence of injuries and improving competitive ability (Mike Boyle, 2003).

Santana. J.C also summarized the movement modes of the human body in his theory of "IHP" functional training methods, categorizing them into four categories: push pull, rotation, horizontal displacement, and vertical movement, known as the "four pillar movements". In the training system he created, the four pillar movements were organically integrated into physical fitness training plans, fully reflecting the functionality of training (Santana. J.C, 2004).

Vern's research believes that the unique adaptability of the human body will enhance the integrity of the structure without Physical change in the human body. In other words, people can improve their overall motor ability without increasing their muscles. Functional training integrates body structure by improving coordination,

while also improving motor skills, based on neural adaptability (Vern Gambetta, 2004).

The functional anatomy of the human body and the biomechanical principles of human movement are the theoretical basis for the design of functional physical training programs. The human body has a total of 600 muscles, most of which are multi joint and long action muscles. Higashihara and others believe that training these multi joint muscles has a more important role in improving the speed of action. In addition, they can effectively adjust the force ratio between different links of the human Kinematic chain to improve the coordination of the whole-body movement. The training of these muscles is the focus of functional training (Higashihara A. et al., 2010).

In summary, functional training is a natural movement mode based on human body structure, and its theoretical basis is human functional anatomy, Exercise physiology, sports training, sports biomechanics, etc. The functional anatomy of the human body explains that attention should be paid to the training of muscles around the trunk and joints of the human body; From the perspective of Exercise physiology, it emphasizes the fixation of auxiliary muscles and the antagonism of antagonistic muscles, as well as the ability of the nervous system to dominate muscles; From a biomechanical perspective, functional training places more emphasis on the practical effects of functional exercise exercises; Sports training is the fundamental theory of all sports.

3.4 An empirical study on functional training

Most of the movements in competitive sports are a complete Kinematic chain structure, and they are all completed in a moment, which requires the body to have good explosive force. Explosive force is the ability of the human body to quickly convert biological Chemical energy into mechanical energy and output strong mechanical power (P=F * V). The greater the power, the stronger the explosive force displayed by muscles (Vern Gambetta., 2004). The ultimate goal of functional training is explosive strength training and explosive endurance training, many of which require athletes to complete quickly. Many movements in functional training require

complete amplitude and speed close to specific needs, which are beneficial for improving muscle strength and speed effects, thereby increasing muscle power output.

Mark Verstegen proposed that "the essence of sports is action". The AP Physical Training Center he founded has trained many Professional sports in various High-performance sport in the United States with a scientific functional training system, and has made brilliant achievements in various sports (Mark Verstegen et al., 2005). In 2005, the physical fitness team led by Mark cooperated with Klinsmann, the head coach of the Germany national football team, to help the German team achieve outstanding results in the 2006 World Cup. Collaborating with multiple sports teams of the Chinese Olympic delegation during the London Olympic cycle, making significant contributions to the excellent performance of the Chinese delegation in winning 38 gold medals. In the 2014 Brazil World Cup cycle, we continued to help the German team win the World Cup championship. Afterwards, it was renamed EXOS Fitness Training Center.

Oliver et al. conducted a Scientific control of functional balance training on 26 college volleyball and soccer players aged 17-22. The experiment lasted 13 weeks, 4 times a week, 10 minutes each time. The main measurement indexes of the experiment were body composition (weight,body fat, BMI), strength(quadra-ped: left, right;single leg squat (left,right), muscular endurance (sit up),balance (biodex balance test: left, right).The results showed that the single leg square (right, left) and sit up data significantly improved, but there was no significant difference in BMI, weight,body fat, quadruped (left, right), and Biodex (right, left)(Oliver et al.,2009).

Tomljanovic et al. conducted a group of Scientific control of functional training and traditional resistance training on 23 moderately trained male athletes aged 22-25 years. The experiment cycle was five weeks, three times a week. The results showed that, The scores of athletes hexagon test, standing overarm medicine ball throw, jump height, power peak, and ground contact time have significantly improved; lying medicine ball throw, air time, 5-10-5m, 10m, 20m, 10-20m, weight, height, Body fat percentage, body fat, lean body mass, total body water indicators showed no significant changes (Tomljanovic et al. ,2011).

In May 2006, Norwegian researchers found that suspension training improved the balance, kicking speed, and trunk balance abilities of excellent football players. When comparing the kicking speed of the comparison group and the control group, the suspension training group showed an average increase of 3.3 km/hr ($P<0.05$), and the kicking speed with an approach increased by 1 km/hr. The shaking speed of the support foot during kicking decreased by an average of 18%, and the difference in instantaneous shaking speed of both legs decreased from 51% to 3% (Spennewyn. K., 2008).

In 2009, a researcher carried out a study to compare two commonly used training methods in Strength training - functional training and traditional Strength training for the first time. The study found that after training, the training effect of the functional training group was far better than that of the traditional Strength training group. Compared with the traditional Strength training group, the strength of the functional training group increased by 58%, the balance ability was 196%, and the joint pain was reduced by 30%. It can be seen that functional training is more efficient than traditional training methods (Mark Verstegen, et al.,2009).

Shaikh A and DS Mondal randomly selected 19 male college students aged 19-25 and conducted functional training three times a week for 8 weeks. It was found that their speed, endurance, muscle strength, explosive power, flexibility, and sensitivity were significantly improved (Shaikh A, 2012).

Lamberth J et al. divided the golfers into two groups for 6 weeks of functional Strength training and the original golf Strength training plan. The results showed that the original golf Strength training plan significantly improved the strength of squats and supine leg lifts, while the speed of vertical jump and swing did not change significantly, while functional Strength training significantly improved in all data (Lamberth J, 2013).

Through functional training and traditional Strength training for two groups of young people aged 19-21 years old, Agron Kasa found that compared with the control group, the Core stability of the experimental group could be better activated and had a higher contribution ratio in the Kinematic chain. Therefore, the balance ability, movement stability and explosive force of the experimental group were significantly

better than the control group. These research results fully demonstrate the advantages of functional training (A Kasa, 2014).

Elbadry conducted a 10 week, 3 times a week, 10-minute balance and strength comparison experiment on young female handball players. The research results showed that the athletes' Static strength test, Dynamic balance, and back strength indicators were significantly improved, while Handgrip Strength and leg strength showed no significant changes (Elbadry,2014).

Keiner et al. divided 48 Elite adolescent soccer players into four groups. The first group used traditional Strength training, the second group used plyometrics and sprint training, the third group used functional training, and the fourth group was the control group. Athletes train twice a week for 60 minutes each time. After 10 months of training, their 20 m speed, change of direction sprint, jump performance, and 1RM have all significantly improved (Keiner et al. ,2020).

Baron et al. conducted 12 weeks of functional training on 20 football players around the age of 17. In the comparison of pre and posttests of athletes' speed and acceleration, it was found that there was little change in acceleration at 0-5 meters, but there was a significant increase in speed and acceleration at 5-10 meters, 10-30 meters, and 30 meters, demonstrating that functional training can significantly improve athletes' speed and acceleration (Baron et al., 2020)

Table 4 Empirical study on functional physical training

Study	Design	Type of Athletes	Population Characteristics	Interventions	Measures Index	Outcomes
Oliver Et Al. (2009)	Pre-post test control test	College volleyball and soccer players	Sex:female Age:17-22	Length:13 weeks Frequency:4times/week Time:10 min	Body composition (WT,BF, BMI), strength， muscular endurance (sit up),balance	Significant increase in strength and muscular endurance
Tomljanovic Et Al.(2011)	Pre-post test control test	Moderately trained athlete	Sex:male Age:22-25	Length:5 weeks Frequency:3times/week	Agility (5-10-5 test,), power , strength , speed (10 m, 20 m), body composition	hexagon test, 5–10–5 test,jump height,power peak,ground contact time, Significant increased
Shaikh A, (2012)	Pre-post test control test	college students	Sex:male Age:19-25	Length:8 weeks Frequency:3times/week	speed, endurance, muscle strength, explosive power, flexibility, and sensitivity	speed, endurance, muscle strength, explosive power, flexibility, and sensitivity were significantly improved
Lambert h J, (2013)	Pre-post test control test	golfers	Sex:not reported Age:not reported	Length:6 weeks	Functional strength training	Significant increase in strength
Yan Qi (2013)	Pre-post test control test	Elite hockey players (national team)	Sex:female Age:19-25	Length:18 months	Speed (25-50 yard sprint), agility, endurance (25 yard turn back run), explosive power (spin side throw gravity ball), FMS	Significant improvement has been made in the main specialized physical fitness test indicators of hockey.
Elbadry, (2014)	Pre-post test control test	Young handball players	Sex:female Age:15.2 ± 0.6yr	Length:10 weeks Frequency:3times/week Time:60 min	balance and strength	body fat mass percentage, repeated sprint ability
Keiner Et Al. (2020)	Pre-post test control test	Elite adolescent soccer players	Sex:not reported Age:17.45 ± 0.52yr	Length:10 weeks Frequency:2times/week Time:60 min	Speed (20 m, Change of direction sprint;), power (Air time; Jump height） strength(1RM)	Significant increased Speed (20 m, Change of direction sprint;),power (Air time; Jump height ）, strength(1RM)significantly improved
Baron Et Al. (2020)	Pre-post test control test	Young football players	Sex:not reported Age: 16.8 ± 0.6 yr	Length:12 weeks Time:70-90 min	Speed and acceleration (0-5 m, 5– 10 m,10–30 m, 30 m)	Significant improvement in grades for 5-10 m, 10-30 m, and 30 m.

To sum up, foreign experts in the field of High-performance sport have different views on the understanding of functional physical training. Experts represented by Gray Cook and Mike Boyle believe that functional training is to seek common ground between different sports, while experts represented by Santana J. C and James C. Radcliffe believe that functional physical training must reflect the special characteristics of different sports, there are numerous supporters of both views in the field of physical fitness training research in countries such as Europe and America. In conclusion, in recent years, the application of functional physical training in High-performance sport has been widely valued. Foreign scholars have made preliminary exploration on the effect of functional physical training and achieved good results. However, in recent years, the application of functional physical training in High-performance sport has received extensive attention. Foreign scholars have explored and studied the effect of functional physical training. However, at present, functional training has not been defined uniformly, nor has a specialized functional training method or system been formed for all sports events. Therefore, the study of functional training in this paper has great theoretical and practical significance.

Physical training has always been a weak link in our national High-performance sport. In recent Olympic Games, China has consistently ranked among the top two in the world in gold medal ranking. In the 29th Olympic Games in 2008, China ranked first in the total number of gold medals, but its performance was poor in sports dominated by physical fitness or sports with physical contact. Since 2006, the General Administration of Sport of China has gradually improved the relatively backward situation in this field by continuously learning and introducing foreign advanced physical training methods and theories. In this environment, the theory of functional training, a new physical training method, has begun to attract the attention of many coaches and experts in China, and it has gradually entered the training system of competitive sports in China. Yan Qi, Wang Mingbo, Ren Manying, Huang Yan and others have successively verified the effect of functional physical training in hockey, Taekwondo, judo, swimming and other sports. Among them, Yan Qi proposed a pyramid model for functional physical training in competitive sports, which has been successfully applied to the national women's hockey team (Yan Qi, 2012).

According to literature, functional training is still in the exploratory stage in China, and the sports teams that truly carry out functional physical training are only limited to some projects of national high-level sports teams, and there has been no promotion research for grassroots sports teams. This study will draw on the research results of relevant fields both domestically and internationally, conduct interviews with experts in relevant fields, and combine the physical characteristics and performance of college basketball players in matches to conduct empirical research on two college basketball teams preparing for the China University Basketball Association League (CUBAL), effectively improving the physical fitness level of college basketball players.

4. Research on functional physical training methods

4.1 Research on the Application of Functional Physical Training Methods in Different Projects

Functional training is purposeful training, with training content tailored to specific technical characteristics and serving specific sports events. Therefore, there are personalized differences in functional training among different sports in terms of physical fitness training.

Yan Qi took the Chinese women's field hockey team as the research object, analyzed the physical characteristics of women's field hockey events, analyzed the physical problems exposed by the Chinese women's field hockey team in matches, and constructed a functional physical training method system for women's field hockey athletes, with a total of 366 training methods. The training arrangement is divided into three cycles, namely the development cycle of basic physical motor function (160 types), the development cycle of general motor function (160 types), and the development cycle of specialized motor function (46 types) (Yan Qi, 2013).

Table 5 Functional physical training method system for excellent women's hockey

Training cycle	Training content	Training method
Training methods for basic physical motor functions (160 types)		Core stability training methods (40 types)
		Upper limb stability training methods (25 types)
		Lower limb stability training methods (25 types)
		Flexibility training methods (55 types)
		Basic action mode training methods (15 types)
General exercise function training methods (160 types)	Aerobic endurance	4000 meter endurance run, 30 minute endurance run, Fadlet endurance run, multi obstacle endurance run on the field
	Anaerobic endurance	300 meter interval run, 200 meter interval run, figure 8 circular run, corner run, 300 yard turn back run,2 * 25+2 * 50+75 yard run
	Speed	Short distance sprints (4 types), stretch pull runs (2 types), slope runs (2 types), starting trainer exercises (2 types), throwing a gravity ball back and turning to accelerate running, and standing resistance high leg lifting exercises
	Agility	Soft ladder footwork training (22 types), hurdle footwork training (15 types), agile running training (10 types)
	Strength	Body strength training methods (25 types), upper limb strength training methods (20 types), lower limb strength training methods (25 types), whole body power training methods (20 types)
		Functional strength training methods (10 types)
Special sports function training methods (46 types)		Functional speed and sensitivity training methods (12 types)
		Functional endurance training methods (12 types)
		Functional integration training methods (12 types)

Zhu Yong conducted functional training for college football students in three stages for 15 weeks. The first stage was adaptive training (3 weeks), with the main task of activating the neuromuscular system, correcting body posture, and improving movement patterns; The second stage is a specialized strengthening stage (6 weeks), with the main tasks being to strengthen the core muscle group strength training, improve joint flexibility training, and quickly expand and retract composite training;

The third stage is the specialized reinforcement stage (6 weeks), with the main tasks being to strengthen the action chain training, strength and explosive training, and specialized action skill training(Zhu Yong,2022).

Table 6 Methods of football specialized functional training actions

Phase 1	Phase 2	Phase 3
Self weight alternating lunge Single Leg Squat Self weight push ups Cycling - Rolling Bells Gluteal bridge Swiss Ball - Russian Swivel Dynamic Plate Support Kneeling Support - Alternate Side Lift	Elastic Band Squat Lie prone, bend knees, and lift Dynamic split leg side bridge support Mini Band - Hip Joint Bilateral Opening and Closing Elastic Band - Side Slide Rope Ladder - Open Close Jump Jumping small hurdles Continuous Frog Jump	Heavy squat Burpee 25m * 4 turn back running 30m Sprint Run Alternating load lunge Swiss ball - curly belly Swiss Ball - Plate Support Elastic band logging

Deng Jiaxin conducted 8 weeks of functional physical training on 18 national first-class handball players, including muscle activation and recovery, upper and lower limb strength, core area strength, speed, agility, and more. The experimental results showed that the various physical fitness indicators of the experimental group were significantly improved compared to the control group, indicating that functional physical training has a better training effect on improving the specialized speed, explosive power, and basic strength of handball players compared to traditional physical training. The functional physical training exercise mode selects various exercises to strengthen small muscle groups, improve muscle strength in weak areas, and focus on the development of symmetrical muscles on both sides (Deng Jiaxin,2021).

Table 7 Functional physical training plan for the experimental group

Training content	Training movements	Groups	Times/ Distance	Intermittent (S)
Dynamic activation	Greatest stretching, lateral crawling, rope ladder practice	1	20m	60s
Upper body strength	Elastic band swing arm, quick solid ball hitting wall in one minute, Swiss ball horizontal push	3	12-15	90s
Lower limb Strength	TRX hand support lateral lunge, kettlebell weight jump, balance pad deep squat,	3	12-15	90s
Core training	Lying on the back with weight, stepping on both feet, half circle balance ball at the top of the hip, Russian rotation, side bridge to hip bridge	3	12-15 12-15 60s	90s
Agility training	Turn around to catch the corner kick practice, hurdle side reverse jump, hip turn jump	3	12-15 12-15 30s	60s
Speed training	Follow the instructions of the whistle to slide, Practice the "six meter line" cross step movement, Run with your back to the signal	3		60s
Organize and restore	Massage stick rolling, static stretching	1	20s	5s

Xu Keyu conducted 10 weeks of functional physical training for 10 female volleyball athletes, with a focus on upper and lower limb explosive strength, speed, agility, and endurance training to adapt to volleyball specific sports. The experiment was divided into three stages: basic training stage, intensive training stage, and special training stage. After 10 weeks of training, the experimental group's various test data have significantly improved (Xu Keyu,2018).

Table 8 Functional training enhancement phase training plan for the experimental group

	ACTION	LOAD	GROUPS	REQUIREMENTS	INTERMITTENT TIME
STRENGTH	Barbell squat	5RM	3		2min
	20 meter sprint with raised legs in place	dead-weight	3		2min
	Half way hard pull	10RM	3		2min
	Calf raise	15RM	3		2min
	Continuous vertical jump in place	dead-weight	3		2min
	Continuous fast clean and jerk	10RM	3		2min
	Weighted sit ups	20RM	2		90s
SPEED	Running back to back listening to signals		2	2 times	1min
	Listen to the signal and run in the direction		2	30s	1min
	80 meter timed run		4		5min
	Run with small steps in place		2	30s	2min
	Continuous Fast Abdominal Jump		2	30s	3min
	Throwing and catching a hexagonal ball		2	15 times	2min
AGILITY	Quick Run with straight steps		2	13 grids	10s
	Wide step cushion step hook leg single leg support S-shaped forward		4	13 grids	20s
	T. U, Mouth shape mixed running of markers		3		3min
	Continuous straight leg mini hurdle jump		10	2 groups	1min
	Squat up with both feet on balance pads		5	2 groups	20s
ENDURANCE	Bicycle practice		3	2min	1min
	Interval running		2	15min	1min

Song Lulu conducted a 16-week empirical study on the physical exercise function training of 12 female basketball players (8 national first level athletes and 4 national master level athletes). The experimental training was divided into three stages. The first stage (8 weeks) focused on developing athletes' aerobic endurance, improving body composition, and strengthening basic strength, and adopted various training methods such as body stability, basic movement patterns, and aerobic endurance. The main purpose of the second stage (4 weeks) is to enhance the all-round physical fitness of athletes, including anaerobic endurance, full body strength,

speed and sensitivity, body stability, and pre rehabilitation training, with a focus on consolidating the athlete's strength foundation; The third stage (4 weeks) mainly focuses on specialized sports functions and pre rehabilitation training that are combined with the needs of basketball matches. Through physical exercise function training, athletes have increased their average weight and Ketolet index, while their body fat percentage and waist hip percentage have decreased; No new sports injuries occurred during physical exercise training; Athletes have achieved varying degrees of improvement in strength, endurance, speed, agility, coordination, and flexibility (Song Lulu,2022).

Table 9 Training plan for the consolidation and improvement phase of body movement function training

Purpose	**Practice Movements**	**Load**	**Number Of Groups**	**Requirements**	**Intermittent Time**
Muscle Activation Training	7-9 actions	dead-weight	1	5min	5s
Core Instability Training	Prone Swiss spin	dead-weight	2	15 times	15s
	Prone Swiss dorsalis ball pass	dead-weight	2	15 times	15s
	Kneeling position abdominal muscle wheel push forward	dead-weight	2	12 times	15s
	Skateboard swings left and right to catch the ball	dead-weight	2	15 times	15s
Dynamic Stretching Training	10 actions	dead-weight	1	14m	5s
Action Mode Training	Freehand layup action mode	dead-weight	2	10 times	10s
	Rebound grabbing action mode	dead-weight	2	10 times	10s
	Slide action mode	dead-weight	2	10 times	10s
Specialized Endurance Training	Guards and forwards resist resistance and steal the ball	Elastic band	3	10 times	30s
	Guards and forwards resistance dribbling	Elastic band	3	28m	30s
	Center restricted area multiple points for ball shooting	dead-weight	3	8 times	30s
	Center forward breaks through the restricted area with multiple dribbles	dead-weight	3	8 times	30s
Aerobic Endurance Training	30 minute aerobic endurance run	dead-weight	1	30min	--

Pre Rehabilitation Training	Group FMS corrective actions	dead-weight	3	8 times	20s
Regenerative Recovery Training	14 movements for stretching training	dead-weight	1	30s	5s
	Fascia relaxation training	dead-weight	1	60s	5s

By summarizing the relevant research on functional training in the field of competitive sports, currently, most of them divide the functional training cycle into three stages. The first stage focuses on solving the basic motor function and posture of the body; The second stage mainly focuses on developing general physical fitness, emphasizing the development of core strength throughout the body; The third stage is to develop specialized physical fitness based on the characteristics of specialized sports.

Functional training, as an emerging training method, has been practiced and applied in various sports projects, and is more flexible and extensive than traditional physical training methods. Its training movement characteristics are in line with the human body's sports anatomy, physiology, and biomechanics characteristics, emphasizing the theory of multi joint and multi-dimensional movement modes, making the training content more suitable for the movement techniques required by different sports projects. Training in speed, strength, endurance, agility, and flexibility under the guidance of serving specific purposes, with a focus on core strength exercises, helps to comprehensively improve various physical fitness and motor skills.

However, the current research on functional training is relatively limited, and the system of action methods for athletes of different specialties and levels is not yet perfect. There is also a lack of applied research on various projects. This study will summarize the existing methods and systems of functional physical training for various sports and combine the characteristics of basketball to develop a set of suitable functional physical training methods and systems for college basketball athletes.

4.2 Functional physical training pyramid model for college basketball players

The functional training pyramid model was first proposed by Dr. Yan Qi as the basic framework for the functional physical training of the national women's hockey team in preparation for the 2012 London Olympics. The application of this model has been successful in the national women's hockey team. In his model, he divided functional physical training into three levels. The first level of functional training is the training of basic motor functions of the body. Athletes in any event need to establish good physical stability, flexibility, and high-quality movement patterns, which are the foundation of the latter two levels; The second level of functional training is the training of general motor functions, such as strength, speed, endurance, sensitivity, etc; The third level of functional training is the training of sports specific functions, which varies among different sports. This is the core of functional training in competitive sports and the pinnacle of the pyramid model of functional physical training in competitive sports (Yan Qi, 2013). This study, as the first doctoral thesis in the field of functional physical training in China, has broad guiding significance for the evaluation, testing, training, and monitoring of various sports specific physical fitness training, and has expanded the system of physical fitness training methods.

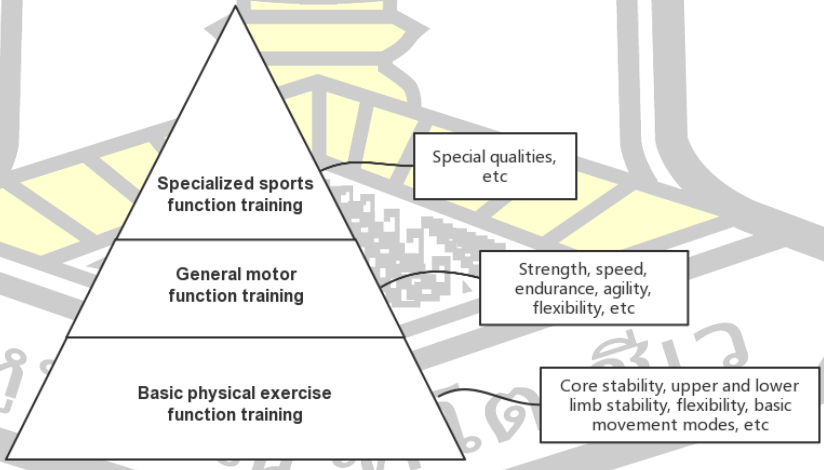


Figure 3 Competitive sports functional physical training pyramid model

In this study, the functional physical training pyramid model was applied, in the implementation of training, functional physical training is divided into three levels

into three training stages. The first stage is the basic motor function training stage of the body, with the main purpose of enhancing the flexibility and stability of various joints of the body, ensuring that various parts of the body are not restricted as part of the human action chain, so that every athlete can conduct higher level training in good physical condition. The content of this training is not very different from other specialties. The selection of its content mainly depends on the athlete's movement mode, and according to the laws of human movement development, it lays the foundation for the athlete from body stability, flexibility, static control ability, and dynamic control ability level by level, continuously improving the athlete's basic motor function level, so that they can still maintain good movement mode in the increasingly difficult mechanical environment.

The second stage is the general motor function training stage, with the main goal of helping athletes complete the transformation from motion quality to motion energy, so that they can improve their basic physical fitness such as general strength, endurance, agility, flexibility, and coordination under the premise of correct motion modes. This stage of physical training is different from other special projects, according to the physical needs of basketball to practice.

The third stage is the specialized sports function training stage, which is an important stage for athletes to transform their general sports ability into specialized sports. Before entering this stage, athletes had a relatively reasonable movement pattern and comprehensive physical fitness, but at this time, the combination of physical fitness and specialized skills was not close. Different sports events vary greatly, and different venues, equipment, and forms have completely different requirements for each system of the athlete's body. At this stage of training, it is necessary to understand the essential issues such as project characteristics, competition rules, and basic rules of specialized sports. Within this framework, by creating a stimulating environment similar to the competition during training, the specialized physical fitness of the sports should be strengthened.

4.3 Design of functional physical training methods for college basketball players

4.3.1 Training methods for basic physical motor functions

4.3.1.1 Physical flexibility and stability training

In the functional physical training pyramid model, flexibility and stability are the foundation of human movement, and all movements require a stable fixed point, surface, or axis. In the multi link movement of the human body, adjacent joints always alternate to play a flexible and stable role, so solving the problem of multi link and multi-dimensional stability of the body is the focus of functional physical training.

4.3.1.1.1 Training methods for shoulder joint and upper limb stability

The shoulder joint is considered one of the most complex joints in the human body, mainly composed of the glenoid joint of the scapula and the humeral head. The shoulder joint plays a supporting and moving role in the upper limbs of the human body, so its biomechanical properties are crucial for the daily activities and performance of the human body. In the anatomy of the shoulder joint, the fit between the humeral head and the groove of the scapula is very strict. Therefore, when demonstrating endurance and strength training in the shoulder joint, it is important to maintain a highly coordinated movement of the humerus and scapula to avoid adverse mechanical stress.

The biomechanical model of the shoulder joint represents the mechanical model of the human shoulder joint as a continuum dynamic model, which represents the mechanical behavior of the human shoulder joint in various activities. The biomechanical model of the shoulder joint can reveal the specific longitudinal vector and angle of motion of the shoulder joint, providing scientific basis for the diagnosis and rehabilitation treatment of shoulder joint injuries.

As the most flexible joint in the human body, its stability is of great significance. Shoulder joint movement includes the movement of the scapula and the movement of the glenoid humeral joint. The movements of the scapula include lifting, pulling down, internal rotation, external rotation, forward extension, and backward extension. The movements of the glenoid humeral joint include forward flexion, backward extension, adduction, abduction, internal rotation, and external rotation. Unlike other

joints, the glenoid humeral joint is a joint with poor bone stability, with a larger joint ball and a smaller and shallower joint socket. Therefore, the shoulder joint mainly relies on the combined force of muscle contraction in different directions to compress the humeral head into the glenoid socket to maintain stability (Wang Liang, 2018). Internal and external rotations of the shoulder joint are a pair of actions often used to test the balance of antagonistic muscle strength, with the primary muscles acting as antagonistic muscles to each other. Research has shown that the normal value of the ratio of internal and external rotation antagonist muscle strength of the shoulder joint is 3:2 (Yuan Peng, 2010). Once the internal and external rotator muscle strength is imbalanced, it can easily lead to shoulder joint injury (Noffal GJ., 2003). The stabilizing muscles of the glenoid humeral joint - the rotator cuff muscle group - start from the scapula, and the correct position of the scapula is necessary to effectively perform their functions.

For basketball, the movements of the upper limbs are delicate and complex, and the normal function of the shoulder strap will directly affect the range of touch for the athlete's hands. In the context of the specialized demand for long-term, large-scale, and fast movement of the upper limbs, any minor compensatory movements of the scapula and glenoid humeral joint can pose a hidden danger to sports injuries. According to this approach, the main purpose of selecting training methods for shoulder joint and upper limb stability is to promote the balance of muscle strength of the antagonistic muscles around the shoulder in multiple planes and dimensions, so that the scapula is unrestricted in multi-directional movement and maintains dynamic balance at all times, maintaining normal shoulder humeral rhythm (Cailliet R., 1980). By creating an unstable mechanical environment, strengthen the muscle strength of the shoulder stabilizing muscle group in both near and far fixed situations to enhance its function of maintaining joint stability. Based on the above theoretical research, a total of 24 training methods for shoulder and upper limb stability of college basketball players were selected.

(1) Stretch exercises with elastic rope around the front and back shoulders

(2) Standing Y-shaped training

(3) Standing T-shaped training

(4) Standing W-shaped training

(5) Standing L-shaped training

(6) Shoulder joint pull against wall training

(7) Elastic band resistance shoulder joint against wall for water training

(8) Straight knee push up training

(9) Crocodile push up training

(10) Knee bending suspension supine pull training

(11) Straight Knee Suspension Supine Pull training

(12) Knee bending suspension prone push training

(13) Straight knee suspension prone push training

(14) Kneeling support Swiss Ball Stability training

(15) Stand up Swiss Ball Stability training

(16) Türkiye stand up training

(17) Two Hand Elastic Stick Stability training

(18) One handed elastic rod stability training

(19) Kneeling elastic belt oblique pull stability training

(20) lift practice crawling training

(21) Crawling training

(22) Wide distance push-up training

(23) Narrow distance push-up training

(24) Push-up horizontal training

4.3.1.1.2 Core stability training methods

Core stability originated from the theory of human spinal anatomy and physiology and is mainly applied in the field of human rehabilitation. It refers to the

ability of the human body to establish a fulcrum for the muscles of the limbs through the stability of its core parts during movement, creating conditions for the transmission of upper and lower limb strength, maintaining or maintaining the normal anatomical position of the spine and pelvis, and optimizing the generation, transmission, and control of force. The quality of core stability depends on the coordination of core strength, recruitment ability, and cross-sectional area of muscle fibers.

Core stability training is an exercise method that enhances body stability and strength by strengthening the core muscle groups of the body. Core stability plays an important role in every competitive sport. When the body is in frequent and rapid stable movements, the core muscle group not only needs to undergo static contraction, but also needs to maintain strength and resistance at all times.

The core muscle group refers to the lumbar spine, pelvis, proximal lower limb, abdomen, hip joint complex where the center of gravity of the human body is located, as well as the surrounding ligaments and connective tissue. The core muscle group is mainly composed of rectus abdominis, obliquus abdominis, lower back muscle, and erector spinal muscle, responsible for protecting spinal stability. The abdominal muscles are in the front, the back and buttocks are behind, the diaphragm is above, and the pelvic floor muscles and muscle groups surrounding the hips are below.

In basketball, core stability is crucial for improving athletes' performance and reducing potential sports injuries. Basketball is a sport that involves frequent and intense physical confrontations. The stability of the core muscle groups in multiple planes ensures that the basketball player's torso can quickly activate and contract to counter the continued loss of control of body posture, keeping the body's center of gravity within a controllable range.

Core stability training is different from core strength training. It mainly involves stable muscle groups in the core areas, such as deep muscles such as transverse abdominis and multifidus. They belong to slow muscle fibers and maintain the body posture for a long time through slow and long-lasting contraction. Therefore, the overall movement rate of core stability training is relatively slow, and even includes more static exercises; The purpose of core strength training is to treat the core muscle

group as a movement link for active contraction ability training, which requires fast and powerful practice methods. Based on the above theoretical research, a total of 22 training methods were selected to train the core stability of college basketball players:

(1) Elbow plank support training

(2) Single leg (single hand) plate support training

(3) Single hand and single foot plate support training

(4) Suspension plate support training

(5) Elbow support side bridge training

(6) Hand support side bridge training

(7) Double leg hip bridge training

(8) Single leg hip bridge training

(9) COOK style hip training

(10) Hand and foot support alternating shoulder touch training

(11) Prone back muscle superhero training

(12) Prone Swiss ball back muscle superhero training

(13) Swiss ball skiing practice training

(14) Supine hands touch training

(15) Prone hands touch training

(16) Abdominal drip training

(17) Back muscle water training

(18) Knee and elbow support prone and opposite hand and foot lift training

(19) Knee and elbow support prone position with same side hand and foot lift training

(20) Hand and foot support prone position with opposite hand and foot lift training

(21) Hand and foot support prone position with hand and foot lift training on the same side

(22) Elastic band crawling training

4.3.1.1.3 Lower limb stability training methods

In basketball, the load intensity and amount of exercise borne by the lower limbs exceed that of other parts of the body. This is because basketball involves a lot of shifting, changing direction, running, jumping, and physical confrontation, with lower limb joints repeatedly bearing multi-directional impacts. In the survey of 24 participants in this study, lower limb injuries accounted for the main proportion of all physical exercise injuries. Among them, knee and ankle injuries are the most common. The knee joint is a trochlear joint composed of the femur, tibia, fibula, and patella, which is the largest and most complex joint in the human body, with more opportunities for injury; The knee joint capsule is loose and weak, with no muscle protection around it. It only relies on the surrounding ligaments for reinforcement. Once damage or joint relaxation occurs, it is not easy to produce reversible changes. In basketball, patellar tendinitis, meniscus tear, collateral ligament tear, and cruciate ligament tear are more common. Improving the stability of the knee joint requires the human body to have good movement patterns, muscle proprioceptive ability, and a balance of antagonistic muscle strength (Wang Liang, 2018). The hip joint and thigh muscles have a decisive impact on the stability of the knee joint. The muscle strength comparison of the hip joint adductor and abductor muscles determines the relative position and angle of the femur and tibia. The muscle strength ratio of the thigh flexor and extensor muscles determines the motion and control ability of the knee joint during flexion and extension. Therefore, knee joint stability training should include the strength and control ability of the hip joint and thigh muscles.

The ankle joint is also a frequently injured area for basketball players, with sprains being the main cause, accounting for half of the total number of injuries. The ankle joint is the weight-bearing joint closest to the ground in the human body, which means that the weight borne by the ankle joint is greater than any other joint. When the speed changes, it is the first buffering joint and bears the maximum impulse. The bone structure of the ankle joint determines that it is a stability-oriented joint, so it is

prone to damage during high-speed displacement. The main idea of ankle stability training is to first correct the relative position of the hip and knee joints to prevent them from causing varus due to the extension of the force line. Secondly, to strengthen the muscle strength of the small muscle groups around the ankle joint, improve their centrifugal contraction ability, enhance the sensory ability of the leg muscles, accelerate the nerve reflex speed, and activate them as soon as external force deformation occurs in the ankle joint, Shrink quickly to resist greater deformation. Finally, enhance the ability to control the center of gravity by adjusting the body's center of gravity to immediately remove the key forces that cause damage when the ankle joint is subjected to unreasonable external forces. Based on the above theoretical research, a total of 20 lower limb stability training methods were selected to train college basketball players.

(1) Yan style balance training

(2) Barbell single leg hard pull training

(3) Single leg support hip joint adduction and abduction training

(4) Supine hip joint abduction training

(5) Elastic band resistance lateral movement training

(6) Double legged supine hook pull Swiss ball training

(7) Single leg supine pull Swiss Ball training

(8) Suspension supine bilateral knee joint flexion and extension training

(9) Suspension supine unilateral knee joint flexion and extension training

(10) Standing resistance and multi-directional strength stability training

(11) Stability training of horse stance resistance and multi-directional strength

(12) Lunge resistance and multi-directional strength stability training

(13) Suspension single leg lunge squat training

(14) Suspension single leg Side lunge squat training

(15) Stability training for front and rear landing of small hurdles

(16) Continuous forward and backward jumping training with small hurdles

(17) Stability training for left and right landing of small hurdles

(18) Continuous left and right jump training with small hurdles

(19) Stability training for double legged jump bosu ball

(20) Stability training for single leg jump bosu ball

4.3.1.2 Body Flexibility Training

Flexibility refers to the range of motion of soft tissues such as muscles, fascia, and ligaments connected to joints. In basketball, physical flexibility not only affects an athlete's specialized ability, but also plays an important role in preventing sports injuries. Basketball, as a competitive sport on the same field, is fiercely contested for space. In situations where the body shape is similar, good flexibility can increase the range of athletes' movements, allowing them to take the lead in occupying the target position or occupying an absolute advantage in attack and defense control area. In addition, basketball matches are more intense, and in many cases, the body's center of gravity cannot be completely under one's own control, leading to excessive muscle elongation in certain situations, or in the event of intense collisions between two athletes, good flexibility can help athletes slow down more momentum without causing muscle strain (Wang Liang, 2018).

4.3.1.2.1 Stretching training

Stretching training helps to improve muscle proprioception. By regularly stretching muscles and connective tissue, it reduces muscle pain after high-intensity training, improves muscle work ability, increases joint range of motion, and reduces the probability of joint sprains and muscle strains. Stretching exercises in preparation activities can reduce muscle viscosity and improve the attention of women's basketball players. Stretching exercises after exercise can cause lymph and tissue fluids to flow back, accelerating the recovery of muscle fatigue (Song Lulu, 2022). The stretching training methods for college basketball players mainly include the following 18 types:

(1) Neck stretching

(2) Straight arm side traction and stretching

(3) Head back bending arm stretching

(4) Double shoulder straight arm stretching

(5) Shoulder blade stretching

(6) Stretching of pectoralis major muscle

(7) Infraspinatus muscle stretching

(8) Lateral trunk muscle group stretching

(9) Supine knee hug stretching

(10) Supine hip flexion and thigh stretching

(11) Adductor group stretching

(12) Supine straight leg stretching

(13) Side lying thigh muscle group stretching

(14) Achilles tendon stretching

(15) Greatest Stretching

(16) Sumo Squat

(17) 4-word stretching

(18) Fried dough twists stretching

4.3.1.2.2 Fascia relaxation training

Fascia relaxation is a kind of active recovery training method, which uses foam axis compression to improve muscle microcirculation and prevent injury of basketball players. Athletes use their own weight to press the foam axis on the muscle to be relaxed, activate the muscle tension at the tendon position, inhibit the change of muscle length in the muscle fiber, thereby reducing the muscle and tendon tension, and achieve the purpose of relaxing and restoring the muscle. Foam axis rolling

before training can reduce the muscle density of basketball players, lay the foundation for action preparation training, and foam axis rolling after training can help promote the rapid recovery of basketball players. The main methods of fascia relaxation training for college basketball players include the following 12:

(1) Achilles tendon and posterior calf fascia relaxation exercise

(2) Lateral calf fascia relaxation exercise

(3) Calf front fascia relaxation exercise

(4) Relaxation exercise of the inner thigh fascia

(5) Relaxation exercise of the outer thigh fascia

(6) Gluteus maximus fascia relaxation exercise

(7) Relaxation exercises for the fascia of the external and internal oblique muscles of the abdomen

(8) Back fascia relaxation exercise

(9) Shoulder and neck fascia relaxation exercises

(10) Relaxation exercises for pectoralis major and pectoralis minor fascia

(11) Relaxation exercises for deltoids and rotator cuff fascia

(12) Relaxation exercises for the forearm muscle group and triceps brachii fascia

4.3.1.3 Basic action mode training

The basic action mode is a method of classifying movements based on biomechanics. Basketball games have a fast pace of attack and defense, and their technical movements are complex and varied. However, these complex movements are all composed of various basic movement modes, including preparation posture, running, jumping, landing, rotation, lunge, deep squat, and directional change techniques. Good movement modes are required to complete various complex movements. Running, jumping, and landing are the most common basic movement modes in basketball. Incorrect running posture, rubbing feet on the ground, etc., can damage the knee joint; When taking off and landing, there are issues with the angle

and force sequence of the hips, knees, and ankles, which can cause a lot of pain in the knees, ankles, and waist. Including multi-directional starting, acceleration, deceleration, braking, direction change, as well as sliding and cross stepping techniques, are also basic technical movements in basketball. Improving these techniques can not only greatly enhance the agility of athletes, improve attack and defense efficiency, but also provide important protection against sports injuries.

In the training of basic action modes, the first emphasis is on the quality of action completion, the difficulty of the action is easy first and then difficult, the exercise load is first self-weight and then appropriate weight bearing, and the exercise intensity is repeated slightly before increasing the number of exercises. The training methods for basic movement modes of college basketball players mainly include the following 11 types:

(1) Running posture action mode training

(2) Start action mode training

(3) Multi directional starting and braking action mode training

(4) Lunge movement mode training

(5) Squat mode training

(6) Training of takeoff and landing action modes

(7) Training for directional movement action mode

(8) Cross step movement mode training

(9) Slide action mode training

(10) Turning motion mode training

(11) Fall action mode training

4.3.2 General exercise function training methods

4.3.2.1 General strength training methods

Strength is the foundation of various other physical qualities and is also one of the most important parts of physical confrontation in basketball. It is also of great significance in preventing sports injuries. This study will develop training methods for upper limb strength, lower limb strength, and core strength in response to the strength needs of basketball players.

4.3.2.1.1 Upper limb strength training methods

Basketball players complete various technical movements with or without the ball in the game. When designing upper limb strength movements, they first need to complete the strength of push, pull, adduction, abduction, and rotation based on the human upper limb structure. Secondly, it is necessary to comply with the characteristics of functional training, involving multiple planes, angles, and all directions. The upper limb strength training methods for college basketball players mainly include the following 25 types:

(1) Horizontal push training

(2) Supine barbell oblique upward push training

(3) Standing barbell chest push training

(4) Supine diagonal pull up training

(5) Barbell somersaults training

(6) Pull up training

(7) Supine dumbbell bird training

(8) Sitting dumbbell push up training

(9) Standing dumbbell single arm elbow uplift training

(10) Standing dumbbell double arm elbow bending and lifting training

(11) Standing Keiser hands down training

(12) Standing Keiser hands pull training

(13) Elastic elbow flexion and extension training

(14) Sitting on a Swiss ball and lifting dumbbells for training

(15) Swiss ball bench press barbell training

(16) Kettlebell single arm lifting training

(17) Kettlebell double arm lifting training

(18) Grip strength training

(19) Sitting wrist flexion and extension training

(20) Solid ball grab training

(21) Possession rowing training

(22) Standing posture dumbbell side horizontal lifting training

(23) Standing posture bow dumbbell bird training

(24) Supine horizontal pull training

(25) Standing position barbell blade head left and right arc training

4.3.2.1.2 Lower limb strength training methods

In basketball games, athletes need strong lower limb strength to complete various movements such as starting, accelerating, braking, changing direction, taking off, and landing. During the exercise process, the hip, knee, and ankle joints will participate in completing the push, pull, adduction, abduction, and rotation movements of the lower limbs. Lower limb push and pull exercises can maintain balanced muscle development, as well as exercise the strength of the hamstring muscle, which can effectively reduce sports injuries to the knee joint; Developing the adductor and abductor muscles of the hip joint can improve the speed and strength of basketball players' lateral movement and confrontation. The lower limb strength training methods for college basketball players mainly include the following 24 types:

(1) Barbell half squat training

(2) Barbell squat training

(3) Kettlebell squats training

(4) Barbell front and back split leg squat training

(5) Barbell lunge alternating squat training

(6) Weight-bearing heel lifting training

(7) Elastic band resistance high leg lift training

(8) Dumbbell bulgarian squat training

(9) Weight-bearing three directional lunge training

(10) Dumbbell romania hard pull training

(11) Kettlebell hard pull training

(12) Swiss ball supine top hip training

(13) Swiss ball supine single leg hip training

(14) Standing posture elastic band resistance lifting knee and hip abduction training

(15) Standing posture elastic band resistance lifting knee and hip adduction training

(16) Elastic band three direction quick step up training

(17) Prone resistance knee bending training

(18) Sitting resistance knee extension training

(19) Fast and continuous hurdle jumping training with both feet forward

(20) Double foot lateral rapid continuous hurdle jumping training

(21) Single foot forward fast continuous hurdle jumping training

(22) Single foot lateral fast continuous hurdle jumping training

(23) Keiser resistance hip abduction training

(24) Keiser resistance hip adduction training

4.3.2.1.3 Core strength training methods

Core strength is an important environment in human movement, which is the hub connecting upper and lower limb movements. The motor muscles in the core area mainly include the rectus abdominis, oblique abdominis, and erector spinalis. Their contraction can help the trunk complete flexion, extension, lateral flexion, and rotation movements. Strong core strength can reduce the loss of energy during transmission and plays an important role in improving movement amplitude and speed, as well as enhancing body stability. Core strength training is strength training that includes strengthening the deep stabilizing muscles and surface motor muscles. The goal is to train the muscle strength of the deep stabilizing muscles, increase the stability of the core muscle group, strive to coordinate the entire body, and ensure that the core muscle group plays a role in stabilizing the body and transmitting energy during athletes' movements. The core strength training methods for college basketball players mainly include the following 26 types:

(1) Supine quick two head up training

(2) Supine quick knee bend and pole wrap training

(3) Quick rise training with hands and feet collisions on the opposite side of a supine

(4) Quick rotation training with knee elbow contact on the opposite side of the supine position

(5) Supine knee bend ipsilateral dand foot alternating touch training

(6) Weight-bearing Russian twist training

(7) Training of three directional throwing and catching gravity balls in sit-ups

(8) Supine straight leg lift training

(9) Supine resistance knee bending and leg retraction training

(10) Elbow support Swiss ball bridge training

(11) Leg support Swiss ball bridge training

(12) Supine bicycle training

(13) Supine hip bend Leg push pull Swiss ball training

(14) Supine kick Swiss ball hip Lift training

(15) Four aspects of support training

(16) Kneeling position abdominal muscle wheel forward push training

(17) Standing abdominal wheel forward push training

(18) Stand up resistance torso fast rotation training

(19) Rapid contraction training of prone dorsal muscles

(20) Quick and continuous lifting training of the opposite limb in prone position

(21) Back Muscle exercise chair weight-bearing push up training

(22) prone Swiss ball back flexion and extension training

(23) prone Swiss ball torso rotation training

(24) Supine weight-bearing hip training

(25) Standing position weight-bearing body lateral bending training

(26) Standing position split leg kettlebell forward and backward swing training

4.3.2.2 General speed training methods

The speed training in basketball specifically refers to the training of movement speed, including linear movement speed and multi-directional movement speed. Speed is an important component of an athlete's competitive ability, especially for competitive sports such as basketball, having faster speed than an opponent means being able to seize more favorable offensive and defensive positions faster than the opponent. To improve an athlete's speed ability, it is necessary to first establish a basic

running pattern, then have sufficient explosive power levels, and also improve the stability of the core and lower limbs to prevent sports injuries during speed training. After basic speed practice, resistance speed practice can be added to improve speed skills. The speed training methods for college basketball players mainly include the following 11 types:

(1) 3/4 basketball court sprint training

(2) Side run training

(3) Change direction running training

(4) Backward run training

(5) Elastic belt resistance high leg lift running training

(6) Elastic belt resistance variable speed running training

(7) Drag drag resistance acceleration running training

(8) 30 meter sprint training

(9) 60 meter sprint training

(10) Uphill running training

(11) Downhill running training

4.3.2.3 General endurance training methods

4.3.2.3.1 General aerobic endurance training methods

Research shows that in a fierce basketball game, aerobic energy supply accounts for about 15%. Although aerobic energy does not account for a high proportion in basketball matches, it is the foundation of basketball physical fitness. Aerobic endurance training can improve the energy supply level of athletes' energy system, control their body composition, accelerate the clearance of metabolic waste after high-intensity training, and improve their fatigue recovery level. Regular endurance training can make athletes feel dull and boring, so weekly aerobic endurance training can be appropriately changed in form and location. In addition, continuous changes of

different intensities have a good exercise effect on the energy supply of the heart and lungs, and can effectively delay the generation of fatigue through continuous changes in the external environment. The aerobic endurance training methods for college basketball players mainly include the following 5 types:

(1) 30 minute aerobic endurance run training

(2) Off road run training

(3) 3200 m run training

(4) YOYO run training

(5) power cycling training

4.3.2.3.2 General anaerobic endurance training methods

The characteristics of basketball determine its high requirements for anaerobic endurance, with anaerobic and mixed energy sources accounting for approximately 85%. There are many confrontations in basketball games, and after the confrontation, it is necessary to complete technical movements such as dribbling, passing, and shooting, while also maintaining a high degree of stability. Therefore, in addition to regular anaerobic endurance training, it is also necessary to simulate the load characteristics and competition environment of basketball games for training to improve muscle endurance. The general anaerobic endurance training methods for college basketball players mainly include the following 8 types:

(1) 28 m * 6 returns

(2) 5.8m * 6 returns

(3) 15 m * 17 returns

(4) 200 meter interval running

(5) Variable speed running

(6) high-intensity comprehensive endurance cycling training

(7) 50m tire rolling training

(8) 1min quick swing battle rope training

4.3.2.4 General agility training methods

In basketball games, whether it's getting rid of defense in attack or chasing defense in defense, athletes need to have good agility. Sensitivity is a comprehensive reflection of an athlete's speed, explosive power, dynamic balance ability, multi-directional movement ability, and coordination ability. Sensitivity training has high requirements for athletes' neuromuscular and power output, and needs to be carried out when the nervous system is relatively excited, energy metabolism pressure is low, and muscles are not fatigued. It is necessary to ensure that the methods are varied, short in time, and with multiple intervals to achieve the best training effect. When designing sensitivity training for college basketball players, it is necessary to integrate their reaction ability, multi-directional starting, acceleration, braking, and directional change, in order to improve their ability to respond immediately and make quick choices during the game. The general sensitivity training methods for college basketball players mainly include the following 10 types:

(1) Rope ladder multi step training

(2) Hexagonal jump training

(3) Multi pose reaction initiation training

(4) Multi directional reaction start brake training

(5) Directional training

(6) Arc run training

(7) T-shaped running training

(8) 5-10-5 agile running training

(9) 米-type run

(10) M-type run

4.3.2.5 Enhanced training methods

Enhanced training, also known as rapid stretching compound training, is a commonly used method of training explosive force in sports physiology. It strengthens the subsequent centripetal contraction by pre stretching the length of muscles and tendons before the centripetal contraction (Wang Liang, 2018). For example, the Counter Movement Jump after rapid squatting (centrifugal contraction) will jump higher than the Static Squat Jump alone. Enhanced training is a form of strength training that can also be used as a pre competition or pre training preparation activity. Before training, it is necessary to ensure that the muscles are fully stretched and activated. The enhanced training methods for college basketball players mainly include the following 24 types:

(1) Double legged left and right jump training

(2) Double legged forward and backward jump training

(3) Single leg left right jump training

(4) Single leg forward and back jump training

(5) Quadrant jump training with two feet

(6) Single leg quadrant jump training

(7) Hip jump training

(8) Small steps with left and right hip hop training

(9) Skating jump training

(10) Jump forward on one foot continuously training

(11) Level 10 frog jump training

(12) Ten step jump training

(13) Bobby jump training

(14) Standing and lying support training

(15) Mountaineering training

(16) Standing open close jump training

(17) Prone support shoulder touch open and close jump training

(18) Knee bend and abdominal jump training

(19) Straight knee abdominal jump training

(20) Jump box training

(21) Step jumping training

(22) Deep jump training

(23) Weight bearing swing training

(24) Post throw gravity ball turn and accelerate run training

4.3.3 Special sports function training methods

During the game, basketball players attack with or without the ball, while defensive players passively defend and complete multiple difficult technical and tactical movements in a fast-paced and highly confrontational environment. Athletes from different positions also have different requirements for their specialized athletic abilities. Outside players need fast running ability, while inside players need stronger resistance and jumping ability. Therefore, functional training methods for basketball players from different positions also vary. This study mainly focuses on three types of specialized functional training for college basketball players: specialized strength training, specialized speed and sensitivity training, and specialized endurance training.

4.3.3.1 Special strength training methods

Basketball is a series of movements that start and end with the athlete's basic posture (feet slightly wider apart than the shoulder joint, knee joint flexion to 130 °~150 °), with the middle connecting single foot jump, double foot jump, front and back split leg squat, side lunge squat, and double leg squat basic movement modes such as squatting, turning, and multi-directional running can be strengthened by

applying load stimulation during the conversion process of these basic movement modes. Due to the need for highly simulating the mechanical characteristics of the competition in specialized strength training, the selection of resistance that athletes face should mainly focus on non trajectory unstable resistance, and the strength confrontation between athletes should be considered as the main content of specialized strength training. Before conducting specialized strength design, it is first necessary to fully understand the physical foundation and technical characteristics of basketball players, and closely combine their technical and tactical levels to develop training plans. The specific strength training methods for basketball players in different positions mainly include the following 16 types:

(1) Resistance turning training with gravity ball

(2) Holding gravity ball resistance step training

(3) lunge up training with gravity ball

(4) Step and turn training with gravity ball

(5) Hand chest gravity ball training

(6) Hand head gravity ball training

(7) Push and jump training with gravity ball

(8) Continuous longitudinal jump training of elastic band resistance

(9) Resistance dribbling training

(10) Heavy basketball passing training

(11) Heavy basketball dribbling training

(12) Heavy basketball layup training

(13) Heavy basketball shooting training

(14) Resistance sliding step training

(15) Center dribbling back to back against man training

(16) Guard and forward take off and lay up against foul training

4.3.3.2 Special speed and agility training methods

Speed and agility are very important in basketball games, players need to get rid of defenders through their flexibility in attack, and defenders need to chase and defend offensive players through quick reaction ability and movement ability. The basketball game is changing rapidly, which requires players to have good perception, prediction and quick reaction ability on the court, and make the most reasonable technical moves to complete the offense or defense. For example, when the player perceives or confirms the running position of his partner, the opponent's offensive or defensive moves, etc., he needs to make a quick decision, whether to choose to dribble, shoot, or pass to his partner when attacking; When defending, choose to slide, double team, steal, or block a shot. (Bohemian J, Beardsley C, 2015). Special speed and agility training methods for college basketball players mainly include the following 10 kinds:

(1) Rope ladder multiple dribbling training

(2) Rope ladder multiple pass training

(3) Rope ladder multiple dribbling and passing combinations training

(4) Elastic band resistance dribbling training

(5) Two players get out of training without a ball throughout the game

(6) Two dribbles throughout the court to break free from training

(7) Reaction dribbling turnback run training

(8) Continuous dribbling over marker bucket training

(9) Halftime no dribbling attack and defense training

(10) No dribbling attack and defense training

4.3.3.3 Special endurance training methods

In basketball matches, around 85% of the time is spent on anaerobic and mixed oxygen energy supply. Fast paced attack and defense and high-intensity physical confrontation greatly consume athletes' physical energy. Special endurance training can help athletes efficiently perform various technical and tactical actions in a good physical state. In addition to energy metabolism, basketball players should also strengthen muscle strength and endurance. Basketball players from different positions have different training methods. Defenders and forwards need to complete more horizontal and rapid movements, while centers need to have strong physical resistance. Therefore, when designing training methods, it is necessary to combine the specific characteristics of athletes and their position on the field to strengthen the strength endurance of specific muscles under specific contraction modes and speeds, help athletes enhance muscle tolerance, and maintain the stability of basic techniques. This is of great significance for improving the quality of the last game or back-to-back competition in basketball games. The specialized endurance training methods for college basketball players mainly include the following 20 types:

(1) Guard and forward resistance sliding training

(2) Guard and forward resistance dribble acceleration training

(3) Guard and forward resistance breakthrough layup training

(4) Resistance movement defensive exercises in the center's restricted area

(5) Practice of catching the ball in the center's restricted area

(6) Center restricted area more holding the ball shooting training

(7) Guard and forward half 1V1 attack and defense training

(8) Center restricted area 1V1 offensive and defensive training

(9) Guard and small forward running catch and shoot off the three-point line

(10) Center reasonable outside the collision zone multi-point catching and shooting training

(11) Full-court 3v3 running shooting game (guard, small forward outside the three-point line, power forward and center outside the paint zone shooting, making 100 shots)

(12) Full court 2-person fast attack training

(13) Full-court fast break 2 attack 1 training

(14) Full court fast break 3 attack 2 training

(15) All three 8-figure fast attack training

(16) Half court corner pass and catch training

(17) 8 people running the whole court continuously hitting the rebound

(18) Full-court 1V1 attack and defense training

(19) Full-court 2V2 quick attack and defense training

(20) Full-court 3V3 quick attack and defense training

Summary

By summarizing previous research and combining my long-term experience in team training and competition, this study referenced the functional training pyramid model and established a complete system of functional physical training methods for college basketball players based on their physical characteristics. There are a total of 286 training methods, including 107 basic physical exercise function training methods and 133 general exercise function training methods, there are 46 methods for specialized sports functional training, and each level of functional training includes multiple specific training methods. The detailed information is shown in Table 10.

Table 10 Overview of functional physical training methods for college basketball players

Level 1	Level 2	Level 3	Number of Training Methods
Body Basic Motor Function Training Methods (107)	Physical flexibility and stability training	Training methods for shoulder joint and upper limb stability	24
		Training methods for shoulder joint and upper limb stability	22
		Lower limb stability training methods	20
	Body flexibility training	Stretching training	18
		Fascia Relaxation Training	12
	Basic action mode training		11
General Motor Function Training Methods (133)	General strength training methods	Upper limb strength training methods	25
		Lower limb strength training methods	24
		Core strength training methods	26
	General speed training methods		11
	General endurance training methods	General aerobic endurance training methods	5
		General anaerobic endurance training methods	8
	General agility training methods		10
	Enhanced training methods		24
Special Sports Function Training Methods (46)	Special strength training methods		16
	Special speed and agility training methods		10
	Special endurance training methods		20
Sum			286

CHAPTER III
RESEARCH METHODS

1. Research design

This chapter describes the overall design of this study, including the selection of samples, measurement indicators and measuring instruments, the formulation of training plans, experimental arrangements, data collection procedures and statistical analysis. This study will adopt a comparative experiment to carry out 10-week physical training for two universities respectively. The experimental group adopts functional physical training and the control group adopts traditional physical training. Various physical data of basketball players in the two groups before and after the experiment are obtained through pre-test and post-test, and the influence of functional physical training on the athletic performance of college basketball players is verified through comparative analysis. The research framework is shown in Figure 4.

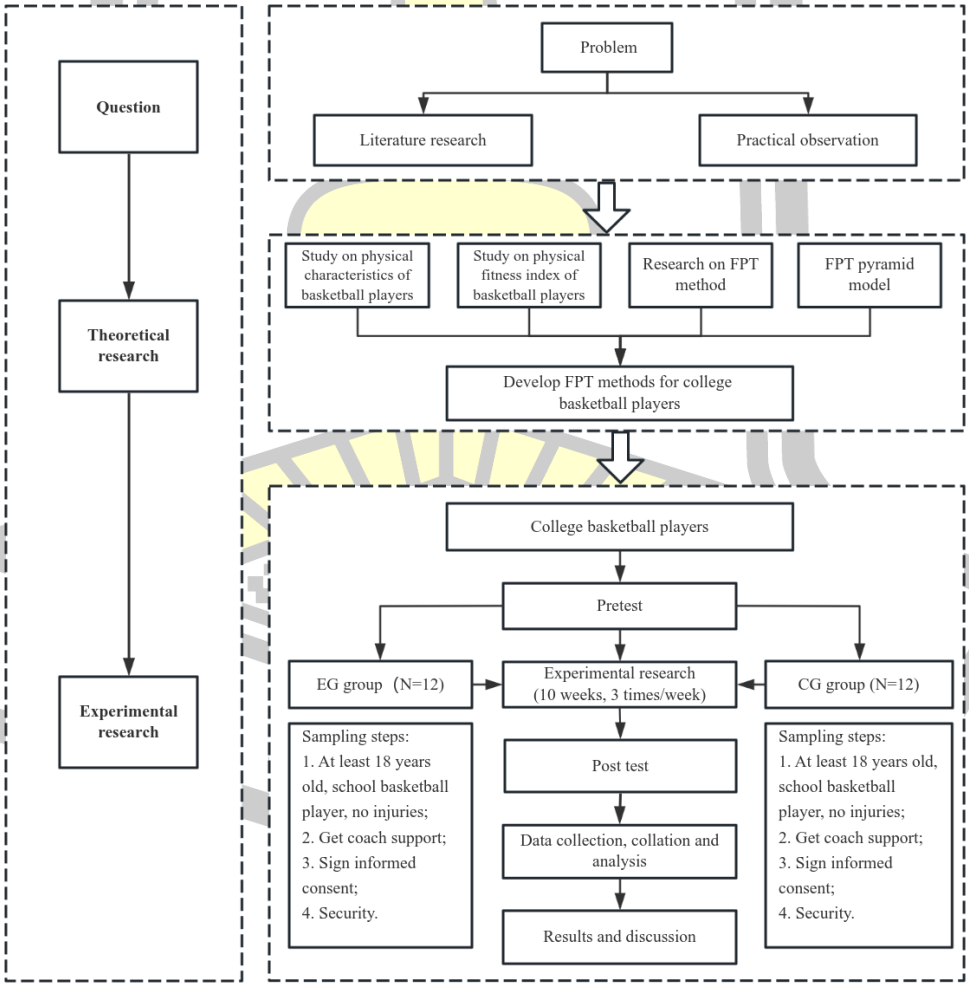


Figure 4 Research framework

Permission was obtained from the Human Ethics Committee of Mahasarakham University on January 31, 2024, before formal data collection, and the permission letter is attached in the appendix.

2. Research subjects

2.1 Theoretical research object

This study takes the basic theory of functional physical training and the application effect of functional physical training methods for college basketball players as the theoretical research object.

2.2 Empirical research object

A total of 24 basketball players from A University (EG: 12 male players) and B University (CG: 12 male players) in Hubei Province, who are preparing for the 2024 Chinese University Basketball Association League (CUBAL), are used as empirical research objects.

3. Research method

3.1. Literature research method

This study was collected through the Chinese Journal Network full-text database (CNKI), Baidu academic search engine, Web of Science citation database, Education Resources Information Center (ERIC), British Library ETHOS, online library, and other literature. CUBAL, basketball, physical fitness, physical fitness training, functional training, functional physical training, and other keywords were used for retrieval, and sports physiology, sports training, etc. were also consulted Sports biomechanics, as well as specialized books on foreign physical fitness training and other related disciplines, provide a comprehensive understanding, analysis, and induction of important research results such as relevant journal literature, theoretical works, and dissertations, master the current research status in relevant fields both domestically and internationally, understand the core ideas and internationally recognized basic principles, methods, and training guidelines, and contemplate the shortcomings and problems of current research, inspiring the research ideas of this

study, Identify innovative points and provide theoretical basis for all work in this study.

3.2 Induction and deduction

This study collects and organizes the application of functional training methods in various sports projects, especially in the study of functional physical training in the same field competitive event group. It summarizes the functional physical training methods suitable for college basketball players, and designs targeted functional physical training methods based on the physical characteristics of basketball players in different positions.

3.3 Experimental method

3.3.1 Objective of the experiment

Using a controlled experiment, a 10-week experimental study was conducted on two groups of basketball players to compare the changes in various specialized quality indicators of athletes and verify the effect of functional physical training on the performance of college basketball players.

3.3.2 Experimental Hypothesis

The hypothesis is that compared to traditional physical training, functional physical training can better improve various specialized quality indicators of college basketball players and enhance their athletic performance.

3.3.3 Experimental subjects

3.3.3.1 Sample size

This study selected 12 participants from 20 members of A University as the experimental group for functional physical training research, and 12 participants from 18 members of B University as the control group for traditional physical training research. Among the 12 players in each team, there are 5 guards, 4 forwards, and 3 centers. 24 basketball players are in good physical condition and have no obvious sports injuries, and voluntarily participate in this study experiment and sign the informed consent form. To ensure fairness and accuracy of data, during the 10 weeks of the experimental, both teams must strictly follow the experimental plan and conduct training without any additional training. I will participate in the training of

the experimental group at A University throughout the entire process, while another member will participate in the training of the control group at B University throughout the entire process.

Table 11 Basic information of basketball players

Groups	Number	Age	Height	Weight
A University（EG）	12	21.00±1.54	186.17±7.30	85.38±11.71
B University（CG）	12	21.42±1.24	185.08±8.16	84.94±13.31
T		-0.731	0.343	0.085
P		0.473	0.735	0.933

Note: * represents p<0.05, * * represents p<0.01

Table 12 Basic situation of EG group basketball players

No.	Name	Age	Height (Cm)	Weight (Kg)
1	ZFQ	20	181	83.3
2	ZXL	19	180	87.4
3	ZWQ	23	175	72.5
4	YJQ	19	183	77.8
5	LJJ	24	178	73.6
6	ZZX	21	187	83.4
7	LHH	21	186	77.8
8	LZM	20	188	78.3
9	WCL	20	190	84.2
10	ZWL	22	192	90.6
11	XC	21	193	107.4
12	DJY	22	201	100.2

Table 13 Basic situation of CG group basketball players

No.	Name	Age	Height (Cm)	Weight (Kg)
1	ZH	22	175	86.3
2	SY	21	175	61.9
3	XHP	21	174	68.2
4	LJH	19	182	72.7
5	AQB	22	180	78.8
6	SYG	20	185	80.7
7	ZP	21	185	92.0
8	LZ	24	191	94.8
9	WC	22	188	84.3
10	HJS	21	193	91.4
11	YFL	22	195	106.0
12	YDS	22	198	102.2

3.3.3.2 Sampling procedure

The two universities selected have been participating in CUBAL competitions in recent years, and in the same participating group, they have won the top 6 in CUBAL Hubei Province competition in recent years. Another reason is that my two friends are the coaches of these two teams respectively, which brings convenience to the implementation and control of empirical research and is conducive to improving the accuracy of experimental results. After contacting the head coach, I explained to them in detail the purpose and value of my research, as well as the measures to ensure the health and safety of athletes, and finally won the support of the two coaches. Therefore, this study finally selected 24 men's basketball players from University A and University B as the empirical research objects.

Sample

The 12 athletes selected from each team must meet the following conditions:

(1) Must be a member of the school basketball team at this university and ensure sufficient time to participate in training

(2) Must be at least 18 years old

(3) Must be physically healthy with no potential injuries or illnesses

(4) Must be willing to participate in this experimental research

Eliminate

During the sampling process, functional motion screening (FMS) was first conducted on 20 members of A University and 18 members of the B University training team to eliminate potential injuries and illnesses. Then, through communication with coaches and athletes, 12 athletes from each group were retained for empirical research.

When conducting investigations on sampled basketball players, the following situations should be emphasized:

(1) Excluding athletes under the age of 18

(2) Eliminate athletes with potential injuries and illnesses

(3) Excluding athletes who are unwilling to participate in this experimental study

(4) Exclude athletes who cannot participate in regular training

Safety guarantee

Considering the full participation of all team members during training, as well as the injury situation during training and competition, and taking into account the principle of multiple collection, all remaining athletes who are eager to test will be tested. If a team member is accidentally injured and exits during the experiment, other team members will be substituted to participate in the experiment. All athletes participating in the test sign an informed consent form, and the basic information related to the athletes is collected by the coaches of each team.

Safety measures for participants during experiments and testing:

(1) Obtain support from the head coach of the basketball team

Contact the head coach of the basketball team and explain in detail the value of your research, the purpose of the research, the entire research process and the measures to ensure the health and safety of the athletes. The most important thing is to

explain the necessity of cooperation between researchers and coaches, to share research results to meet the needs of the coaching team in training theory, to obtain the support of the head coach of the basketball team, and to ask the head coach to recommend the best candidates to participate in the experimental test.

(2) Explain the research value and safety measures of the experimental process to participants

After determining the athletes who meet the requirements, conduct group discussions with the athletes to promote the value of the research, clarify the testing content and duration of the experiment, and reach preliminary cooperation intentions based on their own training and competition arrangements. The training during this experiment is similar to conventional training, with only differences in training content and methods. Pre - and post tests are also routine physical fitness tests and will not cause any harm to the body.

(3) Security protection of participant's personal information

All personal information of participants will be retained and will not be made public. Your personal information will only be used for this study, and relevant data will be destroyed at the end of the study. All data you participate in the experiment will be encrypted and saved on the researcher's computer. After the experiment is completed, the experimental data on the experimental instrument will be completely deleted to ensure that the experimental data will not be leaked during the data collection process. The analysis and digitization of experimental data are carried out on the researcher's computer to ensure there is no risk of data leakage. We will only use comprehensive information and data for reporting and will not disclose the personal information of volunteers.

(4) Interview

Interview athletes who voluntarily participate in the cooperation, propose specific experimental requirements, notify the safety assurance of the entire experimental process, and sign a written document of voluntary participation in the experiment.

Participants' autonomy of choice:

(1) If participants are injured or unable to continue participating in the experiment due to physical reasons during the experiment, they are free to choose to withdraw from the experiment without any negative impact.

(2) Participants who wish to interrupt their participation in the experiment can freely choose to withdraw from the experiment without any negative impact.

3.3.4 Experimental time and location

The experiment will be conducted on the two groups of basketball players for 10 weeks from February 2024 to May 2024, 3 times a week, 90 minutes each time. The two groups of basketball players will be tested before and after the experiment. The pre-test will be conducted one week before the experiment, and the post-test will be conducted one week after the experiment. The test and experiment sites were conducted at University A and University B respectively.

3.3.5 Test indicators and instruments

When evaluating the physical fitness of college basketball players, the primary task is to first establish evaluation indicators and select appropriate measurement tools and methods that can reflect this evaluation indicator. The purpose of measurement is to reflect the attributes or features of things through measured values, so the attributes or features of the things to be measured are the first element of measurement. In practical applications, the deeper the understanding of the attributes of the measured object, the higher the scientific nature of the measurement (Sun Qingzhu, 2006).

Before the test, it is necessary to screen the primary indexes and measuring instruments of basketball players' physical fitness test. A total of 5 experts were selected to participate in the screening of test indicators and measuring instruments. These 5 experts have been engaged in basketball theory and training research for a long time, or engaged in physical training research for a long time, and have a high reputation of professors, doctors and physical trainers.

Table 14 Basic Information of Basketball Players

No.	Name	Position	Research Direction	Organization
1	Zeng Hongtao	Prof.,Ph.D	Basketball theory and practice	Wuhan Sports University
2	Dai Fei	Prof.	Basketball training and competition	Central China Normal University
3	Wang Xingyu	Prof.	Basketball theory and practice	Chengdu Sport University
4	Yang Bin	Prof.	Physical trainer	Yangtze University
5	Sun Ronghui	Prof.	Basketball training and competition	Xi'an Physical Education University

Sampling Procedure

The five experts selected must have the following conditions:

(1) The professional title is professor or has a doctor's degree

(2) Engaged in basketball theory and training or physical training and other related research, and has a high level of research

(3) Have a certain amount of working time and energy to cooperate with the completion of the relevant work of this study

3.3.5.1 Testing indicators

An expert questionnaire survey was conducted on the primary indexes of college basketball players' physical fitness test, which was sent and recovered by mail. Through experts' screening of physical fitness test indicators and measuring instruments for college basketball players, three first-level indicators related to physical fitness of college basketball players are obtained, including body form, body function and athletic quality, and 12 second-level indicators such as height, fitness, vital capacity, heart rate, strength, speed, endurance and agility. And 28 level 3 indicators (Table 15 lists the physical fitness test indicators and test instruments).

Table 15 Physical Fitness Test Indicators for College Basketball Players

First-Level Indicators	Second-Level Indicators	Test Indicators	Testing Instrument
Body Shape	Height	height, standing touch height	Visbody 3D Intelligent Body Tester (China), measuring ruler
	Fullness	Weight, BMI index, body fat Percentage	
Body Function	Vital capacity	Maximum expiratory volume	TZCS-3 electronic Vital capacity tester(China)
	Heart rate（HR）	Quiet HR, HR_{max} during 17 turn back run, heart rate at immediately , 1 minute, 2 minutes, and 4 minutes after the end.	Polar H10 Heart rate monitor(China)
Sports Quality	Maximum strength	Bench press 1RM、 Deep squat 1RM	Stopwatch, tape measure, height feeler, barbell combination equipment, box, gravity ball, Yoga mat.
	Power	Both hands chest pass gravity ball, Standing long jump, Vertical jump height with both feet, Jump height on one leg in the run-up	
	Strength Endurance	90s bench press, 90s deep squat, 1 min knee flexion Sit-up, Plank	
	Speed	3/4 Basketball court sprint run	Brower TCI timing speed tester (USA), stopwatch, Mark bucket
	Anaerobic endurance	Basketball court 17 turn back run	
	Aerobic endurance	3200m run	
	Agility and coordination	T-test, Hexagon jump	
	Flexibility	Sit and reach	Lingkang Sitting Forward Bending Tester

3.3.5.2 Measurement Instrument

The main measuring tools of this study refer to the research of Dr. Xu Jianhua and Dr. Chen Chong. The measuring instrument for BMI and body fat percentage is InBody720 body composition analyzer (South Korea), the measuring instrument for Vital capacity is TZCS-3 electronic Vital capacity tester, and the heart rate tester is Polar H10 Heart rate monitor (Xu Jianhua, 2011); The speed measurement instrument is the Brower TCI timing speed tester (USA), which uses wireless infrared timing and has high testing accuracy (Chen Chong, 2016).The body composition analyzer used in this study is Visbody 3D intelligent body measurement instrument (China), which can quickly generate a real 3D human model through 360-degree scanning, and accurately evaluate body composition, body circumference, muscle mass, fat distribution and

other data. These measuring instruments are internationally recognized and recognized by experts.

Figure 5 Body composition analyzer

Figure 6 Heart rate monitor

Figure 7 Speed

Figure 8 Vital capacity tester

Figure 9 Sit-and-reach tester

3.3.6 Experimental intervention

According to the established functional physical training methods for college basketball players (discussed in Chapter 2), functional physical training was conducted on the experimental group and traditional physical training was conducted on the control group. The experimental intervention period is 10 weeks, with a duration of 3 times a week for 90 minutes each time. Basketball specialized technical and tactical training is conducted every Monday, Wednesday, and Friday, and physical fitness training is conducted every Tuesday, Thursday, and Saturday. Divide the 10 week experimental intervention cycle into three stages, each with its own training objectives and focus.

The first stage is the development of basic motor functions of the body, lasting for 3 weeks. The focus is on developing athletes' aerobic endurance, improving body composition, and strengthening basic strength. The main training methods include body stability training, body flexibility training, basic movement mode training, basic strength training, aerobic endurance training, etc.

The second stage is the development of general motor function, lasting for 4 weeks, focusing on developing athletes' all-round physical fitness and consolidating their strength foundation. The main training content includes anaerobic endurance training, speed and sensitivity training, whole body strength training, body stability training, etc.

The third stage is the development of specialized sports functions, lasting for 3 weeks. The main focus is on developing specialized sports functions, which are combined with competition needs. The main training methods include whole body explosive strength training, specialized endurance training, specialized speed and sensitivity training, and specialized strength training.

Table 16 Functional physical training cycle plan for college basketball players

Period	Pretest	Stage 1 （Week 1-3）	Stage 2 （Week 4-7）	Stage 3 （Week 8-10）	Post Test
Time	2024.2.19-2.25	2024.2.26-3.17	2024.3.18-4.14	2024.4.15-5.5	2024.5.6—5.12
Content	Body shape body function sports quality	Body basic motor function development	General motor function development	Special motor function development	Body shape body function sports quality

3.3.7 Experimental control

One week before the formal testing, conduct a drill on the testing operations and procedures to ensure that every participant understands the testing procedures. The testing methods, evaluation methods, and testers for the pretest and posttest of the experiment are consistent. The coaches of the experimental and control groups must implement training according to the prescribed training plan, supervise and manage

the training process well, and ensure that every athlete can complete the training plan as required during the training experiment.

To ensure the reliability and validity of the experimental results, both groups are not allowed to undergo additional training except for the specified specialized technical and tactical training and physical fitness training. I will participate in and guide the training of the experimental group at A University throughout the entire process, while another team member will participate in the training of the control group at B University throughout the entire process to reduce experimental errors caused by external factors on the training effect.

3.3.8 Data Collection Procedure

This study was conducted under the approval of the Ethics Committee of Mahasarakham University, Approval number: 053-601/2024.

The pretest and posttest will be conducted on-site at A University and B University, respectively, to assess the feasibility of the testing method and familiarize testers and participants with the testing method. All tests are conducted by the same group of testers. Before the formal test, athletes should be fully prepared for warm-up activities to avoid injury.

3.3.8.1 Testing Group Members

The test team consists of 5 basketball coaches and physical education teachers from University A and University B, as well as 5 students majoring in physical education from University A. I and the coaches of the two teams participated in the whole test process, and 5 students assisted and cooperated with the teachers in the test.

During the testing process, testers have a clear division of labor, reasonably arrange testing projects, and each testing indicator is completed by a fixed testing team member. The use of testing instruments and operating procedures are consistent. To ensure the fairness and accuracy of the test results, the scheduling of pre and posttests, the projects responsible for by the test team members, the order of testing for each project, and the order of testing by team members are all the same. The information of the testing team members is shown in Table 17.

Table 17 Information of Test Team Members

Name	Position	Major	Employer	Test Task
Yuan	Lecturer	Human sports science	A University	Body shape, Human body composition analyzer, Heart rate monitor
Jie	Asst Prof.	Sports training	A University	Speed tester
Xiong	Asst Prof.	Physical education and training	A University	Strength
Zhang	Lecturer	Sports training	B University	Flexibility, Endurance
Liu	Asst Prof.	Physical education and training	B University	Vital capacity, Agility and coordination
Li Etc. 5 People	student	physical education	A University	Assistance and cooperation

3.3.8.2 Test arrangement

A pre-test is conducted before the formal test. The two teams will conduct two days of testing respectively, and reasonably arrange the test sequence and interval time according to the difficulty, exercise intensity, test duration, field equipment, etc. Considering that the test results of the subjects cannot be affected by fatigue, we will arrange the test time relatively generous, so that the subjects have enough time to recover physical fitness. In order to ensure the fairness and accuracy of the test results, the time arrangement of the pre-test and post-test, the items that the members of the test team are responsible for, the order of the tests of each project, and the order of the tests of the members are the same.

Table 18 Test Schedule

Time		Test sequence
First day (A University)	a.m	Age, height, weight, BMI, body fat percentage, vital capacity, sitting forward bend, standing long jump, standing height, standing jump with two feet, running with one foot jump height
	p.m	1 minute sit-up, 1RM bench press, 1RM squat
The Second Day (A University)	a.m	Quiet heart rate, two-handed chest gravity ball, 3/4 basketball court acceleration run, T run, Hexagon jump, 17 return run (including maximum heart rate and post-exercise heart rate)
	p.m	Plank, 90S bench press, 90S squat, 3200m run
The third day	a.m	Age, height, weight, BMI, body fat percentage, vital capacity, sitting forward bend, standing long jump, standing height,

(B University)		standing jump with two feet, running with one foot jump height
	p.m	1 minute sit-up, 1RM bench press, 1RM squat
The fourth day (B University)	a.m	Quiet heart rate, two-handed chest gravity ball, 3/4 basketball court acceleration run, T run, Hexagon jump, 17 return run (including maximum heart rate and post-exercise heart rate)
	p.m	Plank, 90S bench press, 90S squat, 3200m run

3.3.8.3 Preparing for Tests

Based on the problems found during the test preparation process, eliminate all potential hazards that may affect the accuracy of the test, install and debug the equipment, and prepare. The participants wore lightweight sportswear and basketball shoes. All subjects were numbered and recorded before the start of the test and were fully warmed up.

3.3.8.4 Test Process

Athletes complete each test item in sequence according to the numbering order, and the person in charge of each test point organizes and evaluates the completion of the athletes and records and collects the results of the athletes. After the first subject completes the test and saves the test data, the second subject starts the test, completes the test for all subjects in turn, and correctly saves the test data. Errors in the testing process should be retested in time. When performing bench press and squat tests, protect and help to avoid injury. See appendix 1 for specific test methods.

3.3.8.5 Precautions

The first is to ensure the safety of the subjects, to let the subjects fully understand the test requirements and procedures, and to ensure that the subjects are fully warmed up before the test to avoid sports injuries. The second is to ensure the safety of the test instrument, to hire professional operators to operate, to avoid operating errors and affect the accuracy of the test process and test results. The third is to ensure the safety of the data, after the test, to save and backup the test data in time.

3.3.9 Data Analysis

Statistical analysis was conducted on pretest and post test data using software Excel 2021, and independent sample T-tests and paired sample T-tests were conducted on pretest and post test data using SPSS 27.0 software. Finally, longitudinal differences and significance were compared and analyzed between the pretest and post test data after processing, and then horizontal differences and significance were compared and analyzed to draw experimental conclusions.

4. College basketball players functional physical training cycle arrangement

The two men's basketball teams will prepare for the CUBAL competition in 2024. According to the competition schedule and the progress arrangement of this study, in order not to affect the preparation of the teams, a 10-week comparative study and analysis of functional physical training and traditional physical training will be conducted between the two teams from February 2024 to May 2024, with a view to providing guidance for the teams to achieve excellent results.

According to the functional training pyramid model, the experimental group divided the research process into three training stages, namely, the basic motor function training stage, the general motor function training stage and the special motor function training stage. In these three stages, targeted training plans will be implemented according to the actual situation of the athletes and the physical needs of the athletes in the basketball game.

Table 19 Functional physical training cycle arrangement

Training Stage	Time	Objective	Content
The first stage: basic motor function training	Weeks 1-3	Establish a good basic movement pattern.	Upper limb flexibility and stability, lower limb and core stability, running, jumping and multi-directional movement, body flexibility and stability, base strength, flexibility,etc.
The second stage: general motor function training	Weeks 4-7	In the correct movement mode, comprehensively improve the physical quality indicators.	General strength, core strength, speed, aerobic endurance, anaerobic endurance, agility, flexibility, plyometrics, etc.
The third stage: special motor function training	Weeks 8-10	Combine basketball special sports, consolidate and improve special physical quality.	Special strength, special speed and agility, special endurance, etc

In the design and arrangement of functional physical training programs, we need to follow the following principles: First, let the athletes learn and master the correct movement mode. For example, action essentials, force order, precautions and so on. Second, the easy things first and then the difficult ones, step by step. For example, the transition from simple to complex technical action, the transition from multiple support points to less support points, the transition from stable support surface to unstable support surface, and the transition from contralateral support to the same side support mode. Third, the exercise load is gradually increasing from small to large. For example, when performing basic strength exercises, you can start with simple self-weight training, and then with the aid of simple instruments, the weight gradually increases, and the number of exercises and repetition groups can also be gradually increased from less to more.

After formulating the functional physical training plan, the prepared training plan will be sent to 5 basketball experts and physical training trainers by email, inviting experts to evaluate the scientific nature of the functional physical training plan, and modify the training plan with low score according to the suggestions of experts.

4.1 Body basic motor function training cycle arrangement

The goal of this stage of training is to help athletes establish good basic motor functions. The training cycle is 3 weeks (1-3 weeks), every Tuesday, Thursday, Saturday training, each training about 90min, including the basic movement mode, joint flexibility, body stability, flexibility, basic strength, etc.

4.1.1 Weekly training plan arrangement

Basic motor function training is the basic part of functional physical training, and the training focuses more on enabling basketball players to master the correct basic movement mode. In the weekly training plan, the first week mainly focuses on upper limb flexibility and stability, the second week focuses on core stability, and the third week focuses on lower limb stability. In view of the athletes every Monday, Wednesday and Friday to conduct technical and tactical confrontation training, therefore, in the design of every Tuesday, Thursday and Saturday physical training plan should be organically combined with technical and tactical training, reasonable arrangement. In the basic motor function training stage of functional physical training, Tuesday mainly focuses on basic movement patterns, including running, jumping, and multi-directional movement; Thursday mainly focuses on body flexibility and stability, including upper and lower limb stability, core stability, etc. Saturday mainly focuses on basic strength and pre-rehabilitation training.

Table 20 Body basic motor function training stage weekly training arrangement

Training Week		Training Content	Duration	Training Purpose
Week 1	Tuesday.	Warm-up training Basic movement pattern training Joint flexibility and stability training Regenerative recovery training	25min 20min 25min 20min	Dynamic warm-up preparation between marching, activate muscles, complete the correct action mode of multi-direction starting, acceleration and braking, improve joint flexibility and range of motion.
	Thursday	Warm-up training Upper limb stability training Regenerative recovery training	25min 45min 20min	Enhance the stability of upper limb shoulder, elbow and wrist joint, improve coordination; Improve body flexibility.
	Saturday	Warm-up training Basic strength training Regenerative recovery training	25min 45min 20min	Self-weight or light equipment strength training, master the correct movement mode, improve the body control ability; Relax stretching and restore finishing.

	Tuesday.	Warm-up training Basic movement pattern training Anaerobic endurance training Regenerative recovery training	25min 25min 20min 20min	Complete the basic movement modes such as changing direction, turning, sliding step and crossing step, and improve the special movement ability of basketball; Increase anaerobic endurance.
Week 2	Thursday	Warm-up training Core stability training Regenerative recovery training	25min 45min 20min	Develop core muscle strength and improve core stability; Improve body flexibility.
	Saturday	Warm-up training Basic strength training Regenerative recovery training	25min 45min 20min	Self-weight or light equipment strength training, master the correct movement mode, improve the body control ability; Relax stretching and restore finishing.
	Tuesday.	Warm-up training Basic movement pattern training Aerobic endurance training Regenerative recovery training	20min 20min 30min 20min	Complete running, turning, squat, jumping, landing, falling and other movement patterns to improve the weak side chain; Improve aerobic capacity.
Week 3	Thursday	Warm-up training Lower limb stability training Regenerative recovery training	20min 50min 20min	Development of hip, knee and ankle joint stability; Relax stretching and restore finishing.
	Saturday	Warm-up training Basic strength training Regenerative recovery training	20min 50min 20min	Self-weight or light equipment strength training, master the correct movement mode, improve the body control ability; Relax stretching and restore finishing.

4.1.2 Class training arrangement

In the basic motor function training stage of functional physical training, the first thing is to let basketball players master the correct basic movement mode, and complete the movement mode of running, jumping, squat, turning, sliding, cross-step, backward step, multi-direction starting, acceleration and braking; The second is to strengthen the body flexibility exercise, improve the flexibility and range of motion of each joint; The third is to increase the strength of small muscle groups to improve the stability of upper and lower limbs and core; The fourth is to appropriately increase aerobic and anaerobic exercise to improve the internal load stimulation of basketball players.

Table 21 lists the training plan of the first class of the first week of functional physical training. The training time is arranged from 6:00 PM to 7:30 PM, with a total of 90 minutes. The training focuses on the upper limbs and is supplemented by the lower limbs. Because it is the first class of functional physical training, the first is to let students master the basic movements and requirements of warm-up preparation and dynamic stretching; Secondly, let the students establish the basic upper and lower

limb movement pattern; The third is the flexibility and stability training of shoulder joint, as well as the stability training of the entire upper limb. The training is from easy to difficult, and the load adopts the body weight or the elastic band to resist resistance. Finally, static stretching accelerates the recovery of muscle fatigue and improves the flexibility of the body.

Table 21 Body basic motor function training stage class training arrangement (Week 1 Tuesday example)

Training Purpose	Training Content	Groups	Duration/ Times/Distance	Intermittent Time
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Muscle Activation	Crawl	2	15m	60s
Upper Limb Movement Pattern	Stand in Y-shape	3	15-20 times	15s
	Stand in T-shape	3	15-20 times	15s
	Stand in W shape	3	15-20 times	15s
	Stand in L-shape	3	15-20 times	15s
Lower Limb Movement Pattern	Lunge exercise	2	15m	15s
	Running form exercise	1	15m	15s
	Starting and scram exercises	2	15m	20s
	Multi-directional movement and braking exercises	3	6m*10	20s
Shoulder Flexibility	Stretch the elastic band back and forth around the loop	2	10 times	30s
Scapular Stability	Shoulder joint stroke against the wall	3	15-20 times	30s
	Stretch strap shoulder joint against wall stroke	3	12-15 times	30s
Upper Limb Stability	Bend your knees and do push-ups	2	20 times	30s
	Straight knee push-ups	2	20 times	30s
	Two-handed elastic bar stability exercises	2	20s	30s
	One-handed elastic bar stability exercises	2	20s	30s
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

4.2 General motor function training cycle arrangement

The goal of this stage of training is to ensure that the athletes are in the correct movement mode and improve the overall physical fitness indicators. The training cycle is 4 weeks (4-7 weeks), including general strength, core strength, speed, aerobic endurance, anaerobic endurance, agility, plyometric training, etc.

4.2.1 Weekly training plan arrangement

In the first stage of basic motor function development training, basketball players have mastered the correct movement mode, including running, jumping, stopping, multi-direction movement and braking, basic strength exercises, and upper and lower limb stability and core stability. The second stage is the development of general motor function, which will continue to consolidate the stability of the body, while focusing on the training of general motor quality. According to the overall arrangement of this stage, on Tuesday mainly to general speed, sensitivity and coordination, anaerobic endurance; Thursday focused on the development of athletes' general strength and core strength, consolidating the stability of the body; Saturdays are plyometrics and cardio. At the end of each training session, it is supplemented with flexibility exercises to relax muscles and promote recovery from fatigue.

Table 22 General motor function training stage weekly training arrangement

Training Week		Training Content	Duration	Training Purpose
Week 4	Tuesday.	warm-up	20min	Develop body coordination and rapid reaction ability, as well as the ability to move quickly in multiple directions, improve anaerobic endurance.
		Agility and coordination training	25min	
		Speed training	15min	
		Anaerobic endurance training	15min	
		Regenerative recovery training	15min	
	Thursday	warm-up	20min	Develop overall muscle strength, enhance body stability, and improve muscle endurance.
		Strength training	50min	
		Regenerative recovery training	20min	
	Saturday	warm-up	20min	Develop explosive power and aerobic endurance.
		Plyometric training	20min	
		Aerobic endurance training	30min	
		Regenerative recovery training	20min	
Week 5	Tuesday.	warm-up	20min	Develop body coordination and rapid reaction ability, as well as the ability to move quickly in multiple directions, improve anaerobic endurance.
		Agility and coordination training	25min	
		Speed training	15min	
		Anaerobic endurance training	15min	
		Regenerative recovery training	15min	
	Thursday	warm-up	20min	Develop overall muscle strength, enhance body stability, and improve muscle endurance.
		Strength training	50min	
		Regenerative recovery training	20min	
	Saturday	warm-up	20min	Develop explosive power and aerobic endurance.
		Plyometric training	20min	
		Aerobic endurance training	30min	
		Regenerative recovery training	20min	

	Tuesday.	warm-up	20min	Develop body coordination and rapid reaction ability, as well as the ability to move quickly in multiple directions, improve anaerobic endurance.
		Agility and coordination training	25min	
		Speed training	15min	
		Anaerobic endurance training	15min	
		Regenerative recovery training	15min	
Week 6	Thursday	warm-up	20min	Develop overall muscle strength, enhance body stability, and improve muscle endurance.
		Strength training	50min	
		Regenerative recovery training	20min	
	Saturday	warm-up	20min	Develop explosive power and anaerobic endurance.
		Plyometric training	20min	
		Anaerobic endurance training	30min	
		Regenerative recovery training	20min	
Week 7	Tuesday.	warm-up	20min	Develop body coordination and rapid reaction ability, as well as the ability to move quickly in multiple directions, improve anaerobic endurance.
		Agility and coordination training	25min	
		Speed training	15min	
		Anaerobic endurance training	15min	
		Regenerative recovery training	15min	
	Thursday	warm-up	20min	Develop overall muscle strength, enhance body stability, and improve muscle endurance.
		Strength training	50min	
		Regenerative recovery training	20min	
	Saturday	warm-up	20min	Develop explosive power and aerobic endurance.
		Plyometric training	20min	
		Aerobic endurance training	30min	
		Regenerative recovery training	20min	

4.2.2 Class training arrangement

Table 23 lists the training arrangements on Thursdays of the fourth week of general motor function training. On Thursdays, general strength training, core strength training and body stability training are mainly used. In the design of upper body strength training, the first is to combine the structure of human upper body and the characteristics of basketball, complete the push, pull, adduction, abduction and rotation and other forces; Secondly, multi-plane, multi-angle and all-round participation conforming to functional training. Basketball players in the game continue to complete a variety of starting, acceleration, emergency stop, change direction, jump and landing and other actions, so the athlete's lower limb strength requirements are very high.

The lower extremity joint consists of hip, knee and ankle. In the design of lower extremity strength training, athletes also need to complete the lower extremity push, pull, adduction, abduction and rotation, so as to enhance the muscle strength of lower

extremity, improve the stability of joint and reduce the sports injury of knee and ankle joint.

The core motor muscles of the body are the hub connecting the upper and lower limbs. Strong core muscle strength can reduce the loss of energy in the transmission process, improve the movement range and speed, and enhance the stability of the body. In the design of core strength training, athletes mainly complete the trunk flexion, extension, lateral flexion, rotation and other actions to enhance the strength of the deep stabilizing muscles and the surface motor muscles.

Table 23 General motor function training period training arrangement
(Week 4 Thursday example)

Training Purpose	Training Content	Load	Groups	Duration/Times/Distance	Intermittent Time
Warm-Up	6 dynamic movements	——	2		15s
Dynamic Stretch	8 dynamic stretches	——	1		15s
Core Instability Training	Elbow Swiss ball over bridge	Own weight	3	45s	30s
	Swiss ball down the bridge with legs	Own weight	3	45s	30s
	Supine Swiss ball Russian spin	Own weight	3	15-20 times	30s
Upper Limb Muscle Activation	push-up	Own weight	2	20 times	30s
Upper Body Strength Training	Bench press	65-75%1RM	3	10-15 times	60s
	Stand on the bar and push on the chest	30-35KG	3	10-15 times	60s
	Stand with keiser and pull both hands down	65-75%1RM	3	10-15 times	60s
Lower Limb Stability Training	Standing elastic band to resist knee and hip abduction	——	3	15-20 times	60s
	Standing position elastic band anti-resistance knee lift hip adduction		3	15-20 times	60s
Lower Limb Strength Training	Calf Raise	40KG	3	15-20 times	60s
	Kettlebell squat	10KG	3	15-20 times	60s
Regenerative Recovery Training	Stretch training 10 movements	——	1	30s	5s
	Fascial relaxation		1	60s	5s

4.3 Special motor function training cycle arrangement

This stage is combined with basketball special sports, consolidate and improve the athletes special physical quality. The training cycle is 3 weeks (8-10 weeks), including special strength, special speed and agility, and special endurance.

4.3.1 Weekly training plan arrangement

After the first two stages of training, the movement pattern and physical qualities of basketball players have been improved and strengthened. In the third stage of the special sports function training cycle, it will further combine with the special basketball and the technical characteristics of basketball players in different positions, increase the exercise intensity, and focus on improving the special strength, speed, sensitivity, endurance and other qualities of college basketball players. About 85% of the time in basketball games are anaerobic and mixed oxygen energy for physical confrontation, getting rid of offensive and defensive actions, therefore, the third stage will continue to strengthen the basic strength, increase the special speed and sensitivity, as well as special anaerobic endurance training proportion, improve the basketball players' physical confrontation ability.

Table 24 Special motor function training stage weekly training arrangement

Training Week		Training Content	Duration	Training Purpose
Week 8	Tuesday	warm-up Special speed and agility training Special endurance training Regenerative recovery training	15min 20min 35min 20min	Improve body sensitivity and quick reaction ability; Strengthen physical confrontation and muscular endurance.
	Thursday	warm-up Special strength training Regenerative recovery training	15min 55min 20min	Strengthen the physical strength and instability countervailing power of athletes.
	Saturday	warm-up Special speed and agility training Special endurance training Regenerative recovery training	15min 20min 35min 20min	Improve body sensitivity and quick reaction ability; Strengthen muscle endurance and anaerobic endurance.
Week 9	Tuesday	warm-up Special speed and agility training Special endurance training Regenerative recovery training	15min 20min 35min 20min	Improve body sensitivity and quick reaction ability; Strengthen physical confrontation and muscular endurance.
	Thursday	warm-up Special strength training Regenerative recovery training	15min 55min 20min	Strengthen the physical strength and instability countervailing power of athletes.

	Saturday	warm-up Special speed and agility training Special endurance training Regenerative recovery training	15min 20min 35min 20min	Improve body sensitivity and quick reaction ability; Strengthen muscle endurance and anaerobic endurance.
	Tuesday	warm-up Special speed and agility training Special endurance training Regenerative recovery training	15min 20min 35min 20min	Improve body sensitivity and quick reaction ability; Strengthen physical confrontation and muscular endurance.
Week 10	Thursday	warm-up Special strength training Regenerative recovery training	15min 55min 20min	Strengthen the physical strength and instability countervailing power of athletes.
	Saturday	warm-up Special speed and agility training Special endurance training Regenerative recovery training	15min 20min 35min 20min	Improve body sensitivity and quick reaction ability; Strengthen muscle endurance and anaerobic endurance.

4.3.2 Class training arrangement

Table 25 lists the training course arrangement of Saturday in the eighth week of the special motor function training stage. The training content mainly includes special speed and agility training and special endurance training. The training purpose is to improve the athletes' quick reaction ability, enhance their muscle tolerance and anaerobic endurance ability, so that they can complete offensive and defensive movements with high quality under high-intensity confrontation. In the special speed and agility training, it mainly focuses on the ability to get rid of the ball and the change of dribbling rhythm in the attack and defense of the whole court; In the special endurance training, it mainly focuses on the speed and sensitivity of basketball players' sliding defense, the ability of full-court offensive and defensive transition, and the stability of shooting under high-intensity exercise.

Table 25 Special motor function training period training arrangement
(Week 8 Saturday example)

Training Purpose	Training Content	Groups	Distance/ Duration/ Number	Intermittent Time
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Special Speed And Agility Training	Rope ladder a variety of dribbling and passing combination	6	12m	20s
	Two players dribble out of the court	4	28m	60s
	Guards and forwards resist sliding	3	28m	30s
Special Endurance Training	Center block movement defense	3	30s	30s
	Three players 8-figure fast break	4	6 balls	90s
	Guard, forward half 1V1 attack and defense	6	60s	60s
	Center zone 1V1 attack and defense	6	60s	60s
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

4.4 Implementation of training plan

The coach of the experimental group and the control group must implement the training in accordance with the prescribed training plan, do a good job in the supervision and management of the training process, and ensure that every athlete can complete the training plan as required during the training experiment. During the experiment, the athletes should ensure adequate sleep and nutrition.

In order to ensure the reliability and validity of the experimental results, the two groups were not allowed to do additional training except for the specified special technical and tactical training and physical training. The researcher will participate in and guide the training of the experimental group in the whole process, and the other team members will participate in the training of the control group in the whole process, so as to reduce the experimental error caused by the influence of external factors on the training effect.

Before the implementation of the training plan, we must first strengthen the ideological education of the athletes, correct the attitude, and encourage the athletes to focus on the training; The second is to fully warm up before training, so as to avoid

sports injuries; The third is that the training should be carried out scientifically, step by step, strictly control the load and interval time, and always pay attention to the training status of the athletes to avoid sports injuries caused by too much intensity; At the same time, pay attention to the details of the exercise movement, do not occur muscle and joint compensation. The fourth is to stretch and relax after training, prevent excessive fatigue, and always pay attention to the athlete's physical pain and recovery.

CHAPTER IV
RESEARCH RESULTS AND ANALYSIS

In this chapter, according to the purpose of the research, SPSS will be used to conduct T-test on the experimental pre-test and post-test data. First, an outlier test was conducted on the two groups of data to check whether the data conforms to the normal distribution. For samples that do not conform to the normal distribution (< 0.05), non-parametric test was used, Mann-Whitney U test was used for between group data, and Wilcoxon rank-sum test was used for within group data. Then, the t test will be used for data conforming to normal distribution, independent sample t test will be conducted for between group pre-test data and post-test data, and paired sample t test will be conducted for within group pre-test and post-test data.

Research objectives:

(1) To compare the effects of functional physical training and traditional physical training on between groups physical fitness: body shape, body function and sports quality.

(2) To compare the effects of functional physical training and traditional physical training on within group physical fitness: body shape, body function and sports quality.

1. Comparison of physical fitness indexes before and after the experiment between groups

1.1 Body Shape

In this study, Visbody body composition analyzer can be used to obtain the athletes' height, weight, body fat percentage, BMI and other morphological indicators, which can reflect the composition of various internal tissues of the human body and provide a basis for the formulation of scientific and reasonable muscle building and fat reduction plans.

Table 26 Comparison of pre-test body shape between groups

	CG		EG		T	P
	$\overline{X}$	SD	$\overline{X}$	SD		
Height (Cm)	185.08	8.16	186.17	7.30	-0.343	0.735
Weight (Kg)	84.94	13.31	85.38	11.71	-0.085	0.933
Bmi	24.68	2.45	24.57	2.35	0.102	0.92
Body Fat (%)	15.62	3.23	16.16	6.42	—	0.713
Standing Touch Height (Cm)	240.33	10.50	241.08	10.27	-0.177	0.861

Note: * represents p<0.05, * * represents p<0.01

From table 26, it found that height, weight, BMI, body fat percentage, and standing touch height have no differences in the pre-test between groups.

The height of the CG group was 185.08±8.16, and that of the EG group was 186.17±7.30. The t test results of the pre-test data of the two groups showed that the t = -0.343, p = 0.735 (p > 0.05), with no difference.

The body weight of the CG group was 84.94±13.31, and the height of the EG group was 85.38±11.71. t = -0.085, p = 0.933 (p > 0.05), with no difference.

The BMI of CG group was 24.68±2.45, and that of EG group was 24.57±2.35. t = 0.102, p = 0.92 (p > 0.05), with no difference.

The body fat percentage of the CG group was 15.62±3.23, and that of the EG group was 16.16±6.42. Since the pre-measured data of body fat percentage of the CG group did not conform to the normal distribution, Mann-Whitney U test was adopted, and the results showed that there was no difference, p=0.713 (p > 0.05).

The team standing height of the CG group was 240.33±10.50, and that of the EG group was 241.08±10.27. t= -0.177, p = 0.861 (p > 0.05), with no difference.

Table 27 Comparison of post-test body shape between groups

	CG		EG		T	P
	$\overline{X}$	SD	$\overline{X}$	SD		
Height (Cm)	185.08	8.16	186.17	7.30	-0.343	0.735
Weight (Kg)	84.58	13.02	84.71	10.49	-0.060	0.980
Bmi	24.53	2.31	24.38	1.92	0.153	0.880
Body Fat(%)	15.12	3.12	14.64	5.68	—	0.292
Standing Touch Height (Cm)	240.33	10.50	241.08	10.27	-0.177	0.861

Note: * represents p<0.05, * * represents p<0.01

From table 27, it found that height, weight, BMI, body fat percentage, and standing touch height have no differences in the post test between groups.

The body weight of the CG group was 84.58±13.02, and the height of the EG group was 84.71±10.49. The t-test results of the post-test data of the two groups showed that t=-0.060, p=0.953 (p > 0.05), with no difference.

The BMI of CG group was 24.53±2.31, and that of EG group was 24.38±1.92. t=0.153, p=0.880 (p > 0.05), and there was no difference between the two groups.

The body fat percentage of the CG group was 15.12±3.12, and that of the EG group was 14.64±5.68. Since the post-measurement data of body fat percentage of the CG group did not conform to the normal distribution, Mann-Whitney U test was adopted, and the results showed that there was no difference, p=0.292 (p > 0.05).

1.2 Body Function

This study will observe the changes of quiet heart rate of athletes of two teams through a 1-minute morning pulse test (Song Lulu, 2022); Polar H10 heart rate monitor was used to monitor the heart rate of the two groups of athletes during and after the 17 return run to evaluate the cardiopulmonary function of the athletes (Xu Jianhua, 2011).

From table 28 found that vital capacity, quiet HR, HR_{max}, immediate HR, HR 1 min, 2 min, 4 min after exercise have no differences in the pretest between groups.

Table 28 Comparison of body function pre-test between groups

	CG		EG		T	P
	$\overline{X}$	SD	$\overline{X}$	SD		
Vital Capacity (Ml)	4535.42	283.06	4416.58	237.64	1.114	0.277
Quiet Hr	61.92	1.93	62.17	1.80	-0.328	0.746
Hr_{max}	184.58	3.50	185.17	4.99	-0.332	0.743
Immediate Hr	183.25	2.73	184.00	4.61	-0.485	0.633
End 1min	165.83	2.98	165.25	3.65	0.429	0.672
End 2min	145.75	3.39	144.67	3.75	0.743	0.466
End 4min	119.33	4.10	118.92	3.53	0.267	0.792

Note: * represents $p<0.05$, * * represents $p<0.01$

The comparison of pre-test of vital capacity between the two groups, the team data of CG group was 4535.42±283.06, and that of EG group was 4416.58±237.64. t-test results found that t=1.114, p=0.277 ($p > 0.05$), with no difference.

The comparison of quiet HR pre-test between the two groups, the team data of CG group was 61.92±1.93, and that of EG group was 62.17±1.80. t=-0.328, p=0.746 ($p > 0.05$), with no difference.

In the HR_{max} comparison, the team data of CG group was 184.58±3.50, and that of EG group was 185.17±4.99. t=-0.332, p=0.743 ($p > 0.05$), with no difference.

In the immediate HR comparison after the exercise, the team data of CG group was 183.25±2.73, and that of EG group was 184.00±4.61. t=-0.485, p=0.633 ($p > 0.05$), with no difference.

In comparison, 1min after the exercise, t=0.429, p=0.672 ($p > 0.05$), there was no difference.

In comparison, 2min after the exercise, t=0.743, p=0.466 ($p > 0.05$), there was no difference.

In comparison 4min after the exercise, t=0.267, p=0.792 ($p > 0.05$), there was no difference (Table 28).

From table 29 found that vital capacity, quiet HR, HR_{max}, after exercise immediate HR, have no differences in the post test between groups($p > 0.05$). HR 1 min, 2 min, 4 min after exercise have a significant difference($p<0.05$). After 10 weeks of functional physical training, the recovery ability of EG group was significantly enhanced after exercise.

Table 29 Comparison of body function pre-test between groups

	CG		EG		T	P
	$\overline{X}$	SD	$\overline{X}$	SD		
Vital Capacity (Ml)	4614.42	254.55	4729.83	205.41	-1.222	0.235
Quiet Hr	60.67	2.19	60.25	1.60	0.532	0.600
Hr_{max}	182.83	3.38	182.08	4.94	0.434	0.669
Immediate Hr	182.25	2.80	180.83	4.51	0.925	0.365
End 1min	164.50	2.61	160.92	4.17	2.525	0.019*
End 2min	143.58	2.88	139.00	3.67	3.407	0.003**
End 4min	116.50	4.10	109.75	2.56	4.835	0.000**

Note: * represents $p<0.05$, * * represents $p<0.01$

After a 10-week intervention, the comparison of posttest of vital capacity between the two groups, the data of CG group was 4614.42±254.55, and that of EG group was 4729.83±205.41. The t test results showed that t=-1.222, p=0.235 ($p > 0.05$), with no difference.

In the quiet heart rate comparison, the data of CG group was 60.67±2.19, and that of EG group was 60.25±1.60. t=0.532, p=0.600 ($p > 0.05$), with no difference.

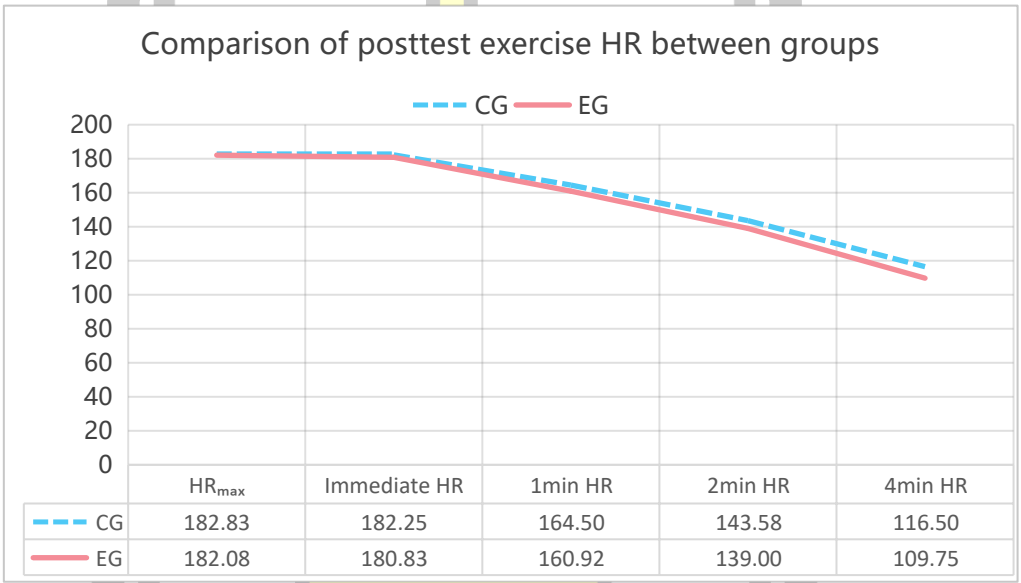
In the comparison of HR_{max}, the team data of CG group was 182.83 ± 3.38, and the team data of EG group was 182.08 ± 4.94. t=0.434, p=0.669 ($p>0.05$), with no difference.

In the immediate HR comparison after the exercise, the team data of CG group was 182.25 ± 2.80, and the team data of EG group was 180.83 ± 4.51. t=0.925, p=0.365 ($p>0.05$), with no difference.

1 minute after the exercise, the CG group had a team data of 164.50 ± 2.61, while the EG group had a team data of 160.92 ± 4.17. t=2.525, p=0.019 ($p<0.05$), have a significant difference.

2 minutes after the exercise, the CG group had a team data of 143.58 ± 2.88, while the EG group had a team data of 139.00 ± 3.67. t=3.407, p=0.003 (p<0.01), have a significant difference.

4 minutes after the exercise, the CG group had a team data of 116.50 ± 4.10, while the EG group had a team data of 109.75 ± 2.56. t=4.835, p<0.01, have a significant difference (Table 29).



	HR_{max}	Immediate HR	1min HR	2min HR	4min HR
CG	182.83	182.25	164.50	143.58	116.50
EG	182.08	180.83	160.92	139.00	109.75

Figure 10 Post-test heart rate curve between groups

1.3 Sports quality

Sports quality is the strength, power, speed, endurance, sensitivity, flexibility and other functional abilities shown by the human body in sports, which is the basis of mastering sports technology and improving sports performance.

1.3.1 Strength and power

According to the characteristics of basketball, the strength quality index selected in this research mainly includes two parts: maximum strength and power. Bench press 1RM and deep squat 1RM were used to assess the maximum strength of athletes' upper and lower limb muscles. The power of the upper limbs of athletes was evaluated by both hands' chest pass gravity ball. The explosive power of lower limbs

was measured by standing long jump, Vertical jump height with both feet and jump height on one leg in the run-up.

From table 30 found that bench press 1RM, deep squat 1RM, both hands chest pass gravity ball, standing long jump, Vertical jump height with both feet and jump height on one leg in the run-up have no differences in the pretest between groups.

Table 30 Comparison of strength and power pretest between groups

	CG		EG		T	P
	$\overline{X}$	SD	$\overline{X}$	SD		
Bench Press 1rm (Kg)	82.92	7.22	82.58	9.10	0.099	0.922
Deep Squat 1rm (Kg)	122.58	7.15	123.33	9.85	-0.213	0.833
Both Hands Chest Pass Gravity Ball (M)	7.79	0.65	7.72	0.63	0.289	0.775
Standing Long Jump (Cm)	264.33	10.00	267.58	13.28	-0.677	0.505
Vertical Jump Height with Both Feet (Cm)	69.00	5.19	69.50	7.57	-0.189	0.852
Jump Height on One Leg in The Run-Up (Cm)	73.42	5.63	73.83	8.36	-0.143	0.887

In the pre-test comparison between groups, the bench press 1RM of the CG group was 82.92±7.22, and that of the EG group was 82.58±9.10. The t test results showed that t=0.099, p=0.922 (p > 0.05), with no difference. The deep squat 1RM of the whole team in CG group was 122.58±7.15, and that in EG group was 123.33±9.85. t=-0.213, p=0.833 (p > 0.05), with no difference.

In both hands chest pass gravity ball comparison, the CG group was 7.79±0.65 and that of the EG group was 7.72±0.63. t=0.289, p=0.775 (p > 0.05), with no difference.

In the standing long jump scores of the CG group and the EG group were 264.33±10.00 and 267.58±13.28 respectively. t = -0.677, p=0.505 (p > 0.05), and there was no difference.

In the vertical jump height with both feet, the scores of CG group and EG group were 69.00±5.19 and 69.50±7.57 respectively. t = -0.189，p=0.852 (p > 0.05), and there was no difference.

In the jump height on one leg in the run-up test, the scores of CG group and EG group were 73.42±5.63 and 73.83±8.36 respectively. t=-0.143，p=0.887 (p > 0.05), and there was no difference (Table 30).

From table 31 found that bench press 1RM, Vertical jump height with both feet and jump height on one leg in the run-up have no differences in the post test between groups; deep squat 1RM, both hands chest pass gravity ball, standing long jump have significant difference.

Table 31 Comparison of strength and power posttest between groups

	CG		EG		T	P
	$\overline{X}$	SD	$\overline{X}$	SD		
Bench Press 1rm (Kg)	86.92	7.10	92.08	8.11	-1.661	0.111
Deep Squat 1rm (Kg)	125.58	7.61	132.42	8.24	-2.11	0.046*
Both Hands Chest Pass Gravity Ball (M)	8.13	0.64	8.70	0.50	-2.412	0.025*
Standing Long Jump (Cm)	267.17	10.55	278.33	13.54	-2.254	0.035*
Vertical Jump Height with Both Feet (Cm)	70.92	5.71	74.33	8.36	-1.169	0.255
Jump Height on One Leg in The Run-Up (Cm)	75.17	6.56	78.67	9.41	-1.057	0.302

Note: * represents p<0.05, * * represents p<0.01

In the post test comparison between groups, the bench press 1RM of the CG group was 86.92±7.10, and that of the EG group was 92.08±8.11. The t test results showed that t=-1.661, p=0.922 (p > 0.05), with no difference. The deep squat 1RM in the CG group was 125.58±7.61, and that in the EG group was 132.42±8.24. t=-2.11, p=0.046 (p < 0.05), have a significant difference.

In both hands chest pass gravity ball comparison, the CG group was 8.13±0.64 and that of the EG group was 8.70±0.50. t=-2.412, p=0.025 ($p < 0.05$), have a significant difference.

In the standing long jump score of CG group was 267.17±10.55, and that of EG group was 278.33±13.54; t = -2.254, p=0.035 ($p < 0.05$), have a significant difference.

In the vertical jump height with both feet, the average score of CG group was 70.92±5.71, and that of EG group was 74.33±8.36. t=-1.169，p=0.255($p > 0.05$), have no difference.

In the jump height on one leg in the run-up test, the average score of CG group was 75.17±6.56, and that of EG group was 78.67±9.41. t=-1.057，p=0.302 ($p > 0.05$), have no difference (Table 31).

1.3.2 Endurance

Endurance is divided into anaerobic endurance, aerobic endurance and strength endurance. In this study, 17 turn back run was used to evaluate the anaerobic endurance of athletes, and 3200m running was used to evaluate the aerobic endurance of athletes. In the normal distribution test of the measurement data of the two teams, the 3200m data of the EG group, $p < 0.05$, did not meet the normal distribution, and this data was tested by Mann-Whitney U test. 90s bench press and 90s deep squat were selected to evaluate the strength endurance of upper and lower limbs of athletes, plank and 1-minute sit-ups were used to evaluate the strength endurance of athletes' core muscles.

In the 90s bench press and 90s squat measurement, the number of consecutive bench press and squat of athletes within 90s is measured first. Then, according to the evaluation standards of Chinese young men's basketball players' physical fitness test, the test results of athletes' 90s weight bench press (squat) are scored according to the weight coefficient of bench press (deep squat). The calculation formula is as follows: Bench press weight coefficient = (bench press weight * number of bench presses)/weight, squat weight coefficient = (deep squat weight * number of squats)/weight, the coefficient is accurate to one decimal place. Finally, the athlete's final score was assessed according to the 90s weight bench press (deep squat) test

score scale (see Annex 2). Under normal circumstances, the greater the weight, the greater the strength, so this test scoring criteria according to the weight of the tested team is divided into 90kg group and 90kg (including 90kg) group.

From table 32 found that 17 turn back run, 3200m run, 90s bench press, 90s deep squat, 1 min knee flexion sit-up, plank have no differences in the pretest between groups.

Table 32 Comparison of endurance pretest between groups

	CG		EG		T	P
	$\overline{X}$	SD	$\overline{X}$	SD		
17 Turn Back Run (S)	63.08	2.80	62.22	2.57	0.783	0.442
3200m Run (Min)	14.13	0.99	14.29	1.63	—	0.769
90s Bench Press (Score)	74.25	8.47	76.83	18.57	-0.438	0.667
90s Deep Squat (Score)	84.25	6.73	86.42	18.55	-0.38	0.710
1 Min Knee Flexion Sit-Up (Times)	48.25	6.30	49.75	8.55	-0.489	0.629
Plank (S)	219.67	70.55	232.50	79.61	-0.418	0.680

Note: * represents p<0.05, * * represents p<0.01

In the pre-test comparison between groups, the 17 turn back run in CG group was 63.08±2.80 and that in EG group was 62.22±2.57. The t test results showed that t=0.783, p=0.442 (p > 0.05), with no difference. 3200m in CG group was 14.13±0.99 and 14.29±1.63 in EG group, and the U test results showed no difference, p=0.769 (p > 0.05).

In the comparison of upper limb strength endurance, the CG group's 90s bench press pre-test score is 74.25±8.47, and the EG group's score is 76.83±18.57. t=-0.438, p=0.667 (p > 0.05), with no difference.

In the comparison of lower limb strength endurance, the score of 90s deep squat in CG group was 84.25±6.73, and that of EG group was 86.42±18.55. t=-0.380, p=0.710 (p > 0.05), with no difference.

In the comparison of 1-minute knee flexion sit-up, the CG group was 48.25±6.30, and that of EG group was 49.75±8.55. t=-0.489, p=0.629 (p > 0.05), with no difference.

In the comparison of plank, the CG group was 219.67±70.55, and that of EG group was 232.50±79.61. t=-0.418, p=0.680 (p > 0.05), with no difference (Table 31).

From table 33, it found that 3200m run, 90s deep squat and plank have no differences in the post test between groups. 17 turn back run, 90s bench press and 1 min knee flexion sit-up have significant difference.

Table 33 Comparison of endurance posttest between groups

	CG		EG		T	P
	$\overline{X}$	SD	$\overline{X}$	SD		
17 Turn Back Run (S)	62.83	3.05	59.79	3.15	2.404	0.025*
3200m Run (Min)	13.87	1.05	13.38	1.74	—	0.114
90s Bench Press (Score)	81.83	9.14	91.92	13.26	-2.169	0.041*
90s Deep Squat (Score)	93.67	5.31	103.00	17.75	-1.745	0.105
1 Min Knee Flexion Sit-Up (Times)	51.00	6.00	57.50	6.67	-2.51	0.020*
Plank (S)	230.42	70.90	256.08	77.66	-0.735	0.470

Note: * represents p<0.05, * * represents p<0.01

In the post test comparison between groups, the 17 turn back of the CG group was 62.83±3.05, and the EG group was 59.79±3.15, and the t test results showed that t=2.404, p=0.025 (p < 0.05), have a significant difference. The 3200m of the CG group was 13.87±1.05, and the EG group was 13.38±1.74, and the U test result have no difference, p=0.114 (p > 0.05).

In the comparison of upper limb strength endurance, the CG group's 90s bench press post test score is 81.83±9.14, and that of EG group was 91.92±13.26. t=-2.169, p=0.041 (p < 0.05), have a significant difference.

In the comparison of lower limb strength endurance, the score of 90s deep squat in CG group was 84.25±6.73, and that of EG group was 86.42±18.55. t=-0.380, p=0.710 (p > 0.05), with no difference.

In the comparison of 1-minute sit-up, the CG group was 51.00±6.00 and the EG group was 57.50±6.67, t=-2.51, p=0.02 (p < 0.05), have a significant difference.

In the comparison of plank, the CG group was 230.42±70.90, and the EG group was 256.08±77.66, t=-0.735, p=0.470 (p > 0.05), no difference (Table 33).

1.3.3 Speed, Agility and Flexibility

In this study, the athletes' speed was evaluated by 3/4 basketball court sprinting run, agility was evaluated by T-test and hexagonal jump, and flexibility was evaluated by sit and reach.

From table 34 found that 3/4 basketball court sprinting run, T-test, hexagonal jump, sit and reach have no differences in the pretest between groups.

Table 34 Comparison of speed, agility, flexibility pretest between groups

	CG		EG		T	P
	$\overline{X}$	SD	$\overline{X}$	SD		
3/4 Basketball Court Sprint Run (S)	3.74	0.17	3.79	0.24	-0.647	0.524
T-Test (S)	11.59	0.80	11.44	0.88	0.44	0.664
Hexagonal Jump (S)	13.43	0.64	13.07	0.87	1.152	0.262
Sit And Reach (Cm)	12.08	3.87	13.50	6.43	-0.654	0.520

Note: * represents p<0.05, * * represents p<0.01

In the pre-test comparison between groups, 3/4 basketball court sprinting run in CG group was 3.74±0.17, and that in EG group was 3.79±0.24. t=-0.647, p=0.524 (p > 0.05), with no difference.

In the comparison of T-test, the CG group was 11.59±0.80 and that of EG group was 11.44±0.88. t=0.44, p=0.664 (p > 0.05), with no difference.

In the comparison of hexagonal jump, the CG group was 11.59±0.80 and that of EG group was 11.44±0.88. t=0.44, p=0.664 (p > 0.05), with no difference.

In the comparison of sit and reach, the CG group was 12.08 ± 3.87, while in the EG group it was 13.50 ± 6.43. t=-0.654, p=0.520 (p>0.05), with no difference.

From table 35 found that 3/4 basketball court sprinting run, T-test, hexagonal jump has no differences in the post test between groups. sit and reach have a significant difference.

Table 35 Comparison of speed, agility, flexibility posttest between groups

	CG		EG		T	P
	$\overline{X}$	SD	$\overline{X}$	SD		
3/4 Basketball Court Sprint Run (S)	3.70	0.21	3.63	0.28	1.566	0.132
T-Test (S)	11.56	0.83	10.82	1.19	1.768	0.091
Hexagonal Jump (S)	13.27	0.76	12.79	1.04	1.292	0.210
Sit And Reach (Cm)	12.92	4.12	17.58	5.42	-2.375	0.027*

Note: * represents $p<0.05$, * * represents $p<0.01$

In the post test comparison between groups, 3/4 basketball court sprinting run in CG group was 3.70±0.21 and EG group was 3.63±0.28. $t=1.566$, $p=0.132$ ($p > 0.05$), with no difference. T-test in CG group was 11.56±0.83 and the EG group was 10.82±1.19, $t=1.768$, $p=0.091$ ($p > 0.05$), with no difference. Hexagonal jump in CG group was 13.27±0.76 and the EG group was 12.79±1.04, $t=1.292$, $p=0.210$ ($p > 0.05$), with no difference. Sit and reach in CG group was 12.92 ± 4.12, and the EG group was 17.58 ± 5.42. $t=-2.375$, $p=0.027$ ($p<0.05$), have a significant difference (Table 34).

Conclusion

From all of these table found that all physical fitness data are no different before the experiment; After 10 weeks of training, height, weight, BMI, body fat percentage, vital capacity, quiet HR, HR_{max}, after exercise immediate HR, bench press 1RM, Vertical jump height with both feet, jump height on one leg in the run-up, 3200m run, 90s deep squat，plank, 3/4 basketball court sprinting run, T-test, hexagonal jump are no different between groups. Heart rate after exercise, deep squat 1RM, both hands chest pass gravity ball, standing long jump, 17 turn back run, 90s bench press and 1 min knee flexion sit-up, sit and reach are significant different between groups.

2. Comparison of physical fitness indexes before and after training within group

2.1 Comparison of physical fitness indexes pre and posttest in EG group

2.1.1 Body shape

From table 36, it found that weight, BMI have no difference between before and after training. body fat percentage has a significant difference.

Table 36 Comparison of body shape pre and posttest in EG group

	PRE		POST		T	P
	$\overline{X}$	SD	$\overline{X}$	SD		
Height (Cm)	186.17[a]	7.297	186.17[a]	7.297	—	—
Weight (Kg)	85.375	11.7105	84.708	10.4871	1.342	0.207
Bmi	24.57	2.347	24.38	1.929	1.337	0.208
Body Fat(%)	16.16	6.424	14.64	5.682	6.444	0.0001**
Standing Touch Height (Cm)	241.08[a]	10.273	241.08[a]	10.273	—	—

Note: * represents p<0.05, * * represents p<0.01

As shown in Table 36, there was no change in height and standing height in the EG group during this process. The pre-test weight data was 85.38 ± 11.71, and the posttest weight data was 84.71 ± 10.49. t=1.342, p=0.207 (p>0.05), with no difference.

The pre-test BMI data was 24.57 ± 2.35, and the post test data was 24.38 ± 1.93. t=1.337, p=0.208 (p>0.05), with no difference.

The pre-test data of body fat percentage was 16.16 ± 6.42, and the post test data was 14.64 ± 5.68. t=6.444, p<0.01, have a significant difference, indicating that functional physical training can effectively improve athletes' body fat percentage.

2.1.2 Body Function

2.1.2.1 Vital capacity

From table 37 found that vital capacity, quiet HR, HR_{max}, immediate HR, HR 1 min, 2 min, 4 min after exercise have a significant difference between before and after training.

Table 37 Comparison of body function pre and posttest in EG group

	Pre		Post		T	P
	$\overline{X}$	SD	$\overline{X}$	SD		
Vital Capacity (Ml)	4416.58	237.643	4729.83	205.41	-16.020	0.0001**
Quiet Hr	62.17	1.801	60.25	1.603	8.373	0.0001**
Hr_{max}	185.17	4.989	182.08	4.94	13.470	0.0001**
Immediate Hr	184.00	4.61	180.83	4.51	15.284	0.0001**
End 1min	165.25	3.65	160.92	4.17	19.282	0.0001**
End 2min	144.67	3.75	139.00	3.67	15.069	0.0001**
End 4min	118.75	3.25	109.75	2.56	14.925	0.0001**

Note: * represents p<0.05, * * represents p<0.01

As shown in Table 37, the pre-test data of vital capacity in the EG group was 4416.58 ± 237.643, and the post test data was 4729.83 ± 205.41. t=-16.020, p< 0.01, have a significant difference.

The pre-test data of quiet heart rate in the EG group was 62.17 ± 1.801, and the post test data was 60.25 ± 1.603. t=8.373, p<0.01, have a significant difference.

In the comparison of pre - and post exercise heart rates in the EG group, the HR_{max} pre-test data was 185.17 ± 4.99, and the post test data was 182.08 ± 4.94. t=13.470, p<0.01, have a significant difference.

The immediate HR after exercise had pre-test data of 184.00 ± 4.61 and post test data of 180.83 ± 4.51. t=15.284, p<0.01, have a significant difference.

1 minute after the exercise, the pre-test data was 165.25 ± 3.65 and the post test data was 160.92 ± 4.17. t=19.282, p<0.01, have a significant difference.

2 minute after the exercise, the pre-test data was 144.67 ± 3.75 and the post test data was 139.00 ± 3.67. t=15.069, p<0.01, have a significant difference.

4 minute after the exercise, the pre-test data was 118.75 ± 3.25 and the post test data was 109.75 ± 2.56. t=14.925, p<0.01, have a significant difference.

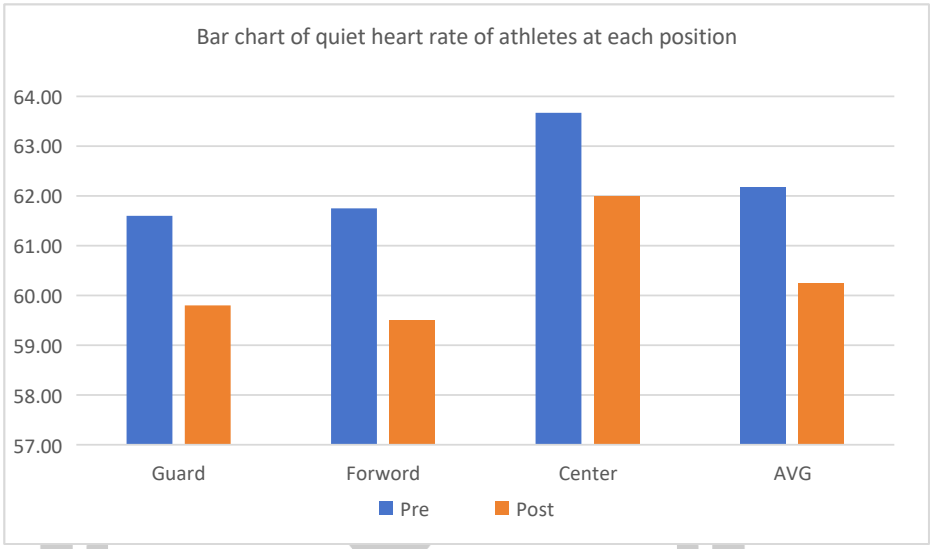


Figure 11 Bar chart of athletes' quiet heart rate at each position

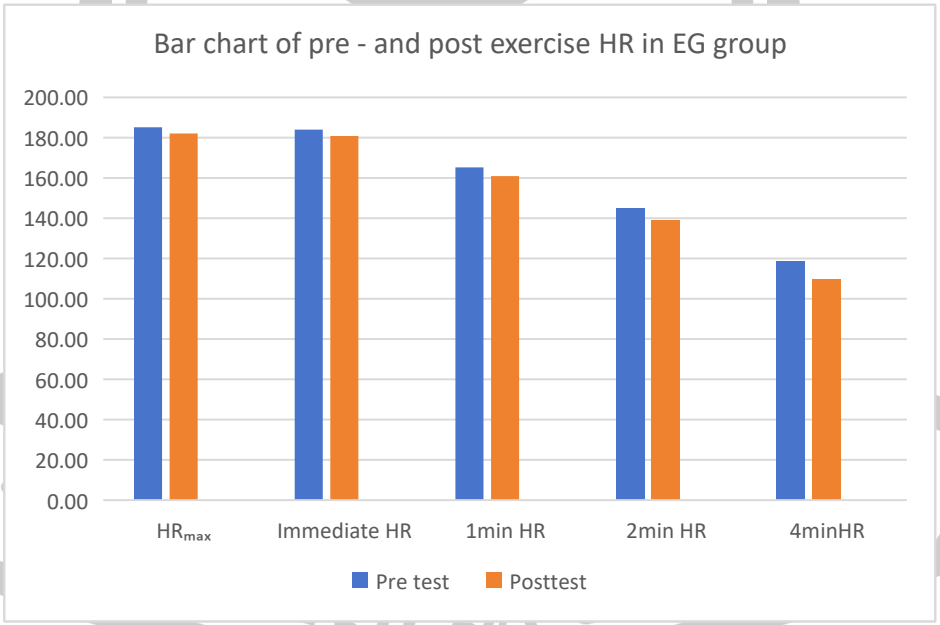


Figure 12 Bar chart of pre - and post exercise heart rate in EG group

2.1.3 Sports quality

2.1.3.1 Strength and power

From table 38 found that bench press 1RM, deep squat 1RM, both hands chest pass gravity ball, standing long jump, Vertical jump height with both feet and jump height on one leg in the run-up have a significant difference between before and after training.

Table 38 Comparison of strength and power pre and posttest in EG group

	Pre		Post		T	P
	$\overline{X}$	SD	$\overline{X}$	SD		
Bench Press 1rm (Kg)	82.58	9.10	92.08	8.107	-12.775	0.0001**
Deep Squat 1rm (Kg)	123.33	9.85	132.42	8.24	-11.899	0.0001**
Both Hands Chest Pass Gravity Ball (M)	7.72	0.63	8.70	0.50	-18.917	0.0001**
Standing Long Jump (Cm)	267.58	13.28	278.33	13.54	-15.654	0.0001**
Vertical Jump Height with Both Feet (Cm)	69.50	7.57	74.33	8.36	-8.603	0.0001**
Jump Height on One Leg in The Run-Up (Cm)	73.83	8.36	78.67	9.41	-9.048	0.0001**

Note: * represents $p<0.05$, * * represents $p<0.01$

The EG group had a pre-test data of 82.58 ± 9.10 and a post test data of 92.08 ± 8.11 for the 1RM bench press in the two maximum strength comparisons. t=-12.775, $p<0.01$, have a significant difference.

The pre-test data for a 1RM deep squat was 123.33 ± 9.85, and the post test data was 132.42 ± 8.24. The t-test results showed that t=-11.899, $p<0.01$, have a significant difference.

As shown in Table 44, the EG group had a pre-test data of 7.72 ± 0.63 and a post test data of 8.70 ± 0.50 for both hands chest pass gravity ball in two comparisons of upper limb explosive power. t=-18.917, $p<0.01$, have a significant difference.

In two comparisons of lower limb explosive power, the pre-test data for standing long jump was 267.58 ± 13.28, and the post test data was 278.33 ± 13.54. t=-15.654, $p<0.01$, have a significant difference.

The pre-test data for Vertical jump height with both feet was 69.50±7.57, and the post test data was 74.33±8.36. t=-8.603, $p<0.01$, have a significant difference.

The pre-test data for jump height on one leg in the run-up was 73.83±8.36, and the post test data was 78.67±9.41. t=-9.048, $p<0.01$, have a significant difference.

2.1.3.2 Endurance

From table 39 found that 17 turn back run, 3200m run, 90s bench press,90s deep squat, 1 min knee flexion sit-up and plank have a significant difference between before and after training.

Table 39 Comparison of endurance pre and posttest in EG group

	Pre		Post		T	P
	$\overline{X}$	SD	$\overline{X}$	SD		
17 Turn Back Run (Cm)	62.22	2.57	59.79	3.15	9.238	0.0001**
3200m (Min)	14.29	1.63	13.38	1.74	—	0.003**
90s Bench Press (Score)	76.83	18.571	91.92	13.256	-7.607	0.0001**
90s Deep Squat (Score)	86.42	18.554	103	17.746	-6.146	0.0001**
1 Min Knee Flexion Sit-Up (Times)	49.75	8.551	57.5	6.667	-10.333	0.0001**
Plank (S)	230.42	70.90	256.08	77.66	-10.703	0.0001**

Note: * represents p<0.05, * * represents p<0.01

In the EG group had a pre-test data of 62.22 ± 2.57 and a post test data of 59.79 ± 3.15 for the 17 turn back run in two comparisons of anaerobic endurance. The t test results showed that t=9.238, p<0.01, have a significant difference.

In the two aerobic endurance comparisons, the pre-test data for the 3200m run was 14.29 ± 1.63, and the post test data was 13.38 ± 1.74. As the 3200m run data did not follow a normal distribution, the Wilcoxon rank-sum test was used, and the results have a significant difference (p<0.01).

The EG group scored 76.83 ± 18.57 on the pre-test and 91.92 ± 13.26 on the post test of the 90 second bench press in two comparisons of upper limb strength endurance, t=-7.607, $p<0.01$, have a significant difference.

In two comparisons of lower limb strength and endurance, the pre-test score for the 90-second-deep squat was 86.42 ± 18.55, and the post test score was 103.00 ± 17.75, t=-6.146, $p<0.01$, have a significant difference.

In the two core strength endurance comparisons, the pre-test data for the 1 min knee flexion Sit-up was 49.75 ± 8.55, and the post test data was 57.50 ± 6.67, t=-10.333, $p<0.01$, have a significant difference.

The pre-test data of the plank was 232.50 ± 79.61, and the post test data was 256.08 ± 77.66. t=-10.703, $p<0.01$, have a significant difference.

2.1.3.2 Speed, Agility and Flexibility

From table 40, it found that 3/4 basketball court sprinting run, T-test, hexagonal jump, sit and reach have a significant difference between before and after training.

Table 40 Comparison of speed, Agility and Flexibility pre and posttest in EG group

	Pre		**Post**		**T**	**P**
	$\overline{X}$	SD	$\overline{X}$	SD		
3/4 Basketball Court Sprint (S)	3.79	0.24	3.63	0.28	5.933	0.0001**
T-Test (S)	11.44	0.88	10.83	1.23	5.138	0.0001**
Hexagonal Jump (S)	13.16	0.84	12.79	1.03	4.410	0.001**
Sit And Reach (Cm)	13.50	6.43	17.58	5.42	-11.406	0.0001**

Note: * represents p<0.05, * * represents p<0.01

In the two speed comparisons of the EG group, the pre-test data for the 3/4 basketball court sprint was 3.79 ± 0.24, and the post test data was 3.63 ± 0.28. t=5.933, p<0.01, have a significant difference.

In the two T-test comparisons, the pre-test data of EG group was 11.44 ± 0.88, and the post test data was 10.82 ± 1.19, with an average improvement of 0.62s for the whole team. t=5.138, p<0.01, have a significant difference.

In the comparison of two hexagonal jumps, the pre-test data was 13.07 ± 0.87, and the post test data was 12.79 ± 1.04, with a team average improvement of 0.37 seconds. t=4.410, p<0.01, have a significant difference.

After a 10-week intervention, in two sit and reach comparisons, the EG group showed a pre-test data of 13.50 ± 6.43 and the post test data of 17.58 ± 5.42. t=-11.406, p＜0.01, have a significant difference.

2.2 Comparison of physical fitness indexes pre and posttest in CG group

2.2.1 Body Shape

From table 41 found that weight, BMI have no difference between before and after training. Body fat percentage has a significant difference.

Table 41 Comparison of body shape pre and posttest in CG group

	PRE		POST		T	P
	$\overline{X}$	SD	$\overline{X}$	SD		
Height (Cm)	185.08[a]	8.16	185.08[a]	8.16	—	—
Weight (Kg)	84.94	13.31	84.58	13.02	1.711	0.115
BMI	24.68	2.43	24.53	2.31	2.171	0.053
Body Fat (%)	15.62	3.23	15.11	3.1179	—	0.002**
Standing Touch Height (Cm)	240.33[a]	10.5	240.33[a]	10.5	—	—

Note: * represents p<0.05, * * represents p<0.01

As shown in Table 41, there was no change in height and standing touch height of the CG group during this process. The pre-test weight data was 84.94 ± 13.31, and the posttest weight data was 84.58 ± 13.02. The t test results showed that t=1.711, p=0.115 (p>0.05), with no difference.

The pre-test BMI data was 24.68 ± 2.45, and the post test data was 24.53 ± 2.31. t=2.171, p=0.053 (p>0.05), with no difference.

The pre-test data for body fat percentage was 15.62 ± 3.23, and the post test data was 15.12 ± 3.12. As the body fat percentage running data did not follow a

normal distribution, the Wilcoxon rank-sum test was used, and the results have a significant difference ($p<0.01$).

2.2.2 Body function

From table 42 found that vital capacity, quiet HR, HR_{max}, immediate HR, HR 1 min, 2 min, 4 min after exercise have a significant difference between before and after training.

Table 42 Comparison of body function pre and posttest in CG group

	Pre		Post		T	P
	$\overline{X}$	SD	$\overline{X}$	SD		
Vital Capacity (Ml)	4535.42	283.06	4614.42	254.55	-5.185	0.0001**
Quiet Hr	61.92	1.929	60.67	2.188	9.574	0.0001**
Hr_{max}	184.58	3.502	182.83	3.38	9.753	0.0001**
Immediate Hr	183.25	2.734	182.25	2.8	4.690	0.001**
End 1min	165.83	2.98	164.5	2.611	5.204	0.0001**
End 2min	145.75	3.39	143.58	2.88	6.734	0.0001**
End 4min	119.33	4.09	116.5	4.10	8.224	0.0001**

Note: * represents $p<0.05$, * * represents $p<0.01$

The pre-test data of CG group's vital capacity was 4535.42 ± 283.06, and the post test data was 4614.42 ± 254.55. The t test results showed that t=-5.185, $p<0.01$, have a significant difference.

The pre-test and post-test quiet heart rate of CG group was 61.92±1.93 and 60.67±2.19, respectively. t=9.574, $p < 0.01$, have a significant difference.

The pre-test data of HR_{max} was 184.58 ± 3.50, and the post test data was 182.83 ± 3.38. t=9.753, $p<0.01$, have a significant difference.

The immediate HR after exercise showed a pre-test data of 183.25 ± 2.73 and a post test data of 182.25 ± 2.80. t=4.690, $p<0.01$, have a significant difference.

1 minute after the exercise, the pre-test data was 165.83 ± 2.98, and the post test data was 164.50 ± 2.61. t=5.204, $p<0.01$, have a significant difference.

2 minute after the exercise, the pre-test data was 145.75 ± 3.39, and the post test data was 143.58 ± 2.88. t=6.734, p<0.01, have a significant difference.

4 minute after the exercise, the pre-test data was 119.33 ± 4.09, and the post test data was 116.50 ± 4.10. t=8.224, p<0.01, have a significant difference.

2.2.3 Sports quality

2.2.3.1 Strength and power

From table 43 found that bench press 1RM, deep squat 1RM, both hands chest pass gravity ball, standing long jump, Vertical jump height with both feet and jump height on one leg in the run-up have a significant difference between before and after training.

Table 43 Comparison of strength and power pre and posttest in CG group

	PRE		POST		T	P
	$\overline{X}$	SD	$\overline{X}$	SD		
Bench Press 1rm (Kg)	82.92	7.22	86.92	7.10	-13.266	0.0001**
Deep Squat 1rm (Kg)	122.58	7.15	125.58	7.61	-5.745	0.0001**
Both Hands Chest Pass Gravity Ball (M)	7.79	0.65	8.13	0.64	-13.146	0.0001**
Standing Long Jump (Cm)	264.33	10.00	267.17	10.55	-8.805	0.0001**
Vertical Jump Height with Both Feet (Cm)	69.00	5.19	70.92	5.71	-6.127	0.0001**
Jump Height on One Leg In The Run-Up (Cm)	73.42	5.63	75.17	6.56	-4.262	0.001**

Note: * represents p<0.05, * * represents p<0.01

In the CG group we had a pre-test data of 82.92 ± 7.22 and a post test data of 86.92 ± 7.10 for the 1RM bench press in the two maximum force comparisons. t=-13.266, $p < 0.01$, have a significant difference.

The pre-test data for a 1RM deep squat was 122.58 ± 7.15, and the post test data was 125.58 ± 7.61. t=-5.745, $p < 0.01$, have a significant difference.

In two comparisons of upper limb explosive power, the pre-test data of the both hands chest pass gravity ball was 7.79 ± 0.65, and the post test data was 8.13 ± 0.64. t=-13.146, $p<0.01$, have a significant difference.

In two comparisons of lower limb explosive power, the pre-test data for standing long jump was 264.33 ± 10.00, and the post test data was 267.17 ± 10.55. t=-8.805 , $p<0.01$, have a significant difference.

The pre-test data for vertical jump height with both feet was 69.00±5.19, and the post test data was 70.92±5.71. t=-6.127, $p<0.01$, have a significant difference.

The pre-test data for jump height on one leg in the run-up was 73.42±5.63, and the post test data was 75.17±6.56. t=-4.262, $p<0.01$, have a significant difference.

2.2.3.2 Endurance

From table 44 found that 17 turn back run have a difference between before and after training, 3200m run, 90s bench press,90s deep squat, 1 min knee flexion sit-up and plank have a significant difference.

Table 44 Comparison of endurance pre and posttest in CG group

	PRE		POST		T	P
	$\overline{X}$	SD	$\overline{X}$	SD		
17 Turn Back Run (S)	63.08	2.80	62.83	3.05	1.973	0.074
3200m (Min)	14.13	0.99	13.87	1.05	5.022	0.0001**
90s Bench Press (Score)	74.25	8.47	81.83	9.14	-7.795	0.0001**
90s Deep Squat (Score)	84.25	6.73	93.67	5.31	-10.367	0.0001**
1 Min Knee Flexion Sit-Up (Times)	48.25	6.298	51.00	6.00	-11.000	0.0001**
Plank (S)	219.67	70.55	230.42	70.90	-12.722	0.0001**

Note: * represents p<0.05, * * represents p<0.01

In the CG group we had pre-test data of 63.08 ± 2.80 and post test data of 62.83 ± 3.05 for the 17 turn back run in two anaerobic endurance comparisons. The t test results showed that t=1.973, p>0.05, have a significant difference.

In two comparisons of aerobic endurance, the pre-test data at 3200m was 14.13 ± 0.99, and the post test data was 13.87 ± 1.05. t=5.022, p<0.01, have a significant difference.

In two comparison of upper body strength endurance, 90s bench press pre-test score is 74.25±8.47, post-test score is 81.83±9.14, t=-7.795, p < 0.01, have a significant difference.

In the comparison of two lower limb strength endurance, the score of 90s deep squat pretest is 84.25±6.73, and the score of 90s deep squat post-test is 93.67±5.31. t=-10.367, p < 0.01, have a significant difference.

In the comparison of the two-core strength and endurance, the pre-test data of 1 minute knee flexion sit-up was 48.25±6.30, and the post-test data was 51.00±6.00. t=-11.000, p < 0.01, have a significant difference.

The pre-test data of plank was 219.67±70.55, and the post-test data was 230.42 ±70.90. t=-12.722, p < 0.01, have a significant difference.

2.2.3.3 Speed, Agility and Flexibility

From table 45 found that 3/4 basketball court sprinting run, T-test no difference between before and after training, Hexagonal jump and sit and reach have a significant difference.

Table 45 Comparison of speed, agility and flexibility pre and posttest in CG group

	Pre		Post		T	P
	$\bar{X}$	SD	$\bar{X}$	SD		
3/4 Basketball Court Sprint Run (S)	3.74	0.17	3.70	0.21	1.381	0.195
T -Test (S)	11.60	0.80	11.56	0.83	1.506	0.160
Hexagonal Jump (S)	13.43	0.64	13.27	0.76	3.866	0.003**
Sit And Reach (Cm)	12.08	3.87	12.92	4.12	-4.022	0.002**

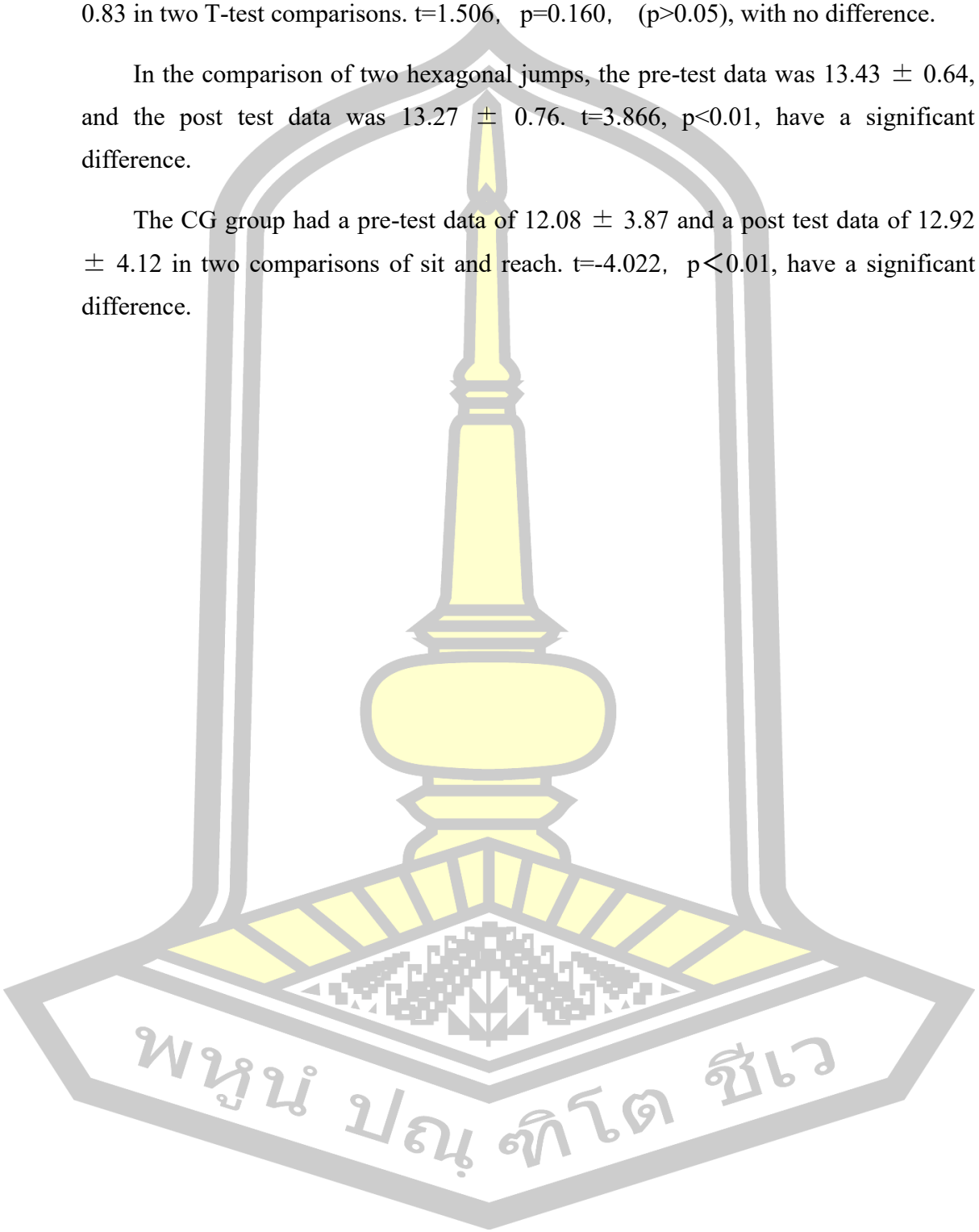
Note: * represents p<0.05, * * represents p<0.01

In the CG group's two speed comparisons, the pre-test data for the 3/4 basketball court sprint run was 3.74 ± 0.17, and the post test data was 3.70 ± 0.21. t=1.381, p>0.05, and there was no difference.

In the CG group had pre-test data of 11.59 ± 0.80 and post test data of 11.56 ± 0.83 in two T-test comparisons. t=1.506, p=0.160, (p>0.05), with no difference.

In the comparison of two hexagonal jumps, the pre-test data was 13.43 ± 0.64, and the post test data was 13.27 ± 0.76. t=3.866, p<0.01, have a significant difference.

The CG group had a pre-test data of 12.08 ± 3.87 and a post test data of 12.92 ± 4.12 in two comparisons of sit and reach. t=-4.022, p＜0.01, have a significant difference.



CHAPTER V

DISCUSSION, CONCLUSION, AND SUGGESTIONS

In the development stage of modern basketball, the athlete's physical fitness level is the primary factor that affects the result of the game. Physical fitness level is the technical and tactical basis of basketball, and the material basis of the team's technical style, tactical style and will quality. The level of physical fitness directly determines the technical and tactical execution ability of athletes in high-intensity competitions (Ferraz, R. et al.,2021). Only with a high level of physical fitness can players withstand greater loads of training and competition, and give full play to their skills and tactics in the fierce competition and confrontation of modern basketball games (Xu Jianhua, 2011).For competitive sports training, it is a prerequisite for sports training to accurately grasp the sports characteristics and training rules of the event, and the cognition of the features of the event is a key link to quickly improve the level of sports training, and the understanding and mastery of special training rules are the basic conditions for improving training efficiency and maintaining high-quality training for a long time (Chen Xiaoping, 2007).

Functional physical training is a means of physical training based on the actual situation of individual physical functions and the specific characteristics of the sports involved (Santana.J.C., 2004). The training content is highly targeted, and it is very closely related to the actual movements in competitions or sports, so as to ensure that the training is closely related to the performance of specific sports (Xu Xiaowei, 2020). The movement patterns of functional training involve acceleration, deceleration and stability of multiple joints and planes, with special emphasis on balance training in unstable states. It is the training of some chains and connections in the human movement chain, including the completion of specific target actions, including acceleration and deceleration of multi-dimensional motion trajectory, as well as stability training activities that meet specific target action characteristics (Gary Cook, 2012). In this study, a total of 24 basketball players from two universities were used as experimental objects for a period of 10 weeks. One group implemented

functional physical training and the other group implemented traditional physical training.

The experiment Objective:

(1) To compare the effects of functional physical training and traditional physical training on between groups physical fitness: body shape, body function and sports quality;

(2) To compare the effects of functional physical training and traditional physical training on within group physical fitness: body shape, body function and sports quality.

This study was conducted by referring to relevant literature, in chapter 1, the primary indexes of basketball players' physical fitness test and evaluation are summarized, and the related research of functional physical training is summarized. In chapter 2, the characteristics of basketball movement and the physical requirements of basketball players in different positions are analyzed. According to the previous studies on functional physical training, combined with the characteristics of college men's basketball players and the physical status of basketball players in the experimental group, a complete system of functional physical training methods for college basketball players is designed, with a total of 286 training methods. The intervention training plan was developed 30 times for 10 weeks, three times a week for 90 minutes each time. Chapter 3 describes the overall design of this study, including sample extraction, selection of measurement indicators and measuring instruments, formulation of training plans, scientific evaluation, experimental arrangement, data collection procedures and statistical analysis. Chapter 4 is the research results and analysis. Excel 2021 is used to make statistics on pre-test and post-test data. SPSS27.0 is used to conduct normal distribution tests on the pre-test and post-test data first. Mann-Whitney U test was used for between group data, and Wilcoxon rank-sum test was used for within group data. Then, t test was conducted for data conforming to normal distribution, independent sample t test was used for between group data, and paired sample t test was used for within group data to compare whether there were significant differences between the two groups of data.

This chapter is divided into three parts. The first part will discuss the influence of functional physical training on the body shape, body function and sports quality of college basketball players from inter-group and intra-group. The second part summarizes the findings of this study. The third part summarizes the application value and limitation of this study and puts forward suggestions for future research.

1. Discussion

The main objectives of this study is to compare the effects of functional physical training and traditional physical training on various physical indexes of college basketball players. Then, the comparison results of various physical indexes between groups and groups will be discussed respectively.

1.1 Comparison results of various physical fitness indexes before and after the experiment between groups

1.1.1 Body shape

Basketball is a game of giants, and height plays an important role in basketball and is an important condition for winning basketball games (Shen Changgeng, 2007). In a competitive game, in addition to height, a strong body will give players an advantage in physical confrontation and possession of the ball. The basketball game can be divided into guard, forward and center according to the position on the court, and each position has different functions and roles, so the body shape has certain differences (Dong Shunbo, 2015). The center's range of activity is most of the time in the restricted zone, when attacking the partner to do pick-and-roll, and finish the shot when the other side is close to the defense, and reasonably lean on the other side and limit its shot, all of which need to have a tall height, strong body, flexible feet to complete. The guard is the commander and soul of the field, an excellent defender needs to have a more comprehensive offensive and defensive technology and organizational ability. The forward runs the most on the field and is the finisher of the game. Therefore, the high percentage of body fat will affect the speed and agility of athletes in various positions to a certain extent, and limit their basketball level.

The body shape indexes in this study include height and fullness. Since the experiment period was only 10 weeks, the height and standing height indexes did not change, and there was no significant difference in BMI between the two groups before

and after the experiment when the average weight of the two groups did not change much. During the normal distribution test, the data of body fat percentage in the experimental group did not meet the normal distribution ($p < 0.05$), which may be related to too small sample size or too high body fat content of center XC, so this data was analyzed by Mann-Whitney U test. The results showed that there was no significant difference in body fat percentage between two groups before and after the experiment ($p > 0.05$), which was basically consistent with the study of Tomljanovi ´ c et al. (Tomljanovi ´ c et al. 2011).

Before and after the experiment, the average body fat percentage of both intervention groups decreased, indicating that both training methods can reduce the body fat percentage of athletes. It is natural that there was no significant difference after the experiment, but it may also be related to the short experimental period. From this, it can be seen that both training methods are effective in changing athletes' body shape and composition, and there is no significant difference between the two.

1.1.2 Body function

Basketball is A sport that combines walking, running, jumping and shooting at various speeds, based on the establishment of anaerobic decomposition of high-energy phosphoric acid compounds, and mainly characterized by anaerobic and aerobic mixed metabolism (Crisafulli A et al., 2002). Basketball players in the game to complete acceleration, sprint, emergency stop, change direction and a series of actions and continuous attack and defense. In a basketball game, players perform approximately 100 sprints of maximum or sub-maximum intensity, each lasting 2-6 seconds, over a period of 70-100 minutes (Cronin J B et al.,2005). Therefore, the characteristics of basketball, such as high intensity, variability and antagonism, determine that athletes must first have a strong anaerobic endurance level (Ma Jiping, 2002). The physical function indicators selected in this study included vital capacity and heart rate.

Vital capacity

Vital capacity is one of the important indexes to judge the cardiopulmonary function. Good vital capacity can effectively improve the athletic performance of athletes (Smith, 2021). First, exercise increases the ability of the heart muscle to

contract. Through exercise training, cardiomyocytes can enhance the sensitivity to stimulation, improve the contraction speed of muscle fibers, and thus enhance the contractility of myocardium (Smith, 2021). Secondly, through endurance training, it can enhance the strength and endurance of respiratory muscles, increase the depth of breathing, improve the efficiency of alveolar ventilation, and thus enhance cardiopulmonary function (Johnson, 2020). In addition, exercise training can also improve the function of the circulatory system and improve the transport capacity of blood. During exercise, the heart rate increases, the blood output of the heart increases, and the blood vessels dilate and the blood flow increases, all of which help to meet the body's capacity needs during exercise (Davis & Lee, 2019). With the progress of exercise training, the cardiopulmonary function will gradually improve, which is manifested by the enhancement of myocardial contractility, the improvement of vascular elasticity, the enhancement of respiratory muscle, the deepening of respiratory depth and the improvement of circulatory system function. These adaptive changes can improve the energy supply efficiency of the human body during exercise, reduce the risk of sports injuries, and thus improve sports performance (Smith, 2021; Davis & Lee, 2019).

The results showed that after 10 weeks of experimental intervention, the lung capacity of the athletes in both groups was improved, and there was no significant difference in the contrast of vital capacity ($p > 0.05$), indicating that the two training methods are effective in improving the cardiopulmonary function of the athletes. However, from the perspective of improvement, the vital capacity of the whole team in the EG group was increased by 313.25ml, which was significantly higher than that in the CG group of 79ml, indicating that functional physical training was superior to traditional physical training in improving athletes' cardiopulmonary endurance.

Heart rate

The heart is the power organ of the human body, and its core function is to pump blood and provide power for blood circulation, so that oxygen, nutrients, metabolites, immune cells, endocrine substances, etc. are transported and distributed in the body to achieve various physiological functions. The realization of the physiological function of the heart mainly depends on its own rhythm, there are changes in the occurrence of

excitatory and contractile movement, good heart pumping function is particularly important for athletes. Heart rate refers to the number of beats per minute of the human heart, which is an important index to evaluate the human motor function. Therefore, the monitoring of athletes' heart rate is helpful to improve the scientific and efficient training, optimize the exercise intensity, track and improve the physical fitness level, and measure the athletes' adaptation level and physical function status to the training load.

Common heart rate tests for athletes include quiet heart rate, maximum heart rate, heart rate immediately after exercise, and recovery heart rate per unit of time after exercise. The resting heart rate can be used to evaluate the degree of athletic fatigue and recovery of athletes, and also to observe the training adaptability of athletes' hearts. The heart rate during and after exercise can reflect the response and recovery of athletes to the amount and intensity of exercise.

Quiet heart rate is the number of heart beats per minute before getting up in the morning, in a quiet state without eating or activity. Under normal circumstances, with the increase of athletes' training years and the improvement of training level, the quiet heart rate will gradually slow down. If the athlete's quiet heart rate suddenly increases, it usually indicates the presence of excessive fatigue or disease (Song Lulu, 2022).

Through the 1-minute morning pulse test of the two groups, it can be seen that the quiet heart rate of the athletes in both teams has changed, and there is no significant difference between the pre-test and post-test comparison between the two teams ($p > 0.05$).

Exercise heart rate is the most common index to evaluate the actual response of athletes to the stimulation of exercise load. During exercise, when the exercise heart rate increases to the maximum, it is called the maximum heart rate. The maximum heart rate is related to age, the maximum heart rate per minute =220- age, with the increase of age, the maximum heart rate will gradually decrease. The heart rate during exercise is related to the intensity of the exercise, and the higher the intensity of the exercise, the faster the heart rate.

When the athlete's heart rate drops when completing the same intensity (or even higher intensity) exercise, it indicates that the athlete's training level has been

improved, and the heart and lung function has been improved. The rate of heart rate decline after exercise can reflect the recovery speed of athletes, and the faster the recovery speed, the better the cardiopulmonary function of athletes (Field, 2003). The immediate heart rate after exercise is generally converted by the number of heart rate within 10 seconds after the end of exercise. By measuring the immediate heart rate after the end of exercise, and the exercise heart rate of 1 minute, 2 minutes and 4 minutes after the end of exercise, the recovery of the athlete's physical function is evaluated.

Through the monitoring and comparison of the heart rate of the two groups of subjects in the 17 turn back run test, there was no significant difference in the five exercise heart rate data of the two groups before the experiment, and the five exercise heart rate indicators of the two groups were improved after the experiment. However, after the independent sample t test on the exercise heart rate data of the two groups after the experiment, it was found that Except for the maximum heart rate and immediate heart rate ($p > 0.05$), the heart rate at 1 minute after exercise showed significant difference ($p < 0.05$), and the heart rate at 2 minutes and 4 minutes showed very significant difference ($p < 0.01$), indicating that after 10 weeks of intervention, the physical function recovery speed of the experimental group was significantly better than that of the control group. It can be seen that functional physical training can better improve the cardiopulmonary function of athletes, make athletes adapt to high-intensity training and competition, and promote the recovery speed of athletes after sports.

1.1.3 Sports quality

The physical quality of basketball players varies due to the different division of labor on the court. The forwards move about 6000m in a full game, and their explosive power jumps more than 100 times (Chi Jian, 2007). In the current basketball game, the rhythm of offensive and defensive transition is fast, and rapid response, strong explosive power and confrontation ability have become key factors. In a basketball game, players move once every 1.7 seconds, and the average movement of all players is 1050 times, while that of guards is 1103 times (Abdelkrim N B,et al.,2012).Zhang Shouwei believes that basketball players must have the ability

to react quickly to various signals such as hearing, touch and vision. Quick movement ability to break, steal, lay up and pass; Displacement velocity ability of emergency stop, acceleration, sprint, fast attack, defense, and quick offensive and defensive transition (Zhang Shouwei et al., 2012). Therefore, this study selected strength, speed, endurance, agility and flexibility as the evaluation indexes of sports quality.

1.1.3.1 Strength

Strength quality refers to the ability of the human body or a certain part of the body's muscles to overcome internal and external resistance when working (contraction and relaxation). Strength quality plays an important role in basketball, it can not only improve the athletes' performance on the court, but also effectively reduce the athletes' injury probability. Therefore, according to the characteristics of basketball, the strength quality index selected in this research mainly includes three parts: maximum strength, power and strength endurance.

Maximum Strength

Maximum force refers to the force generated by a muscle or muscle group of an athlete during the maximum free contraction, often expressed as 1RM, that is, the maximum weight to successfully complete a time. In basketball, the maximum strength of the upper and lower limbs can help the athletes better complete the shooting, dunking, pick-and-roll, and fierce confrontation in the interior. Stronger upper body maximum strength can create more space for themselves to break through offensively and create greater obstacles for opponents on the defensive end. The maximum strength of the lower limbs is the decisive factor when the players of both sides occupy the position, body confrontation or scramble for the ball when the rules allow. In this study, bench press 1RM and deep squat 1RM were used to assess the maximum strength of athletes' upper and lower limb muscles.

Maximum strength is the basis of power endurance, for basketball players, the fierce confrontation in the restricted area fully reflects the athletes' technical movements, only with a good maximum strength, in order to better reflect the advantages of power endurance. The results of the study showed that both teams improved their upper and lower body strength after 10 weeks of training intervention. Through the comparative analysis of the posttest data of EG group and CG group, the

results showed that there was a significant difference in 1RM of squat ($p < 0.05$), indicating that functional physical training is more effective in improving the lower limb strength of athletes. Interestingly, there was no significant difference in bench press 1RM ($p > 0.05$), but from the perspective of bench press 1RM improvement, EG group was better than CG group (EG group average increase of 9.5KG, CG group average increase of 4KG). Both groups of subjects received strength training during the experimental intervention, and their maximum strength was improved, which may be one of the reasons for the insignificant difference in the results, and another reason may be related to the short intervention time. However, it can be seen from the intervention results and improvement range that the effect of functional physical training is significantly better than that of traditional physical training.

Functional physical training first emphasizes the correct movement mode, and then combines the special technical characteristics to enrich the strength training of athletes. The results of this study are very similar to the results of a study by Lamberth et al. Lamberth et al., who divided golfers into two groups for 6 weeks of functional strength training and the original golf strength training program, and found that the original golf strength training program significantly improved the athletes' squat strength. However, there is no significant change in longitudinal jump and swing speed, while functional strength training has a significant increase in all data (Lamberth J, 2013).

Power

Explosive power is an explosive fast power, that is, the ability to show maximum power in the shortest amount of time. In the game, sudden start, rapid change of direction, get rid of the grab position, and continuous jump require players to have this strength. It requires the athlete's muscles to have the ability to contract and relax rapidly, and requires the nervous system to have a high concentration of excitability and rapid inhibition transformation, and has a high flexibility. The strength of the fingers, wrists, shoulders, waist, and legs is emphasized. In this study, the explosive power of the upper limbs was evaluated by both hands chest pass gravity ball and the explosive power of the lower limbs was evaluated by standing long jump, Vertical jump height with both feet and Jump height on one leg in the run-up.

The most commonly used passing technique in basketball games is to pass with both hands in front of the chest. When passing, the arms reach forward quickly, the two wrists rotate in, and the wrist fingers send the ball out. All these require upper body strength to help the players better control the power and direction of the pass, so that the pass is more accurate and powerful. The explosive strength of the upper body also has an important impact on the stability, power output and hit rate of the shot. Good upper body strength can enhance the power output ability of the player in the shooting action, improve the shooting height and speed, and thus improve the shooting percentage.

In the pre-test, the average distance between the experimental group and the control group to both hands chest pass gravity ball was about 7.7m, which was very close and had no statistical difference. After 10 weeks of training, the post-test results of functional physical training in the experimental group were significantly better than those of traditional training in the control group ($p < 0.05$), showing a significant difference. This may be related to the usual strength training arrangement of the two teams, and the usual strength training of the control group is more the use of bench press, hard pull and other ways to improve the absolute strength of the athletes. The experimental group used barbell flips, standing barbell chest fast push, standing keiser hands down and horizontal pull, pull-up, kettlebell, medicine ball and other ways, combined with basketball special practice.

In basketball, jumping moves (block shot, rebound, jump shot, steal) are considered to be one of the most common moves in basketball. These jumping movements are also an important part of explosive training for basketball players and are related to upper and lower limb strength (Ziv G et al.,2010). In basketball games, explosiveness is more reflected in athletes' physical fitness and special technical characteristics, including ball-holding and no-ball changing to get rid of defense, rebounding, blocking shots and defense. Therefore, good explosiveness is one of the key factors to win in basketball games (Boon J et al.,2013).

In many exercises, standing long jump is an important means to cultivate and strengthen the explosive power of lower limbs, mainly through the coordination of lower limb muscle groups and hip muscles, as well as the upper limb, so that the

athlete can burst out powerful energy in an instant, so as to perfect the jumping action, which is conducive to strengthening the athlete's lower limb strength and improving the athlete's body balance. After 10 weeks of training, the standing long jump data of the two teams showed significant difference through independent sample t test ($p < 0.05$), and the experimental group was significantly better than the control group.

In the process of basketball competition, players need to repeatedly finish the emergency stop shot, one-foot jump layup, etc., on the offensive end, two-foot jump block, continuous point grab rebound, and one-foot jump rush grab rebound, etc., in place two-foot jump touch height and one-foot jump touch height are better methods to evaluate the explosive power of athletes' lower limbs. There was no significant difference between the two teams in the jump height of both standing feet and running feet ($p > 0.05$). However, in terms of improvement range, EG group was significantly better than CG group, CG group had an average increase of 2.42cm in starting height of both feet and 2.25cm in starting height of one foot. The scores of EG group both improved by 4.75cm.

From this, it can be seen that functional physical training has shown advantages in improving the explosive power of basketball players' upper and lower limbs. This research result is consistent with the findings of Agron Kasa, who conducted functional training and traditional strength training on two groups of young people aged 19-21. It was found that compared to the control group, the core muscle group of the experimental group could be better activated and contribute more to the movement chain. Therefore, the experimental group's body balance ability, movement stability, and explosive power were significantly better than the control group (A Kasa, 2014).

Strength endurance

Strength endurance refers to the ability of human neuromuscles to continuously contract against a certain resistance. In general, strength endurance is closely related to maximum strength and explosive power. Strength endurance is resistance exercise carried out under the premise of maximum muscle strength (Shi Haiao, 2022), so a certain percentage of 1RM is usually used as the load weight, and the subjects are asked to repeat the prescribed exercises. Keep track of practice times. The strength and endurance of the upper body are mainly manifested as repeated jams under the

basket, non-stop dribbling, shooting, etc. The strength and endurance of lower limbs are mainly manifested in the link of the jam under the basket, the repeated jump to grab the rebound, and the continuous blocking of many times. In the completion of repeated physical confrontation, various basketball techniques, air movements, etc., all need the strength and endurance of the core muscle group to support. According to the evaluation standards of Chinese basketball players' physical fitness test and the specific conditions of CUBAL athletes, this study selected 90s bench press and 90s deep squat to evaluate the strength endurance of athletes' upper and lower limbs, and adopted plank support and 1-minute sit-ups to evaluate the strength endurance of athletes' core muscle group.

In the 90s bench press and 90s deep squat measurement, the number of consecutive bench press and squat of athletes within 90 seconds is measured first. Then, according to the evaluation standards of Chinese young men's basketball players' physical fitness test, the test results of athletes' 90s weight-bearing bench press (deep squat) are scored according to the weight weight coefficient of bench press (deep squat). The calculation formula is as follows: Bench press weight weight coefficient = (bench press weight * number of bench presses)/weight, deep squat weight weight coefficient = (squat weight * number of squats)/weight, the coefficient is accurate to one decimal place. Finally, the final score of the athlete was evaluated according to the 90s weight-bearing bench press (deep squat) test score table (see Annex 2). Under normal circumstances, the greater the weight, the greater the strength, so the scoring criteria according to the weight of the tested team is divided into groups below 90kg and 90kg (including 90kg) group.

In basketball games, athletes need to continue dribbling, passing, shooting, positioning and confrontation, etc., all need upper body strength endurance to support. Lack of upper body strength endurance will lead to athletes dribbling and pass and catch mistakes, as well as a decline in shooting percentage. The results of this study showed that there was a statistically significant difference between the two teams in bench press scores ($p < 0.05$).

Research shows (Sun Lekun, 2017) that in a fierce basketball game, the running distance of the center is about 5000m, the forward is 6000m, and the guard moves the

longest distance, about 6400m; The average jump is about 40, with the center jumping the most. If the athlete's leg strength is not enough, or the leg muscle endurance is not durable enough, it is difficult to maintain an active state in the game, and the lower limb muscle endurance will also bring the risk of sports injury. In weight training, squats directly train the "hip power" compound motion pattern. These muscles help straighten the bent hip joint at the lowest point of the squat, improving muscle endurance through repetition and circuit training. The final score of lower limb muscle endurance was obtained by using the maximum repetition times of 90s deep squat in the physical evaluation manual of Chinese young men's basketball players and comparing with the scoring table of 90s weight-bearing squat test. There was no significant difference in pre-test scores between the two groups ($p > 0.05$). After 10 weeks of training, there was no significant difference in 90s deep squat scores between the two teams, but the 90s deep squat times of the two teams were effectively improved, indicating that the two training methods are helpful to the athletes' lower limb strength and endurance.

Core strength endurance is crucial for basketball players, it involves the muscle groups around the abdomen, back and pelvis. Strong core strength can help athletes maintain physical stability in competition, improve movement speed and agility, to better complete the technical movements. The main muscle groups involved in sit-ups include rectus abdominis and iliopsoas, while the muscles involved in stabilizing the human body include the internal obliquus and external obliquus. The main muscle groups involved in plank include transverse abdominis, oblique abdominis, rectus abdominis and so on. After 10 weeks of training, the one-minute sit-up performance of the experimental group was significantly better than that of the control group, and the statistical results showed significant difference ($p < 0.05$), while there was no statistical difference in plank support. Similarly, the improvement of EG group was better than that of CG group.

1.1.3.2 Speed

The length of the basketball court is only 28 meters, and the general linear sprint distance of the athletes in the game is about 20 meters, which is difficult to reach the highest speed. The speed quality required for basketball mainly includes quick

reaction ability, acceleration ability, and finally absolute speed, but in view of the limited basketball venue, it is difficult for athletes to reach their highest speed, so the NBA rookie camp often uses 3/4 basketball court sprint to evaluate the speed quality of basketball players. Therefore, this study also takes 3/4 basketball court sprint running to evaluate the speed quality of athletes. After 10 weeks of training, the performance of the experimental group was improved by 0.16 seconds on average, which was better than that of the control group, but there was no statistical difference in the post-test data between the two groups ($p > 0.05$). This may be related to the speed training of both teams and the improvement of their performance, or it may be related to the distance of the test event is only 21m, because it is difficult for the athletes to reach their highest speed in a short distance, which may be the reason why the final test results of the EG group and the CG group are not significantly different. A similar study was conducted by M. G. Behrens et al. (2010), which compared the effects of functional training and traditional training on speed. It was conducted for 45 minutes 3 times a week for 8 weeks, and the results showed that both functional training and traditional training had significant effects on speed improvement. But functional training has shown different advantages in improving athletic performance.

1.1.3.3 Endurance

Endurance is divided into anaerobic endurance and aerobic endurance. Anaerobic endurance is the ability of athletes to perform high-intensity exercises in a short period of time, such as high-intensity defense and rapid transition between offense and defense. Aerobic endurance is the ability of athletes to carry out sustained exercise over a long period of time, such as a fierce basketball game needs to last about 2 hours, athletes need to run on the court about 5000-6000m, players need to have good aerobic capacity in order to always maintain efficient performance in the game.

When the measurement data of anaerobic endurance and aerobic endurance of the two teams were tested for normal distribution, the measurement data of 3,200m corresponding to aerobic endurance did not meet the normal distribution, so the Mann-Whitney U test was adopted for this data. After 10 weeks of intervention, the results showed that aerobic endurance was not significant ($p > 0.05$), which may be

related to the CG group's emphasis on aerobic endurance in daily training. The CG group would arrange long-distance running or cross-country running at least 1-2 times a week to improve the athletes' cardiopulmonary endurance. However, there was a significant difference in anaerobic endurance 17 return-to-run comparison ($p < 0.05$), which was very similar to the results of Burgomaster et al.(2008) and Cunningham et al.(2011). As we all know, basketball is a sport dominated by anaerobic endurance and combined with aerobic and anaerobic. Hoff et al.(2002) showed in a study that anaerobic training can significantly improve athletes' short-term explosive power and rapid recovery ability, which is conducive to the improvement of athletes' sports performance.

1.1.3.4 Agility and coordination

Agility refers to the ability of the body to quickly change position, change movements and adapt to changes in response to specific external stimuli during exercise. Coordination refers to the ability of each organ system and each moving part of the body to cooperate with each other in time and space during the movement of the human body. Coordination is a closed-loop motor skill that requires a series of movements and lasts a long time; Agility, on the other hand, is an open-ended skill, with few and short movements that change rapidly. Coordination focuses on the body's rapid comprehensive analysis and rapid response to stimuli, so that muscle groups can quickly cooperate and complete the set target action, while sensitivity is more rapid in response to external stimuli. Thus, coordination is the basis of sensitivity. Based on the physical fitness test indexes of NBA clubs and Chinese basketball players, the T-test and hexagon jump were selected as the evaluation indexes of sensitive and coordinated quality.

After 10 weeks of functional physical training intervention, T-test and hexagon jump improved in the two tests of agility and coordination, and there was no significant difference ($p < 0.05$). However, in terms of progress, EG group was significantly better than CG group, and the reason for no statistical difference may be related to too short intervention cycle or too small sample size.

1.1.3.5 Flexibility

Flexibility refers to the range of motion of each joint in the human body and the elasticity and stretching ability of joint ligaments, tendons, muscles, skin and jumping motion tissues, that is, the range of motion of joints and joint systems. Basketball games need to complete the starting, acceleration, emergency stop, jumping, landing and other actions repeatedly, and the muscle group of the thigh shoulder greater pressure. The sit and reach is a field test used to assess hamstring and lower back flexibility (Baltaci et al., 2003), It is an important index to measure the flexibility of the human body, which can objectively reflect the flexibility of the muscle chain in the back of the human body and reduce the incidence of sports injury.

After 10 weeks of intervention, the study results showed that there was a significant difference in seated forward bending between the two teams ($p < 0.05$), which was consistent with the findings of Yildiz et al., functional training showed a significant improvement in seated forward bending (Yildiz et al., 2019). Similarly, Weiss et al. 's study showed that a 7-week functional training program intervention significantly improved flexibility in college students (non-athletes) (Weiss et al., 2010), unlike the participants in this study, and therefore, should only be used as a guide.

1.2 Comparison results of physical fitness indexes before and after the experiment within group

1.2.1 Body shape

The basketball game divides five players into five positions on the court, namely point guard, shooting guard, small forward, power forward and center. The physical form, physical function and athletic quality of athletes in different positions are not the same, especially in the aspect of physical form.

In a review of functional physical training systems by Wensheng Xiao et al., three studies showed that functional training had no significant effects on weight, height, and BMI (Oliver and Brezzo, 2009; Tomljanovi ´ c et al.,2011; Alonso-fernandez et al., 2017), in addition, Alonso Fernandez et al. (2017) reported a statistically significant improvement in body fat. In this study, after 10 weeks of intervention, there was a significant difference in body fat percentage between the EG

group and the CG group, indicating that the body fat content of athletes can be improved through strength and endurance training, which is consistent with the results of Alonso Fernandez et al.

After 10 weeks of functional physical training in the experimental group, the body fat percentage of the whole team decreased by 1.5% on average, except for the body shape index. For the three center and point guard ZXL with high body fat percentage, power bicycle, aerobic training, high-intensity interval training, strength training, etc., were adopted, and diet was strictly controlled. The weight of center XC and guard ZXL decreased by 4.6kg and 2.7kg respectively, and body fat percentage also decreased by nearly 3 percentage points. There was a significant difference in body fat percentage of the whole group before and after the experiment ($p < 0.01$), and the effect of increasing muscle and decreasing fat was achieved.

1.2.2 Body function

Vital capacity

EG group in the 10 weeks of functional physical training, long and long distance aerobic endurance training, intermittent high-intensity training, and basketball training, etc., all effectively improve the athletes' cardiopulmonary endurance, enhance the heart pumping function, and expand the athletes' vital capacity. In the comparison of two tests, the average vital capacity of the experimental group was increased by 313.58ml, showing a very significant difference ($p < 0.01$), and the cardiopulmonary function of the whole team was effectively improved. The CG group attaches great importance to the aerobic endurance training of the players in the usual training, and they insist on long-distance running at least 2 times a week. Therefore, there was a significant difference ($p < 0.01$) between the two tests of athletes' vital capacity, which effectively improved the players' cardiopulmonary function. It shows that both training methods can effectively improve the athletes' cardiopulmonary function, and further proves that exercise can promote the improvement of human cardiopulmonary function. However, compared with the EG group, the improvement of CG group is still much smaller.

Heart rate

Exercise training can effectively improve cardiopulmonary function, enhance myocardial contractility, and reduce quiet heart rate. By conducting 1min morning pulse test on athletes, the resting heart rate of athletes can be understood. The pre-test data of EG group showed that the average morning pulse of the whole team was 62.17, and the morning pulse of the center was the highest, which had a certain relationship with the tall stature of the center, followed by the forward and the guard. After 10 weeks of training, the morning pulse of athletes in all positions was in a gradual decline level, and the center was the highest, and the average heart rate of the forward dropped to 59.5, slightly lower than that of the guard (59.8), which had a certain relationship with the attack and defense mode of the forward in basketball games. The forward ran the longest distance and had the highest anaerobic intensity during training and competition. Your heart rate drops as well. After the test, the average quiet heart rate of the whole team decreased to 60.25, and the heart rate was significantly different before and after the test ($p < 0.01$). There was also a significant difference in quiet heart rate between the two times before and after the CG group ($p < 0.01$), which was inseparable from their daily training and long-term aerobic endurance training.

During exercise, heart rate is the most common indicator to evaluate the actual response of the athlete's body to the stimulation of exercise load. In the general exercise function training of the second stage of functional physical training, EG group adopted high-intensity anaerobic endurance training such as return running, interval running and variable speed running of different distances, and aerobic endurance running such as 3200m running, YOYO running, power cycling and cross-country running to improve the anaerobic and aerobic endurance quality of athletes. In the special sports function training of the third stage of functional physical training, the athletes' special endurance is improved through resistance exercises, full-court high-intensity 1V1, 2V2, 3V3 quick attack and defense, full-court fast attack with more and less, and less and more defense.

Through the comparison of the two heart rate monitoring before and after the 17 turn back run in EG group, it can be found that the test results after the 17 turn back

run were significantly improved compared with the pre-test. The maximum heart rate during the test, the heart rate immediately after the exercise, the heart rate of 1min, 2min and 4min showed very significant differences ($p < 0.01$), indicating that the athletes' cardiopulmonary function was significantly improved. The body function has been adapted to high-intensity training, speeding up the recovery speed of the body after exercise. There were also significant differences in 5 heart rate indexes in CG group ($p < 0.01$).

There were significant differences in vital capacity, quiet heart rate and exercise heart rate between the two groups, indicating that the athletes' cardiopulmonary function had been effectively improved, and the rate of heart rate decline after exercise also objectively reflected the athletes' recovery ability. This result is consistent with the research results of Song Lulu, which showed that functional training can reduce the maximum heart rate and average heart rate of athletes during aerobic and anaerobic exercise, and greatly improve the heart rate recovery speed after exercise (Song Lulu, 2022).

1.2.3 Sports quality

1.2.3.1 Strength

After 10 weeks of experimental intervention, we compared the maximum strength, explosive power and strength endurance of upper and lower limbs measured before and after the two groups of athletes, and found that the 3 indicators of EG showed significant differences before and after the test ($p < 0.01$), and the 3 indicators of CG also showed significant differences before and after the test ($p < 0.01$). These results indicate that both training methods are effective in improving the strength of athletes, but the improvement of functional physical training in EG group is obviously better than that in CG group. The study of Yildiz and Keiner also proved that functional physical training can effectively improve the performance of athletes in the vertical take-off test (Yildiz et al., 2019; Keiner et al., 2020), the results of this study are basically consistent with those of these studies.

Maximum strength

Bench press 1RM and deep squat 1RM tests are the most commonly used tests to reflect the maximum strength of the upper and lower limb muscles. Before the functional training arrangement of EG group, according to the pre-test data, it can be understood that the maximum upper body strength and lower body strength of athletes in each position of the experimental group are uneven. The four guards ZXL, YJQ, LZM and DJY, the center, are relatively weak in upper body strength, while the guard YJQ and LZM, the forward, are weak in lower body strength. In the functional physical training, first of all, strengthen their basic strength exercises, enhance their body multi-link, multi-dimensional stability; Secondly, in the general strength training, combined with the basketball game with the ball and without the ball to complete the strength training of pushing, pulling, adduction, abduction and rotation, in order to achieve multi-plane, multi-angle and all-round participation of the body. After 10 weeks of functional physical training, the upper and lower limb strength of the four players were effectively improved, and the average 1RM bench press of the whole team increased by 9.5kg, and the average 1RM squat of the whole team increased by 9.09kg. The comparison between the two test data showed a significant difference ($p < 0.01$). The upper limb strength of the center improved the most, and the lower limb strength of the forward improved the most. The center who has the strongest dependence on lower limb strength needs to continue to strengthen lower limb strength training.

The strength training of CG group mainly included bench press, hard pull, squat and other exercises. The average upper extremity strength of the whole team was increased by 4kg, and the average lower extremity strength was increased by 3kg. The results of the two tests also showed a very significant difference ($p < 0.01$), indicating that traditional bench press, hard pull and squat are also helpful to improve the athletes' maximum strength. However, from the point of view of improvement, functional strength training is obviously better than traditional strength training.

Power

In basketball games, most of the technical actions are manifested in the form of explosive power, which directly affects the athletes' technical level. A study by Schumacher, H.R., et al. (2007) focused on the impact of functional strength training on athletes' explosive power, and the results showed that functional strength training can significantly improve athletes' power output and explosive power. Lloyd, R.S., et al.(2013) and Carvalho,A.M.,et al.(2015) also confirmed that functional training can significantly improve the explosive power and rapid reaction ability of young athletes to enhance their sports performance.

In the 10-week functional physical training of EG group, for athletes with weak explosive power, the basic strength was strengthened first to improve joint stability. In the strength training of the whole team, the upper body exercises mainly include barbell somersaults, standing barbell chest fast push, standing keiser two-handed pull-down and horizontal pull, medicine ball against the wall, pull-up, etc. The lower body explosive strength exercises mainly include barbell half squat, squat, ketbell hard pull, one-foot or two-foot jump bar, 10-level leapfrog jump, jump box, jump deep, etc.

The results of the two upper and lower limb tests through the paired sample T-test showed that all the data of the whole team improved significantly, with very significant differences ($p < 0.01$). The explosive strength of the guard's upper body has increased greatly, narrowing the gap between the guard and other position players. In the comparison of explosive power of lower limbs, guards and forwards have the largest increase, while the growth rate of center is relatively small, which may be related to the athletic skills displayed by players in various positions on the field. Guards and forwards need more acceleration and emergency stops, as well as one-foot and two-foot takeoff, while center is more involved in response, cover, inside attack and two-foot takeoff.

Although the upper body explosive power of players in each position of CG group has also been improved correspondingly, from the perspective of improvement, EG group is still better than CG group in improving explosive power. In addition, functional strength training is more closely combined with special skills, which is more conducive to the play of players' special skills.

1.2.3.2 Speed

In basketball games, athletes need speed to break through, get rid of, chase defense, fast attack and so on. After 10 weeks of the experiment, we compared the two groups of subjects before and after the test speed, CG group showed no significant difference ($p > 0.05$), EG group showed a very significant difference ($p < 0.01$). Studies by Behrens M. G. et al. (2010), McMillan G. R. J. et al. (2011) and Haff J. D. E. et al. (2012) also confirmed that functional training can significantly improve the speed of athletes.

In the functional physical training cycle, the experimental group of athletes mainly used reaction speed exercise, sprint running, change direction running, resistance exercise, plyometric training and other methods. By comparing the speed test results of players in different positions, there is a very significant difference between the guard and the forward. Although the speed of the center has improved, there is no significant difference, which is related to the physical quality requirements of players in different positions in the game. The guard and the forward can escape from the defense in attack and chase the defense in defense. Its reaction ability, starting speed and acceleration ability are better than the center forward.

1.2.3.3 Endurance

17 turn back run and 3200m are commonly used indicators of anaerobic endurance and aerobic endurance in basketball. After 10 weeks of training intervention, there was a very significant difference before and after EG group 17 turn back run ($p < 0.01$). The speed endurance of guards improved most significantly, followed by forwards, although the center had no significant difference in the paired sample t test. But the average grade was also shortened by 1.4s. Although there was improvement in CG group, there was no significant difference between before and after test, indicating that functional physical training was better than traditional physical training in improving anaerobic endurance.

In the comparison of aerobic endurance, there were significant differences between the two groups ($p < 0.01$). Since the 3200m running performance of the EG group did not meet the normal distribution, this data was tested by Wilcoxon rank-sun test, showing a very significant difference ($p < 0.01$), and the T-test results of the CG

group before and after 3200m running also showed a very significant difference. This is inseparable from their long-term commitment to endurance running at least 2 times a week. It can be seen that both training methods are effective in improving the aerobic endurance of athletes.

Strength endurance

Strength endurance can ensure that the athletes can complete the technical movements at an agile speed for a long time and ensure that the athletes can maintain strong muscle strength after consuming a lot of energy, which is one of the necessary sports qualities of basketball players. EG group in the functional physical training cycle, first from basic resistance training to complex functional training. The upper body strength endurance mainly adopts crawling, wide and narrow distance push up, push up cross, dumbbell push, dumbbell bird, kettlebell lift, pull-up, 1 minute quick shaking battle rope, 1 minute high-intensity dribbling and other exercises; Lower extremity strength endurance mainly adopts weight squat, barbell split leg squat, kettlebell Bulgarian squat, elastic belt resistance high leg lift, endurance running and other exercises; The core strength endurance mainly adopts four aspects of support, Swiss ball bridge, abdominal muscle wheel, weight-bearing Russian twist, elastic band resistance slide and other exercises.

The evaluation methods of 90s bench press and 90s deep squat are carried out according to the evaluation standards of Chinese youth men's basketball, so the strength endurance scores of athletes' upper and lower extremities are closely related to their weight. In the pre-test, the center had the lowest upper body strength endurance score, and through 10 weeks of functional physical training, he has gradually narrowed his score with other positions. The strength and endurance of the upper and lower limbs and core of the whole team showed significant differences ($p < 0.01$). The strength and endurance scores of the upper and lower limbs increased the most in the guard and center. The guard was lighter than other position players and had a certain advantage in score. In the comparison of strength and endurance of core muscle group, the defender has the greatest improvement, then the forward, and finally the center, showing that the strength and endurance of core stable muscle group of outside players is greater than that of inside players, which is partly related

to the frequent running and jumping of outside players in the game, and also related to the difference in arm strength caused by the tall body of inside players. McBride,J.M.,et al.(2010) and Hoffman,J.R.,et al.(2011) both confirmed that functional training can significantly improve the muscle endurance and overall strength of athletes.

1.2.3.4 Agility and coordination

The T-test mainly examines the agility of the athlete, including the ability to run forward, laterally and backward. This method can reflect the ability of the athlete to accelerate, slow down, coordinate the pace and change direction speed, similar to the acceleration run, side slide step and backward run in the special sports of basketball. The hexagon jump test can reflect the athlete's ability to change the space position and direction of the body movement in a rapidly changing environment, and effectively evaluate the athlete's adaptability to change, the flexibility of foot movement, and the ability of body balance and control.

After two T-test tests in EG group, the evaluation score of the whole team increased by 0.61s, showing a very significant difference ($p < 0.01$), which means that the improvement of players' starting speed and direction changing ability will also have a significant impact on the enhancement of their offensive and defensive ability. Hexagon jump increased by 0.37s on average, also showing a very significant difference ($p < 0.01$).

There was no significant difference in T-test between the two tests in CG group ($p > 0.05$), but there was a very significant difference in hexagon jump between the two tests ($p < 0.01$). The reason for the no significant difference between T-test and CG group may be that the lateral movement ability of CG group athletes was not significantly improved.

1.2.3.5 Flexibility

Good flexibility can increase the flexibility and range of motion of the joint, effectively improve the quality of technical movements of basketball players, and reduce sports injuries. After analyzing and comparing the pre - and post-test flexibility of subjects in the two groups, we found that the pre - and post-test flexibility of

subjects in the two groups showed a very significant difference ($p < 0.01$), but from the perspective of improvement, 4.08cm in the EG group was significantly better than 0.84cm in the CG group.

In the pre-experiment test of the EG group, the guard had the best flexibility, and the two centers XC and DJY had the worst flexibility. Therefore, the whole team arranged dynamic and static stretching, as well as active and passive stretching for each training to increase the flexibility of the body and the flexibility of the joint. After the intervention, the average score of the team's sitting forward bend improved by 4.08cm, which helped the players adjust their body posture more freely in training and competition, and completed the technical movements more effectively.

2. Conclusions

By summarizing previous studies, combining the characteristics of college basketball players and the actual situation of the test group, this study designed a complete set of functional physical training program for college men's basketball players, including three stages of basic motor function development, general motor function development and special motor function development, a total of 10 weeks, 30 intervention training plans, 286 training methods. The 28 physical indexes of athletes were evaluated from three aspects: body shape, body function and sports quality. Through the analysis and discussion of the research results, the following conclusions are finally drawn:

(1) Both functional physical training and traditional physical training can effectively reduce the body fat percentage of college basketball players.

(2) Both functional physical training and traditional physical training can effectively reduce the resting heart rate and exercise heart rate of college basketball players and enhance their cardiopulmonary function, but functional physical training is more conducive to the rapid recovery of physical function after high-intensity exercise of college basketball players.

(3) Both functional physical training and traditional physical training can improve college basketball players' strength, power, strength endurance, anaerobic

endurance, flexibility and other physical qualities, but functional physical training is better than traditional physical training in improving athletes' strength, overall power, strength endurance, flexibility, and anaerobic endurance that is closer to the characteristics of basketball. In terms of speed and speed-led agility, there is little difference.

3. Suggestions

3.1 Impact and contribution

By summarizing previous studies and referring to Yan Qi's "Pyramid model of functional Physical training for Competitive Sports" (Yan Qi, 2012), this study combined the characteristics of college basketball players and the actual situation of the test group, designed a complete set of functional physical training programs for college men's basketball players. It includes three stages of basic motor function development, general motor function development and special motor function development, a total of 286 training methods, a total of 30 intervention training plans in 10 weeks, and 28 physical fitness indicators of athletes from three aspects of body shape, body function and sports quality were evaluated. This study systematically expounds the theory and method of functional physical training in competitive sports, and provides training ideas and training methods for the majority of physical trainers and coaches.

3.2 Limitations

First, due to time constraints, the intervention duration in this study was only 10 weeks. Although the athletes' physical fitness indexes were improved, too short intervention time may result in the training results of the two groups of subjects being close in many indexes, with no statistical difference. Second, the sample size is small, and individual outliers may affect the results of statistical analysis. It is precisely because the sample size is too small, so the statistical analysis and elaboration of the basketball players in each position cannot be carried out. The third is the intervention process. Since the experimental group and the control group conducted the experimental intervention in two different universities respectively, although the two groups of subjects were required before the experiment, the intervention objects of the

two groups were conducted under different coaches and different training conditions, which may also lead to the unfair intervention process.

3.3 Future research

First of all, it is necessary to increase the sample size in the future, optimize and improve the measurement indicators according to the characteristics of players in different positions, and formulate more refined intervention plans. Secondly, it is necessary to increase the research on the characteristics of competition load, including physiological load and psychological load. The competition load of different genders, different levels and different projects is also different. Correctly grasping the characteristics of competition load is helpful for coaches to better carry out training work. In addition, increasing the duration of intervention and doing follow-up long-term follow-up and follow-up can verify the long-term impact of functional physical training on athletes' physical health and athletic performance. At the same time, it can also help coaches to understand the effectiveness of their own training programs, review their shortcomings, and improve their coaching level.

REFERENCES

REFERENCE

Agron Kasa. Effects of Functional Training on the level of balance to the youth of 19 to 21 year old.[J]. Journal of International Academic Research for Multidis, 2014,2(10):122-128.

Abdelkrim N B,Chaouachi A,Chamari K,et al.Positional role and competitive-level differences in elite-level men's basketball players[J]. Journal of Strength &Conditioning Research.2010,24(5):1346-1355.

Alonso-Fernández, D., Lima-Correa, F., Gutierrez-Sánchez, F., and De Vicuña, O. A. G. (2017). Effects of a high-intensity interval training protocol based on functional exercises on performance and body composition in handball female players. J. Hum. Sport Exerc. 12, 1186‑1198.

Boyle M. (2003) Functional Training for Sports. Champaign IL: Human Kinetics.

Ben Abdelkrim, El Fazaa, El Ati J. Time-motion analysis and physiological data of elite under-19-year old basketball players during competition[J]. British Journal of Sports Medicine, 2007(41) : 69-75.

Boon, J., McCormick, M., & Wilson, J. (2013). The role of explosive power in basketball performance. Journal of Sports Science and Medicine, 12(3), 456-463.

Burgomaster, K. A., Howarth, K. R., & Phillips, S. M. (2008). Resistance training and high-intensity interval training improve performance in endurance athletes. Journal of Applied Physiology, 104(1), 50-58.

Baltaci, G., Ozer, H., & Yeldan, İ. (2003). Comparison of Sit-and-Reach Test and Standardized Flexibility Tests for Assessment of Hamstring Flexibility. Journal of Sports Sciences, 21(6), 437-445.

Behrens, M. G., Thompson, J. R., & Miller, C. (2010). Comparing the effects of functional and traditional training on speed. Journal of Sports Science and Medicine, 9(3), 462-470.

Bao Yong, Zhang Qing, Pang Fengdong,&Yang Zhenghua (2013) Comparative study on physical fitness between Cuba men's basketball players and CBA young men's basketball players Shandong Sports Technology, 35 (6), 4

Boyle M. (2003) Advance in Functional Training. Champaign IL: Human Kinetics.

Chi Tian Shu (2010) Research on the Current Situation and Countermeasures of Physical Fitness Training for Men's Basketball Teams in Traditional High School Basketball Schools in Beijing (Doctoral dispersion, Beijing Normal University)

Cunningham, D. A., & Okita, K. (2011). The effect of functional training on performance measures of strength and power. Journal of Strength and Conditioning Research, 25(5), 1433-1442.

Charles Staley.Muscle logic[M].Rodale Books.2005:74-75.

Crawford, D., Drake, N., Carper, M., DeBlauw, J., & Heinrich, K. (2018). Are changes in physical work capacity ınduced by high-ıntensity functional training related to changes in associated physiologic measures? Sports, 6(2), 26.

Chi Jian, Miao Xiangjun, Mi Jing, Zhang Yong,&Guo Yongbo (2007) Research on the Load Characteristics of Modern Competitive Basketball Games Journal of Beijing Sport University, 30 (2), 4

Crisafulli, A., Melis, F., & Fadda, M. (2002). Metabolic demands of basketball: A comprehensive analysis. European Journal of Applied Physiology, 86(3), 301-309.

Cronin, J. B., Hansen, K. T., & Newton, R. U. (2005). The nature of basketball: Analysis of sprinting and high-intensity actions. Journal of Strength and Conditioning Research, 19(4), 812-818.

Chip Sigmon.52-Week BasketballTraining[M].Human kinetics.2004:1-220

Calleja,Fernandez-Rio,Fernandez-García, et al. Whole Body Vibration Training Applied to Female Basketball Players: Long-Term Effects on Strength

Development[J].Medicine & Science in Sports & Exercise(39):S-216.

Cook Gray. Athletic body in balance. Human Kinetics,2003.

Cress M E,Conley K E, Balding S L, et al. Functional training: muscle structure, function, and performance in older women[J]. Journal of Orthopaedic & Sports Physical Therapy,1996, 24(1):4.

Cailliet R.The shoulder in hemiplegia[M]. Philadelphia:FA Davis,1980:80.

Carvalho, A. M., Silva, A. L., & Santos, J. P. (2015). Functional training effects on explosive strength and agility in young athletes. International Journal of Sports Science and Coaching, 10(4), 587-598.

Davis, R., & Lee, T. (2019). Circulatory system adaptations to physical training. Cardiovascular Research Review, 45(3), 789-802.

Dong Shunbo (2015) The physical characteristics and training of basketball players in different positions Journal of Sports, 000 (002), 107-109

D Matthew et al. Heart rate, blood lactate concentration, and time–motion analysis of female basketball players during competition[J], Journal of sports sciences , 2009(8) : 813-821.

Delextrat, A., & Cohen, D. (2008). Physiological testing of basketball players: toward a standard evaluation of anaerobic fitness. Journal of strength and conditioning research, 22(4), 1066–1072. Functional video Digest series, Gray, G. available at www. Functional design systems. com

Feng Lizheng&Pan Wei (2007). Comparative Study on Basketball Fitness Training between China and the United States Chinese Sports Coaches (02), 34-36

Ferraz, R., Silva, P., Oliveira, J., & Almeida, L. (2021). The impact of physical fitness on the execution of technical and tactical skills in high-intensity sports. Journal of Sports Performance and Health, 15(2), 123-135.

Garcia, Anna Rosio.A Cultural Adaptation of Functional Communication Training[D]. ProQuest Dissertations and Theses Full-text Search Platform,2018.

Gary Cook. (1997)functional training for the torso[J] ,Strength and conditioning :14-19.

Gary Cook. (2012). Movement functional movement systems: screening,assessment and corrective strategies. J. Can. Chiropr. Assoc. 56:158.

Gambetta V. ,Gray G. (1995) Following a functional path. Training & Conditioning 5(2): 25-30.

Gambetta V. ,Clark M. (1998) A formula for function. Training & Conditioning 8(4): 24-29.

Gambetta V. (1999) Force and function. Training & Conditioning 9(5): 36-40.

Hoff, J., Helgerud, J., & Wang, E. (2002). The effects of anaerobic training on short-term explosive power and rapid recovery in athletes. European Journal of Applied Physiology, 88(5), 411-418.

Hu Sheng Research on the application of functional training in physical fitness training of male volleyball teams in universities (Doctoral dispersion, Hunan Normal University)

Higashihara A, Ono T, Kubota J, et al. Functional differences in the activity of the hamstring muscles with increasing running speed[J]. Sports Sci, 2010, 28(10):1085-92.

Haines M. Biomechanics for Functional Training, Sports Performance, Strength and Conditioning: Injury Prevention, Rehabilitation and Management[J].Cell, 1988, 54(7):1043-51.

Haff, J. D. E., Stone, M. H., & O'Bryant, H. S. (2012). Functional training and speed development: A review of current research. Strength and Conditioning Journal, 34(4), 52-59.

Han Chunyuan,&Wang Weixing (2014) Analysis of the Concept of Athletic Physical Fitness Physical Education in Chinese Schools: Higher Education (6), 5

Johnson, L. (2020). Respiratory muscle strength and endurance through endurance training. Journal of Exercise Physiology, 29(4), 45-56.

Jin Huijuan, Lv Heli,&Chen Zhiqiang (2009) Comparative Study on the Body Shape Characteristics of the Top 8 Men's Basketball Team Athletes in the 29th Olympic Games China Sports Technology (3), 5

J. SIMENZ.Strength and conditioning practices of NBA strength and conditioning coaches Journal of Strength and Conditioning Research,2005,19(3),495–504.

James C. Radcliffe (2007) Functional Training for Athletes at all levels :2-3.

Juan Carlos SANTANA. The Essence of Program Design [M]. 2004:25.

K. Hakkinen and P. V. Komi, Scandinanvian Journal of Sports Science [M]. Munksgaard International Publishers Ltd. Copenhagen,Denmark. 1985,7(2): 55-76.

Kasa, A. (2014). Effects of Functional Training versus Traditional Strength Training on Core Activation, Movement Chain Contribution, Balance, Stability, and Explosive Power in Young Adults. Journal of Sports Science and Medicine, 13(4), 789-798.

Keiner, M., Kadlubowski, B., Sander, A., Hartmann, H., and Wirth, K. (2020).Effects of 10 months of speed, functional, and traditional strength training on strength, linear sprint, change of direction, and jump performance in trained adolescent soccer players. J. Strength Cond. Res. Publish Ah. 27:3807.

Khlifa R, Aouadi R, Hermassi S, et al. Effects of a plyometric training program with and without added load on jumping ability in basketball players.[J].Journal of Strength & Conditioning Research,2010,24(11):29-55.

Lamberth J, Hale B, Knight A, et al.Effectiveness of a Six-Week Strength and Functional Training Program on Golf Performance[J]. International Journal of Golf Science,2013(1):33- 42.

Li Lijian (2010). Analysis of physical fitness and technical issues of college basketball players in high-intensity and fast-paced games China Sports Technology, 29 (6), 12-16

Li Yuanchun (2021). The role and influence of the Chinese University Basketball

League (CUBAL) in the Chinese basketball system Chinese Sports Science, 41 (5), 27-35

Liu Xinzheng (2006) The problems and solutions of physical fitness training in basketball in China Journal of Physical Education, 13 (5), 3

Liu Jun, Cheng Liping,&Xu Jianhua (2012) The research results on the load characteristics of basketball matches and their implications for physical fitness training Journal of Physical Education, 19 (5), 5

Laplaud D, Hug F, Menier R. Training-induced changes in aerobic aptitudes of professional basketball players.[J].International Journal of Sports Medicine, 2004, 25(02):103-108.

Liu Hongyan (2011) The theoretical basis of functional Strength training for basketball players Shandong Sports Technology, 33 (4), 3

Liu Aijie,&Li Shaodan (2007) Core training of High-performance sport Chinese Sports Coaches (04), 6-8

Li Danyang, Hu Faxin,&Hu Xin (2011) Functional training: definition and application Journal of Shandong Institute of Physical Education, 27 (10), 6

Lamberth J, Hale B, Knight A, et al.Effectiveness of a Six-Week Strength and Functional Training Program on Golf Performance[J]. International Journal of Golf Science,2013(1):33- 42.

LIU Qingshan. Basic Theories of Physical Training and Research on Physical Training of high-level Basketball players in China. (Doctoral dissertation, Beijing Sport University).

Lloyd, R. S., Oliver, J. L., Hughes, M. G., & Williams, C. A. (2013). The effects of different types of strength training on explosive power in young athletes. Strength and Conditioning Journal, 35(2), 50-60.

Li L. (2014). Research on Technical application and diagnosis of skate-led Adversaried ball games. (Doctoral dissertation, Yangzhou University).

Liao W R. (2017). Analysis on the principle of excess recovery training and recovery

regeneration training. Sporting Goods and Technology (15), 2.

Long Kun. (2019). Construction of specific physical fitness evaluation index system for college male basketball players [D]. Wuhan Sports University, 2019

Li Wentao,&Tian Peng (2019) A comparative study on functional physical training and traditional physical training in adolescent basketball Compilation of abstracts from the 11th National Sports Science Conference

Li Tonghui Research on the Index System for Evaluating the Physical Fitness of National Men's Basketball Players [J] Guangzhou Sport University Report, 2016,36 (04): 59-62

Lin Yinping Research on Physical Fitness Evaluation of CUBAL Women's Basketball Players (Qufu Normal University)

Li Chengliang, Ma Yi. Research on Physical Evaluation Index and Quantitative Model of Chinese young men's basketball players [J]. Journal of Shenyang University of Physical Education,2007,(05):53-55.

McMillan, G. R. J., Moore, J. C., & Smith, L. A. (2011). The impact of functional training on athletic speed: A comparison with traditional training methods. Journal of Strength and Conditioning Research, 25(2), 340-348.

Mou Xiaogang (2017) Analysis and research on the current training status of the cuba Sunshine Group in Shandong Province Contemporary Sports Technology, 7 (36), 2

Ma Jizheng (2010) On the Specific Prescription of Sports Training Anhui Sports Technology (1), 4

MICHAEL B. Functional training f or sports[M]. Human kinetics, 2004.

Mc Innes S.The physiological load imposed on basketball players during competition ［J］. Journal of Sports Sciences,1995(13):387－397.

Mark Verstegen , Pete Williams. Core Performance. Rodale Books. 2005（4）.

Mark Verstegen , Pete Williams. Core Performance Essentials. Rodale Books. 2006

（12）.

Mark Verstegen , Pete Williams. Core Performance Endurance. Rodale Books; First Edition, 2008 (12).

Mark Verstegen , Pete Williams. Core Performance Golf. Rodale Books, 2009 (12).

Mark Verstegen , Pete Williams. Core Performance Women. Avery, 2009 (12) .

Ning Qingxin A Study on the Load Characteristics of the 2011 Chinese Women's Basketball Four Country Invitational Tournament (Doctoral dispersion, Beijing Sport University)

Narazaki K, Berg K, Stergiou N, et al. Physiological demands of competitive basketball[J]. Scandinavian Journal of Medicine & Science in Sports, 2009, 19(3):425-32.

Noffal GJ.Isokinetic eccentric-to-concentric strength ratios of he shoulder rotator muscles in Throwers and Nonthrowers[J].Am J Sports Med,2003,31(4):537-544.

Oliver, G. D., and Brezzo, R. (2009). Functional balance training in collegiate women athletes. J. Strength Cond. Res. 23, 2124‑2129.

Pan Zhiguo,&Li Yuanwei (2016) Research on the Characteristics of Physical Training of China women's national basketball team China Sports Technology, 52 (5), 7

Peng Yanchun. Research on Strength Training Theory of high-level professional basketball players and CBA strength training Model [D]. Beijing Sport University,2007.

Quan Er Bao (2007) Research on the Physical Fitness Status and Influencing Factors of High Level Basketball Teams in Beijing Universities (Doctoral dispersion, Beijing Sport University)

Ran Xiaoli, Zhang Xiaoyu,&Xu Yang (2022) The effect of specific training under the guidance of target theory on gait fatigue symptoms of balance disorders in

Parkinson's disease patients Journal of Clinical Psychosomatic Diseases (001), 028

Rodriguez-Alonso, M., Fernandez-Garcia, B, Perez-Landaluce,J, & Terrados,N. Blood lactate and heart rate during national and international women's basketball [J]. Journal of Sports Medicine and Physical Fitness,2003(43) : 432–436.

Sun Zhidian (2018) Differentiation of the concept of "physical fitness" and its difference from "functional training" Sports Fashion (2), 1

Santana J. C. (2004) Functional Training. Boca Raton FL:Optimum Performance Systems.

Steven Plisk. Functional Training[M].NSCA Hot Topic Series.2004:15-16.

Spennewyn,K. 2008. Journal of Strength and Conditioning Research, January, Volume 22, Number 1

Smith, J. (2021). Cardiac muscle adaptations to exercise. Journal of Sports Science, 34(2), 123-134.

Schumacher, H. R., Klein, J., & Smith, T. (2007). The impact of functional strength training on explosive power in athletes. Journal of Sports Science and Medicine, 6(3), 235-242.

Steven Plisk The lumbodorsal fascia in low back disorders: evidence based prevention and rehabilitation［M］. Champaign (IL) :Human Kinetics,2002: 79－80

Sun Lekun (2017) Positional physical fitness characteristics and training strategies of high-level basketball players Shandong Sports Technology, 039 (005), 40-43

She Yanli (2013) The basketball concept reflected in the NBA specialized physical fitness training Journal of Guangzhou Sport University, 33 (3), 4

Sampaio J, Janeira M. Statistical analyses of basketball team performance: understanding teams' wins and losses according to a different index of ball

possessions[J]. International Journal of Performance Analysis in Sport, 2003,3(1):40-49.

Shaikh A, Mondal D S. Effect of Functional Training on Physical Fitness Components on College Male Students-A Pilot Study[J].Iosrjournals Org, 2012, 1(2) :1-5.

Sun Qingzhu(2006) Physical Education Measurement and Evaluation [M]. Beijing: Higher Education Press, 2006.7:15-27

Škarabot J, Beardsley C, Štirn I. Comparing the effects of self-myofascial release with static stretching on ankle range-of-motion in adolescent athletes.[J]. International Journal of Sports Physical Therapy,2015,10(2):203-212.

Tian Maijiu,&Liu Daqing (2012) Sports Training .People's Sports Publishing House

Turna B , Alp M . The Effects of Functional Training on Some Biomotor Abilities and Physiological Characteristics in Elite Soccer Players[J].2020.

Tan Zhenbin, Wang Baocheng,&Huang Li (2004) Research on the Theory and Method of Physical Fitness Training for Basketball Players and the Evaluation Index System Journal of Beijing Sport University, 27 (8), 4

Translated by Sun Huan, National Basketball Physical Fitness Coaches Association (2004) NBA fitness training People's Sports Publishing House

Thomas r. baechle roger w.earle, translated by Yang Zeyi. Physical Training Guidance [M]. Compiled and printed by the Science and Technology Expert Group for the 2008 Olympic Games, 2007

Tomljanovi´c, M., Spasi´c, M., Gabrilo, G., Uljevi´c, O., and Foreti´c, N. (2011). Effects of five weeks of functional vs. traditional resistance training on anthropometric and motor performance variables. Kinesiology 43, 145–154.

Tian Ye. Advanced Course in Exercise Physiology [M]. Higher Education Press. 2003:408-411

Vern Gambetta. Athletic Development[M].Human Kinetics.2004:23-25.

Vern G, Grey G. Following the functional path [EB/OB]. www. gambetta. com.

Weiss, J. M., Smith, R. B., & Johnson, P. A. (2010). Effects of functional training on flexibility in college students. Journal of Strength and Conditioning Research, 24(5), 1225-1233.

Wang Liang. An Empirical Study on Functional Physical Training of young men's basketball players [D]. Hebei Normal University,2018.

Wang Fen, et al (2009) Research on Physical Fitness Training in High Level Competitive Sports Beijing Sport University Press

Wang Baocheng, Kuang Lubin, Tan Zhenbin. Research on evaluation index and index system of Physical Training of basketball players [J]. China Sports Science and Technology,2002,(02):4-5+9.

Wang Xiong,&Liu Aijie (2014) Practical exploration and development reflection of body function training teams Sports Science, 34 (2), 8

Wang Chenshuang (2015). Comparative Analysis of the Physical Fitness Status of CUBA Men's Basketball Players in Beijing [D]. Capital Institute of Sports, 2015

Wang Mudi (2006) Investigation and Countermeasure Research on the Physical Fitness Status of Cuba Athletes Journal of Shaoyang University: Natural Science Edition, 3 (3), 3

Xu Jianhua,&Cheng Liping (2015) A Study on the Positional Characteristics of Specific Sports Quality of Cuba Men's Basketball Players Journal of Shandong Institute of Physical Education, 31 (3), 8

Xavi,TorresRonda,Lorena.An Integrative Approach to Strength and Neuromuscular Power Training for Basketball[J].Strength & Conditioning Journal,2016, 38(3):72-80.

Xu Yuanhong, Wang Ge. Research on evaluation method of special physical fitness of Chinese college women basketball players [J]. Journal of Beijing Sport University,2007,(07):990-991+1006.

Xu Huijun,&Zhang Youxin (2004) Analysis of training data related to the Cuba team and the CBA youth team Journal of Northwestern University: Philosophy and Social Sciences Edition, 34 (5), 3

Young, W. B., & Williford, H. N. (2002). The relationship between agility, speed, and sport performance. International Journal of Sports Physiology and Performance, 1(1), 45-54.

Yan Qi, Ren Manying,&Zhao Huanbin (2012) On the characteristics and application of functional physical training in High-performance sport Shandong Sports Technology, 34 (003),

Yan Qi. Construction and empirical Research of Functional Physical training method system for elite female hockey players [D]. Hebei Normal University,2013.

Yildiz, Y., Genc, S., & Kose, N. (2019). Effects of functional training on flexibility and functional performance in athletes. Journal of Sports Sciences, 37(11), 1234-1243.Yan Qi The Construction and Empirical Study of Functional Physical Training Method System for Excellent Female Hockey Players (Doctoral dispersion, Hebei Normal University)

Yang Shiyong (2013). Physical Training [M]. Beijing: Higher Education Press, 2013:22-23

Yuan Shoulong (2011) Innovative Trends in Theory and Practice of Beijing Olympic Cycle Training Sports research, 32 (4), 7

Yuan Shoulong (2014) The Development Trends and Countermeasures of Modern Physical Fitness Training Journal of Sports Adult Education, 030 (001), 40-43

Yu Shaoyong,&Zhao Yinghui (2005) A Study on the Physical Fitness Test Indicators of Cuba Men's Basketball Players Journal of Beijing Sport University, 28 (3), 3

Yuan Peng et al. Evaluation of post injury strength characteristics and application of isokinetic force measurement in judo athletes [J]. Sports Research, 2010,31 (06): 27-28

Zhang Song, Yan Youjuan, Yu Xing, Tian Jiang,&Tian Mi (2014) A Study on the Height, Weight, Ketolet Index, and Age Characteristics of Male Basketball Players in the London Olympics Sports Research and Education (S1), 5

Zhao Liang, Mi Sen, Zhang Xin. Research on Internal and External Physical Fitness Evaluation System of Chinese elite U19 Men's basketball players [J]. Journal of Tianjin University of Physical Education,2020,35(02):240-248.

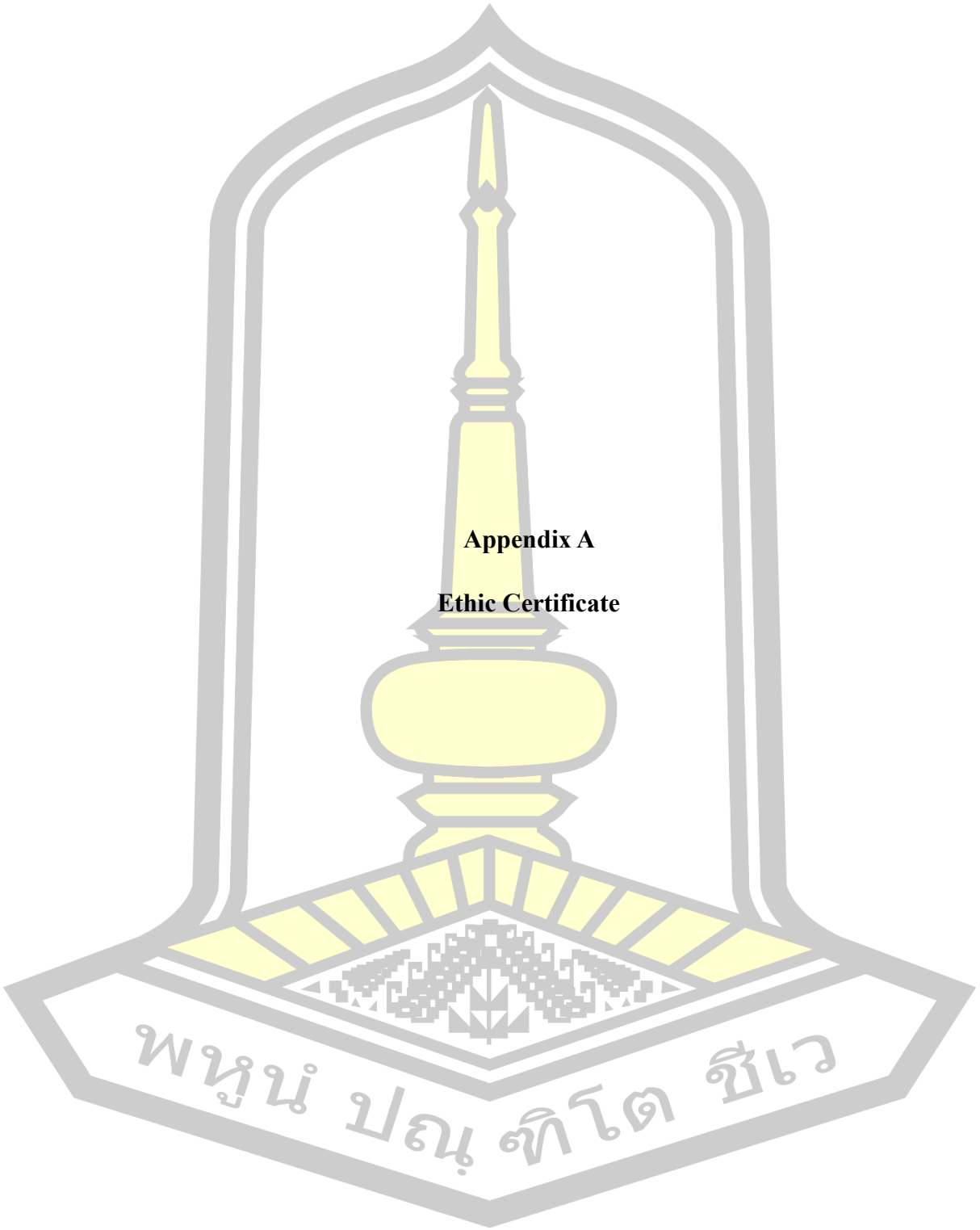
Zhang Tao (2008) Comparative analysis of the technical characteristics of male centers in CUBA and CBA youth teams (Doctoral dispersion, Hunan Normal University)

Zhang Liyue (2014). Fatigue and physical training issues in the training of college basketball players Sports Technology, 33 (4), 58-62

Abbreviations

EG	Experimental group
CG	Control group
FPT	Functional Physical Training
TPT	Traditional Physical Training
CUBAL	China University Basketball Association League
CBA	China Basketball Association
NCAA	National Collegiate Athletic Association
NBA	National Basketball Association
BMI	Body Mass Index
1RM	One Repetition Maximum
HR	Heart rate

APPENDIX



Appendix A

Ethic Certificate

MAHASARAKHAM UNIVERSITY ETHICS COMMITTEE FOR RESEARCH INVOLVING HUMAN SUBJECTS

Certificate of Approval

Approval number: 053-601/2024

Title : The Effect of Functional Physical Training on Improving Sports Performance of College Basketball Players.

Principal Investigator : Hui Xiong
Responsible Department : Faculty of Education
Research site : Jingzhou city, Hubei province, China

Review Method : Expedited Review

Date of Manufacture : 31 January 2024 **expire : 30 January 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.

.....

(Associate Professor Vorapoj Promasatayaprot)
Vice Chairman

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

Informed consent form for research from volunteers
(For volunteers over 18 years old)

I (Mr.) ..... Surname .....
Age.....Year.
House number ..... Village No. ..... Sub-district .... District ..... province.....
Convenient phone ....

Read the explanation / listen to the explanation from Mr. Hui Xiong about volunteering in the research project on "The Effect of Functional Physical Training on Improving Sports Performance of College Basketball Players", 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..... Volunteers
(.....)
Date.....

sign..... witness
(.....)
Date.....

sign..... researcher
(Mr.Hui Xiong)
Date.....

Informed consent form for research from volunteers
(For volunteers over 18 years old)

I (Mr.) ..... Surname .....
Age.....Year.
House number ..... Village No. ..... Sub-district .... District ..... province.....
Convenient phone ....

Read the explanation / listen to the explanation from Mr. Hui Xiong about volunteering in the research project on "The Effect of Functional Physical Training on Improving Sports Performance of College Basketball Players", 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..... Volunteers
(.....)
Date.....

sign..... witness
(.....)
Date.....

sign..... researcher
(Mr.Hui Xiong)
Date.....

Study informed consent from the volunteer head coach

I (Mr.) ..... Surname .....
Age.....Year.
House number ..... Village No. ..... Sub-district .... District ..... province.....
Convenient phone ....

Read the explanation / listen to the explanation from Mr. Hui Xiong about volunteering in the research project on "The Effect of Functional Physical Training on Improving Sports Performance of College Basketball Players", the explanatory text consists of Full details about the purpose of the research, details of the research. I agree with the value of the study, I am aware of the benefits to be gained and the risks that may arise from participating in the study. Include guidelines for possible problems. Explanations and answers to any questions from the head of the research project were also received.

The researcher promised to keep confidential information about my basketball team.

In addition, anonymous or private information may not be made available to the public alone. The findings will be presented in the form of an overview, which is a summary of the findings for academic purposes only.

"As the volunteer's referrer and coach, I gave them permission to participate in the study." I agree that my recommended volunteers can withdraw from the study at any time. This will have no impact and will not result in the loss of any right to study or work in the future.

sign..... Head coach
(.....)
Date.....

sign..... researcher
(Mr.Hui Xiong)
Date.....

Study informed consent from the volunteer head coach

I (Mr.) ..... Surname .....
Age.....Year.
House number ..... Village No. ..... Sub-district .... District ..... province.....
Convenient phone ....

Read the explanation / listen to the explanation from Mr. Hui Xiong about volunteering in the research project on "The Effect of Functional Physical Training on Improving Sports Performance of College Basketball Players", the explanatory text consists of Full details about the purpose of the research, details of the research. I agree with the value of the study, I am aware of the benefits to be gained and the risks that may arise from participating in the study. Include guidelines for possible problems. Explanations and answers to any questions from the head of the research project were also received.

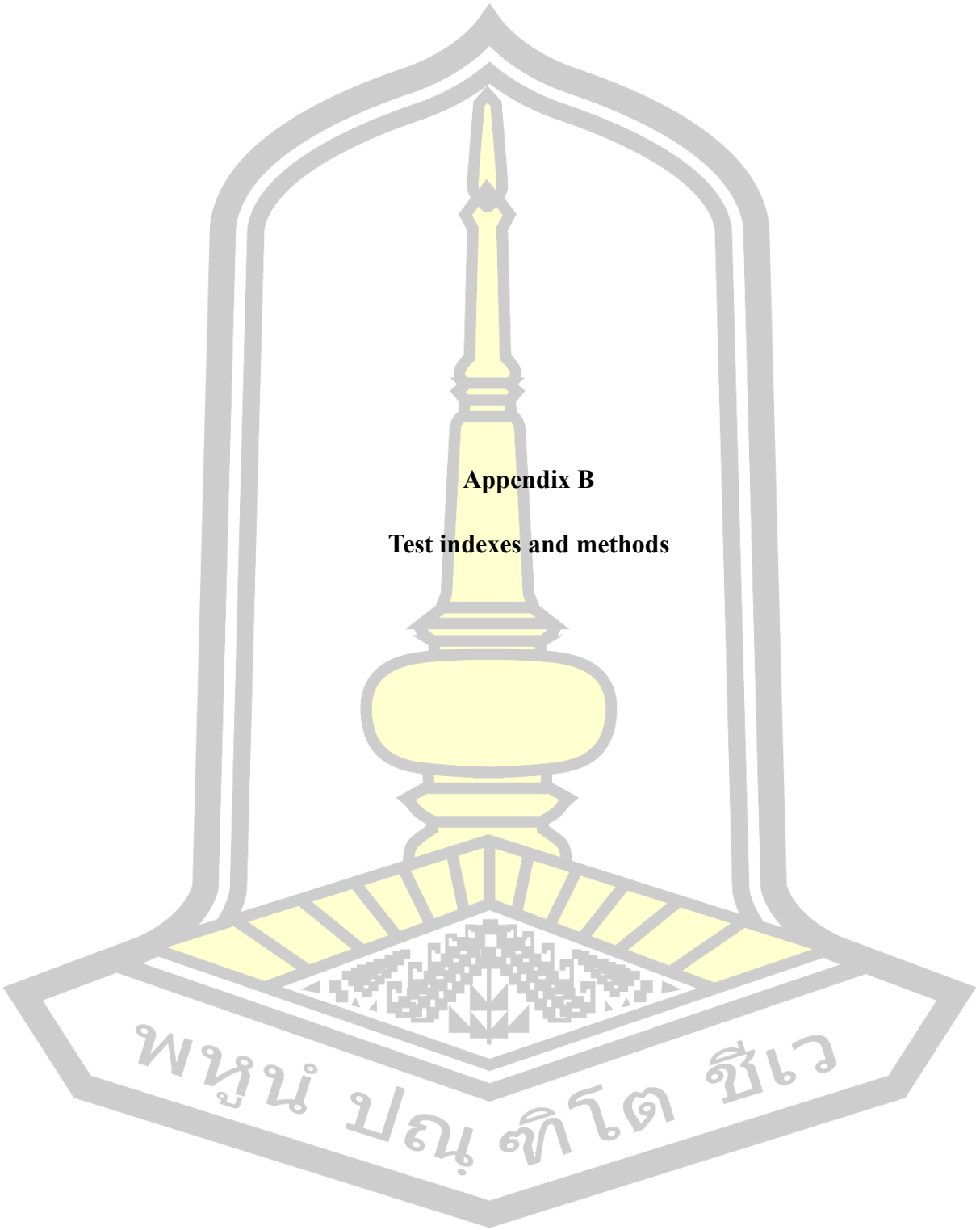
The researcher promised to keep confidential information about my basketball team.

In addition, anonymous or private information may not be made available to the public alone. The findings will be presented in the form of an overview, which is a summary of the findings for academic purposes only.

"As the volunteer's referrer and coach, I gave them permission to participate in the study." I agree that my recommended volunteers can withdraw from the study at any time. This will have no impact and will not result in the loss of any right to study or work in the future.

sign..... Head coach
(.....)
Date.....

sign..... researcher
(Mr.Hui Xiong)
Date.....



Appendix B

Test indexes and methods

Five experts screened the primary indexes of physical fitness test for college basketball players

A total of 5 experts have screened the primary indicators of college basketball players' physical fitness test, and the results are as follows:

Level 1 indicators	**Level 2 indicators**	**Level 3 indicators**	**Expert Evaluation**					**IOC Value**
			1	**2**	**3**	**4**	**5**	
Body shape	Height	Height	1	1	1	1	1	**1**
		Standing touch height	1	1	1	1	1	**1**
	Fullness	Weight	1	1	1	1	1	**1**
		Koleto index	1	0	1	1	1	**0.8**
		BMI	1	1	1	1	1	**1**
		Percentage of body fat	1	1	1	1	1	**1**
Body function	Cardiopulmonary function	Vital capacity	1	1	1	1	1	**1**
	Heart rate (HR)	Quiet HR	1	1	1	1	1	**1**
		HRmax	1	1	1	1	1	**1**
		Immediately HR	1	1	1	1	1	**1**
		Recovery HR (1/2/4 minutes)	1	1	1	1	1	**1**
Sports quality	Strength	Bench press 1RM	1	1	1	1	1	**1**
		Deep squat 1RM	1	1	1	1	1	**1**
	Power	Two hands chest pass gravity ball	1	1	1	1	1	**1**
		Standing long jump	1	1	1	1	1	**1**
		Standing triple Jump	1	1	0	1	0	**0.6**
		Vertical jump height with both feet	1	1	1	1	1	**1**
		Jump height on one leg in the run-up	1	1	1	1	1	**1**
	Speed	3/4 Basketball court sprint run	1	1	1	1	1	**1**
		28m sprint run on basketball court	1	0	1	1	1	**0.8**
		30m run	0	0	1	1	1	**0.6**
		50m run	0	0	1	1	0	**0.4**

	Strength endurance	90s bench press	1	1	1	1	1	**1**
		90s deep squat	1	1	1	1	1	**1**
		1 min knee flexion Sit-up	1	1	1	1	1	**1**
		Arm flexion plate support	1	1	0	0	1	**0.6**
	Anaerobic endurance	Basketball court 17 turn back run	1	1	1	1	1	**1**
		Basketball court see the line turn back run	1	1	1	0	1	**0.8**
		Basketball court 5.8 m * 6 turn back run	1	1	0	1	1	**0.8**
		400 m run	1	1	0	1	0	**0.6**
	Aerobic endurance	YOYO run	1	1	1	0	1	**0.8**
		3200m run	1	1	1	1	1	**1**
	Agility	T-test	1	1	1	1	1	**1**
		5-10-5 agile running	1	1	0	1	1	**0.8**
		Hexagon jump	1	1	1	1	1	**1**
	Flexibility	Sit-and-reach	1	1	1	1	1	**1**
		Prone arm lift	0	1	1	1	1	**0.8**

1RM Bench press/Squat

1. Test purpose

Assess the athlete's ultimate strength level in the upper and lower limbs.

2. Test preparation

(1) Fully warm up, do light machine bench press or squat first.

(2) Determine the subject's starting load.

(3) Do technical instructions and protection measures

3. Test method

(1) The subjects used a relatively light barbell to complete 5-10 bench presses or squats and increased their weight (5-10kg) after resting for 1 minute.

(2) After the subjects complete 3-5 full amplitude bench press or squat, rest for 2 minutes and then increase the weight (5-10kg).

(3) Increase the weight (2-5kg) after the subject has completed 1-2 full amplitude bench press or squat and rested for 2 minutes.

(4) If the subject can only complete 1, it is his 1RM bench press or squat.

(5) If the subject is unable to complete 1 session, reduce the weight (2-5kg) after 2 minutes of rest until the subject can only complete 1 bench press or squat, which is his 1RM bench press or squat.

1RM Prediction Coefficients			1RM-Repetition Table	
Number of repetitions completed	Squat or leg press coefficient	bench or chest press coefficient	Repetitions	% 1RM
1	1.0000	1.0000	1	100
2	1.0475	1.0350	2	95
3	1.1300	1.0800	3	93
4	1.1575	1.1150	4	90
5	1.2000	1.1500	5	87
6	1.2420	1.1800	6	85
7	1.2840	1.2200	7	83
8	1.3260	1.2550	8	80
9	1.3680	1.2900	9	77
10	1.4100	1.3250	10	75
1RM=Load weight * Coefficient			11	70
			12	67
			15	65

90s Bench press/Squat

1. Test purpose

Assess the strength and endurance level of the athlete's upper or lower limbs.

2. Test preparation

(1) Fully warm up, do light machine bench press or squat first.

(2) Determine the test load (bench press 60kg, squat 85kg)

(3) Do technical instructions and protection measures

3. Test method

(1) When lying on the bench, the subject lies on their back, bends their knees, and lands their feet apart. They grip the barbell from the barbell stand (slightly wider than their shoulders), causing the barbell to descend and touch their chest; Then push the barbell up with force until the elbow is fully extended, and push it up as many times as possible in a row as possible. Record the number of consecutive horizontal push attempts within 90 seconds.

(2) When squatting deeply, the subject should keep the barbell balanced in the middle of their shoulder and back, straighten their chest and spread their shoulders, naturally grasp the barbell with both hands, and lock it with their thumbs. The width of the two feet should be directly proportional to their height, and they should land on the ground with their full feet. After reaching the reference pole angle, they should squat up with force and squat up as much as possible. Record the number of consecutive deep squats within 90 seconds.

(3) According to the evaluation standards of Chinese youth basketball players' physical fitness test, the test results of athletes' 90s weight-bearing bench press/squat are scored by the weight coefficient of bench press/squat weight, and the calculation formula is as follows: Bench press weight weight coefficient = (bench press weight * number of bench presses)/weight, squat weight weight coefficient = (squat weight * number of squats)/weight, the coefficient is accurate to one decimal place.

(4) Due to the fact that under normal circumstances, the larger the weight, the greater the strength. Therefore, the scoring criteria for this test are divided into two groups based on the weight of the tested team members: the group below 90kg and the group above 90kg (including 90kg). (The scoring criteria are shown in the following figure)

90s Bench press/Squat test score table

90S weight bench press test score table				90S weight squat test score table			
Bench press weight Weight coefficient (weight < 90kg)	score	Score Bench Press Weight Weight coefficient (Weight 》90kg)	score	Squat weight Weight coefficient (weight < 90kg)	score	Squat Weight Weight coefficient (Weight》90KG)	score
2.5	50	3.5	50	4.0	50	5.0	50
3.0	52	4.0	52	4.5	52	5.5	52
3.5	54	4.5	54	5.0	54	6.0	54
4.0	56	5.0	56	5.5	56	6.5	56
4.5	58	5.5	58	6.0	58	7.0	58
5.0	60	6.0	60	6.5	60	7.5	60
5.5	62	6.5	62	7.0	62	8.0	62
6.0	64	7.0	64	7.5	64	8.5	64
6.5	67	7.5	67	8.0	66	9.0	66
7.0	70	8.0	70	8.5	68	9.5	68
7.5	73	8.5	73	9.0	70	10.0	70
8.0	76	9.0	76	9.5	72	10.5	72
8.5	79	9.5	79	10.0	74	11.0	74
9.0	82	10.0	82	10.5	77	11.5	77
9.5	85	10.5	85	11.0	80	12.0	80
10.0	88	11.0	88	11.5	83	12.5	83
10.5	91	11.5	91	12.0	86	13.0	86
11.0	94	12.0	94	12.5	89	13.5	89
11.5	97	12.5	97	13.0	92	14.0	92
12.0	100	13.0	100	13.5	95	14.5	95
12.5	103	13.5	103	14.0	98	15.0	98
13.0	106	14.0	106	14.5	101	15.5	101
13.5	110	14.5	110	15.0	104	16.0	104
14.0	114	15.0	114	15.5	107	16.5	107
14.5	118	15.5	118	16.0	110	17.0	110
15.0	122	16.0	122	16.5	114	17.5	114
15.5	126	16.5	126	17.0	118	18.0	118

16.0	130	17.0	130	17.5	122	18.5	122
16.5	134	17.5	134	18.0	126	19.0	126
17.0	138	18.0	138	18.5	130	19.5	130
17.5	142	18.5	142	19.0	134	20.0	134
18.0	146	19.0	146	19.5	138	20.5	138
18.5	150	19.5	150	20.0	142	21.0	142

Pass gravity ball with both hands in front of your chest

1. Test purpose

Evaluate the level of explosive power of athletes' upper limbs.

2. Test preparation

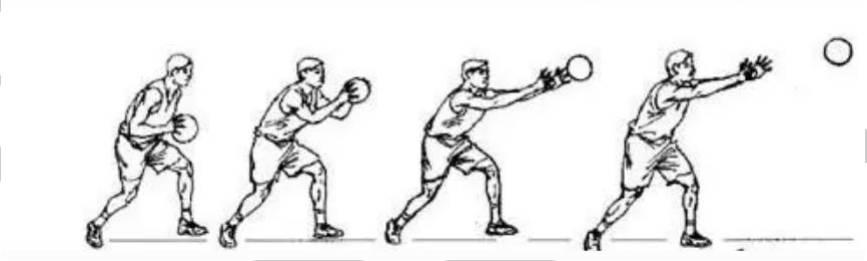
(1) Warm up.

(2) Gravity ball weight 3kg.

(3) Do technical instructions and safety measures

3. Test method

Passing gravity ball with both hands in front of the chest: subjects are required to hold 3kg gravity ball with their hands, stand front and back with their feet, hold the ball above the finger root, bend their elbows naturally at both sides of the body, place the gravity ball in the chest, push off the ground with their back feet, move their weight forward, extend their arms and shake their wrists when passing the ball. Each person is tested twice, and record the best score (m) of passing the ball.



3/4 basketball court speed up the run

1. Test purpose

Assess the athlete's ability to react quickly and start acceleration.

2. Test preparation

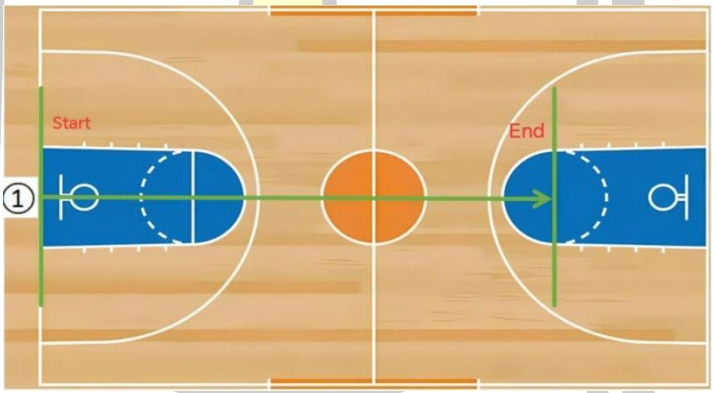
(1) Athletes fully warm up.

(2) The staff set up the speed tester.

3.Test method

(1) The subjects stand outside the end line of the back court of the basketball court, start quickly after hearing the command, accelerate and sprint to the front free throw line.

(2) Each person test twice, record the best results.



17 Return Run (15m*17)

1. Test purpose

Assess the athlete's anaerobic endurance level.

2. Test preparation

(1) Warm up.

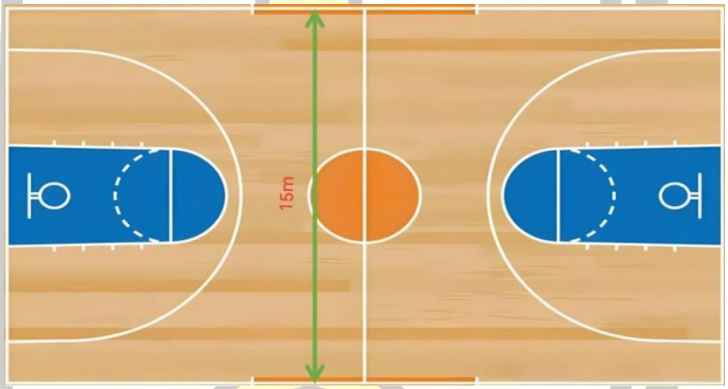
(2) Do a good turn back route and rules.

3. Test method

(1) The subjects started from the sideline of the basketball court and ran to the opposite sideline. One foot stepped on or crossed the sideline once, and completed a total of 17 return-to-sprint runs successively.

(2) The test must have a foot on the line or cross the line, otherwise it is considered a violation.

(3) Each person test twice, record the best results.



T-test

1. Test purpose

Assess agility and coordination, body control during acceleration and deceleration, variable acceleration, horizontal movement, and forward and backward acceleration.

2. Test preparation

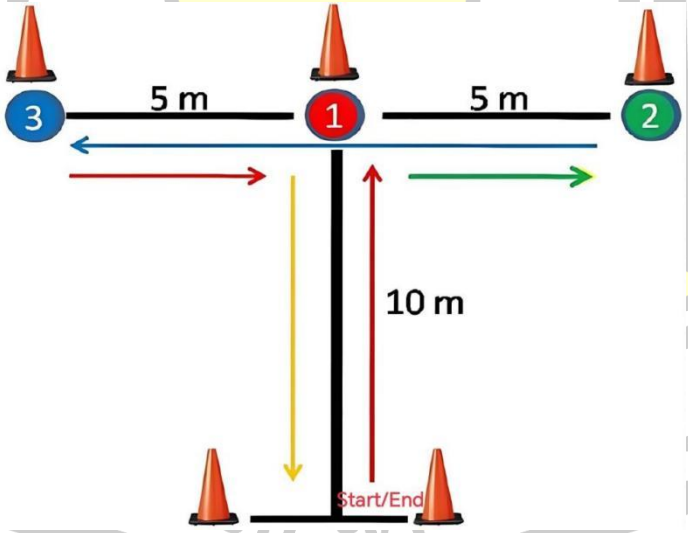
(1) Athletes fully warm up.

(2) Do technical instructions, familiar with the running route.

3. Test method

(1) The subjects place their front feet behind the starting point, after hearing the signal, quickly start and run to point ①, touch the bottom of the cone bucket with their left hand, and then slide to the right side to point ②; after touching the bottom of the cone bucket with their right hand, quickly change to the left and slide to point ③; after touching the bottom of the cone bucket with their left hand, quickly change to the right and slide to point ①; after touching the bottom of the cone bucket with their right hand, run backward and cross the finish line to complete the test.

(2) Each person test twice, record the best result.



Hexagon Jump Test

1. Test purpose

Assess the athlete's ability to control the body, to move at a rapid pace and change direction while maintaining the body's balance.

2. Test preparation

(1) Athletes fully warm up.

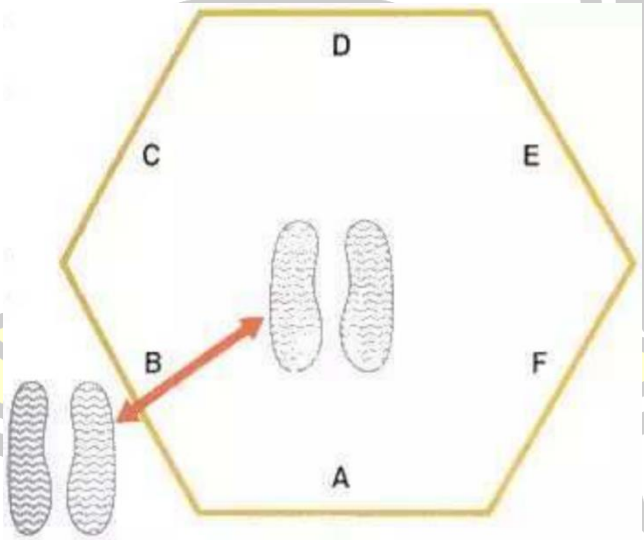
(2) Do a good job of technical instructions, familiar with the jump route.

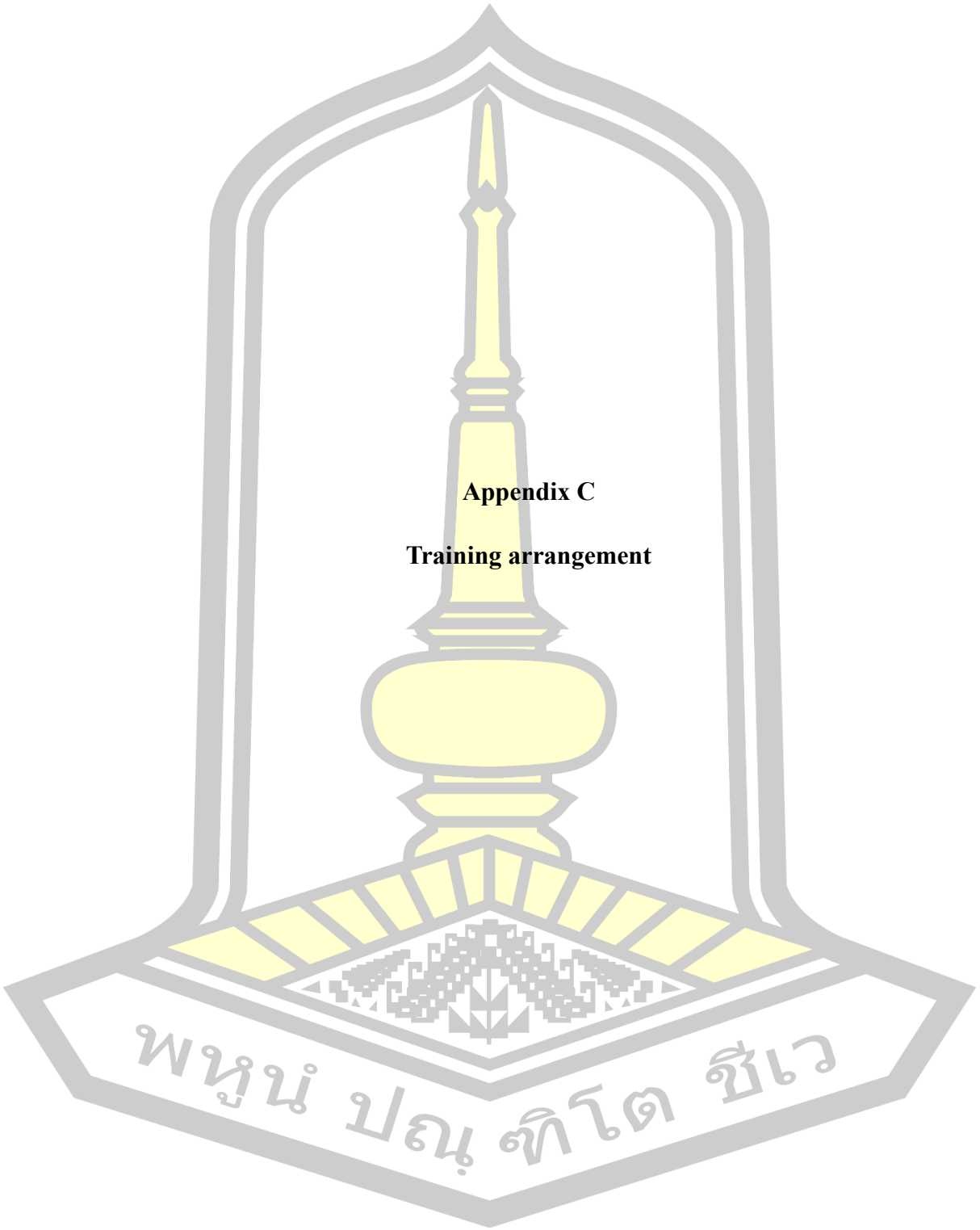
3. Test method

(1) The subject stands in the middle of the hexagon, facing line A, and remains facing line A at all times during the jump.

(2) After hearing the starting signal, the subject jumps over line A, then quickly jumps back to the center, continues to jump outside line B, then jumps back to the center, and so on, completing 3 laps, and finally returning to the center, that is, a complete test. If you misjump, step on the line, or lose your balance, start again.

(3) Each person test twice, record the best results, each test interval 2-3 minutes.





Appendix C

Training arrangement

Five experts examined the science of functional physical training programs for college basketball players.

Functional Physical Training Schedule (1-10 weeks): FPT body basic motor function training phase class training plan (1-3 weeks), FPT General motor function training class training plan (4-7 weeks), FPT special motor function training class training plan (8-10 weeks). A total of 10 weeks of training, three times a week (Tuesday, Thursday, Saturday), 90 minutes each time.

A total of five experts examined the scientific nature of functional physical training programs for college basketball players, and the results were as follows:

Tables	**Week**	**Expert Evaluation**					**IOC Value**
		1	**2**	**3**	**4**	**5**	
Table 1	Week 1 (Tuesday)	1	1	1	1	1	**1**
Table 2	Week 1 (Thursday)	1	1	1	1	1	**1**
Table 3	Week 1 (Saturday)	1	1	1	1	1	**1**
Table 4	Week 2 (Tuesday)	1	1	1	1	1	**1**
Table 5	Week 2 (Thursday)	1	1	1	1	1	**1**
Table 6	Week 2 (Saturday)	1	1	1	1	1	**1**
Table 7	Week 3 (Tuesday)	1	1	1	1	1	**1**
Table 8	Week 3 (Thursday)	1	1	0	1	1	**0.8**
Table 9	Week 3 (Saturday)	1	1	1	1	1	**1**
Table 10	Week 4 (Tuesday)	1	1	1	1	1	**1**
Table 11	Week 4 (Thursday)	1	1	1	1	1	**1**
Table 12	Week 4 (Saturday)	1	1	1	1	1	**1**
Table 13	Week 5 (Tuesday)	1	1	1	1	1	**1**
Table 14	Week 5 (Thursday)	1	1	1	1	1	**1**
Table 15	Week 5 (Saturday)	1	1	1	0	1	**0.8**

Table 16	Week 6 (Tuesday)	1	1	1	1	1	**1**
Table 17	Week 6 (Thursday)	1	1	1	1	1	**1**
Table 18	Week 6 (Saturday)	1	1	1	1	1	**1**
Table 19	Week 7 (Tuesday)	1	1	1	1	1	**1**
Table 20	Week 7 (Thursday)	1	1	1	1	1	**1**
Table 21	Week 7 (Saturday)	1	1	1	1	1	**1**
Table 22	Week 8 (Tuesday)	1	1	1	1	1	**1**
Table 23	Week 8 (Thursday)	1	1	1	1	1	**1**
Table 24	Week 8 (Saturday)	1	1	1	1	1	**1**
Table 25	Week 9 (Tuesday)	1	1	1	1	1	**1**
Table 26	Week 9 (Thursday)	1	1	1	1	1	**1**
Table 27	Week 9 (Saturday)	1	1	1	1	1	**1**
Table 28	Week 10 (Tuesday)	1	1	1	1	1	**1**
Table 29	Week 10 (Thursday)	1	1	1	1	1	**1**
Table 30	Week 10 (Saturday)	1	1	1	1	1	**1**

Functional Physical Training Schedule (1-10 weeks)

Functional physical training body basic motor function training phase class training arrangement (1-3 weeks)

Table 1 Tuesday of Week 1

Training Objective	Training content	Groups	Duration/ times/ distance	Intermit tent time
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Muscle Activation	Crawl	2	15m	60s
Upper Limb Movement Pattern	Stand in Y-shape	3	15-20 times	15s
	Stand in T-shape	3	15-20 times	15s
	Stand in W shape	3	15-20 times	15s
	Stand in L-shape	3	15-20 times	15s
Lower Limb Movement Pattern	Lunge exercise	2	15m	15s
	Running form exercise	1	15m	15s
	Starting and scram exercises	2	15m	20s
	Multi-directional movement and braking exercises	3	6m*10	20s
Shoulder Flexibility	Stretch the elastic band back and forth around the loop	2	10 times	30s
Scapular Stability	Shoulder joint stroke against the wall	3	15-20 times	30s
	Stretch strap shoulder joint against wall stroke	3	12-15 times	30s
Upper Limb Stability	Bend your knees and do push-ups	2	20 times	30s
	Straight knee push-ups	2	20 times	30s
	Two-handed elastic bar stability exercises	2	20s	30s
	One-handed elastic bar stability exercises	2	20s	30s
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

Table 2 Thursdays of Week 1

Training Objective	Training content	Groups	Duration/ times/ distance	Intermit tent time
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Muscle Activation	Crawl	2	15m	60s
Upper Limb Stability	Elastic strap against shoulder joint against wall	2	12-15	30s
	Two-handed elastic bar stability	2	20s	30s
	One-handed elastic bar stability	2	20s	30s
	Crocodile push-ups	3	15-20	30s
	Swiss ball stability on knees	3	20s	30s
	Standing Swiss ball stability	3	20s	30s
Core Stability	plank support	3	120s	60s
	Dorsal bridge	3	120s	60s
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

Table 3 Saturday of Week 1

Training Objective	Training content	Groups	Duration/ times/ distance	Intermitt ent time
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Basic Action Mode	Standing Y-shape (Elastic band)	3	15-20	30s
	Standing T-shape (Elastic band)	3	15-20	30s
	Standing W shape (Elastic band)	3	15-20	30s
	Standing L-shape (Elastic band)	3	15-20	30s
Core Stability	Elbow support side bridge (left)	3	60s	60s
	Elbow support side bridge (right)	3	60s	60s
	Prone back muscle superman	3	15-20	60s
	Prone Swiss ball back muscle superman	3	15-20	60s
Lower Limb Stability	Swallow balance (left)	3	8	20s
	Swallow balance (right)	3	8	20s
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

Table 4 Tuesday of Week 2

Training Objective	Training content	Groups	Duration/ times/ distance	Intermittent time
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Basic Action Mode	Deep squat	3	15-20	30s
	Take-off and landing	3	15-20	30s
	Sliding step	3	15m*2	30s
	Cross step	3	15m*2	30s
	Turn around	3	8	30s
Lower Limb Stability	Elastic band resistance squat	3	12-15	60s
Anaerobic Tolerance	Basketball court four-line run	2	1	60s
	A basketball court sprints diagonally	3	6	60s
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

Table 5 Thursday of Week 2

Training Objective	Training content	Groups	Duration/ times/ distance	Intermittent time
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Upper Limb Stability	Kneeling suspended supine pull	3	12-15	60s
	Straight knee suspension supine	3	12-15	60s
	Bent knee suspension prone bench press	3	12-15	60s
	Straight knee suspension prone bench press	3	12-15	60s
Core Stability	COOK parietal hip	3	15-20	60s
	Hand and foot brace alternately touch shoulder	3	15-20	60s
	Lay on your back and touch both sides of your hands	3	15-20	60s
	Lying prone with both hands touching	3	15-20	60s
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

Table 6 Saturday of Week 2

Training Objective	Training content	Groups	Duration/ times/ distance	Intermittent time
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Upper Limb Stability	crawl	3	15m	60s
	Crocodile push-ups	3	15-20	60s
	Turkey rise	3	12-15	60s
Core Stability	Anal bridge	3	90s	60s
	Abdominal muscle	3	20s	60s
	Dorsal muscle	3	20s	60s
Lower Limb Stability	Elastic bands resist lateral movement	3	8m*2	60s
	Lie on your back and pull the Swiss ball	3	15-20	60s
	One leg back hook Swiss ball	3	15-20	60s
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

Table 7 Tuesday of Week 3

Training Objective	Training content	Groups	Duration/ times/ distance	Intermittent time
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Upper Limb Stability	crawl (Elastic band)	3	15m	60s
Basic Action Mode	Starting acceleration and scram	3	28m	30s
	Combination exercises	3	28m	60s
	(slide + cross + jump + turn)	3	8	30s
	Fall over			
Core Stability	Knees and elbows on the stomach and arms and legs on the opposite side	3	12-15	60s
	Knees and elbows on the stomach with hands and feet on the same side	3	12-15	60s
Aerobic Endurance	3200m run	1	1	5min
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

Table 8 Thursday of Week 3

Training Objective	Training content	Groups	Duration/ times/ distance	Intermittent time
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Upper Limb Stability	Kneeling suspended supine pull	3	12-15	60s
	Straight knee suspension supine	3	12-15	60s
Core Stability	Elbow support side bridge (left)	3	60s	60s
	Elbow support side bridge (right)	3	60s	60s
Lower Limb Stability	The small railings fall back and forth	3	15-20	60s
	Little bars jump back and forth in a row	3	15-20	60s
	Jump bosu ball with both feet	3	12-15	60s
	Hop the bosu ball on one foot	3	12-15	60s
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

Table 9 Saturday of Week 3

Training Objective	Training content	Groups	Duration/ times/ distance	Intermittent time
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Upper Limb Stability	Push up sideways	3	15m	60s
	Straight knee suspension supine	3	15-20	60s
	Turkey rise	3	12-15	60s
Core Stability	Lie on your stomach on your hands and feet and raise your hands and feet on your side	3	15-20	60s
	Lying on the stomach with hands and feet on the same side	3	15-20	60s
Lower Limb Stability	Lie on your back and pull the Swiss ball	3	15-20	60s
	One leg back hook Swiss ball	3	15-20	60s
	Small fence left and right landing stability	3	15-20	60s
	Small bar continuously jump left and right	3	15-20	60s
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

Functional physical training General motor function training class training arrangement (4-7 weeks)

Table 10 Tuesday of Week 4

Training Objective	Training content	Groups	Duration/ times/ distance	Intermittent time
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches (Agility Ladder 8 steps)	1	15m	15s
Agility And Coordination Training	Take small steps forward	3	10m	30s
	Small horizontal slide	3	10m	30s
	Back and forth	3	10m	30s
	In and out	3	10m	30s
	Two in, two out	3	10m	30s
	Parallel step small jump followed by small step	3	10m	30s
	Outside-in-out	3	10m	30s
	Cross step	3	10m	30s
Speed Training	Side running	3	22m	30s
	Variable direction running	3	22m	30s
	Backward running	3	22m	30s
Anaerobic Endurance	Basketball court 5.8 m *6 Shuttle run	4	1	60s
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

Table 11 Thursday of Week 4

Training Objective	Training content	Load	Groups	Duration/ times/ distance	Intermittent time
Warm-Up	6 dynamic movements	--	2	15m	15s
Dynamic Stretch	8 dynamic stretches	--	1	15m	15s
Core Instability Training	Elbow Swiss ball over bridge	Own weight	3	45s	30s
	Swiss ball down the bridge with legs	Own weight	3	45s	30s
	Supine Swiss ball Russian spin	Own weight	3	15-20	30s
Upper Limb Muscle Activation	push-up	Own weight	2	20	30s
Upper Body Strength Training	Bench press	65-75%1RM	3	10-15	60s
	Stand on the bar and push on the chest	25-35KG	3	10-15	60s
	Stand with keiser and pull both hands down	65-75%1RM	3	10-15	60s

Lower Limb Stability Training	Standing elastic band to resist knee and hip abduction	--	3	15-20	60s
	Standing position elastic band anti-resistance knee lift hip adduction		3	15-20	60s
Lower Limb Strength Training	Weight-bearing heel lifting training	40KG	3	15-20	60s
	Kettlebell squats	10KG	3	15-20	60s
Regenerative Recovery Training	Stretch training 10 movements	--	1	30s	5s
	Fascial relaxation		1	60s	5s

Table 12 Saturday of Week 4

Training Objective	**Training content**	**Groups**	**Duration/ times/ distance**	**Intermit tent time**
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Plyometric Training	Hop from side to side	3	30s	30s
	Hop back and forth	3	30s	30s
	Mountain climbing run	3	30s	60s
	Burpees	3	12-15	60s
Core Strength Training	Lie on your back straight leg up	3	12-15	30s
	Lie on your back and bend your knees	3	30s	30s
Aerobic Endurance	3200m run	1	1	5min
Regenerative Recovery Training	Stretch training 10 movements	--	1	30s
	Fascial relaxation		1	60s

Table 13 Tuesday of Week 5

Training Objective	Training content	Groups	Duration/ times/ distance	Intermittent time
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Agility And Coordination Training	(Agility Ladder 6 steps) Hop	3	10m	30s
	Leg side jump	3	10m	30s
	Cross step	3	10m	30s
	One inside and one outside	3	10m	30s
	Cross one's legs	3	10m	30s
	Skating step	3	10m	30s
Speed Training	High leg lift with elastic band resistance	3	22m	30s
	Run with elastic straps and resistance	3	22m	30s
	Elastic band resists longitudinal jump	3	12-15	30s
Anaerobic Endurance Training	28m* 6 Shuttle run	3	1	60s
Regenerative Recovery Training	Stretch training 10 movements	--	1	30s
	Fascial relaxation		1	60s

Table 14 Thursday of Week 5

Training Objective	Training content	Load	Groups	Duration/ times/ distance	Intermittent time
Warm-Up	6 dynamic movements	--	2	15m	15s
Dynamic Stretch	8 dynamic stretches	--	1	15m	15s
Upper Limb Muscle Activation	Standing posture Arms dumbbells up	5KG	2	15-20	30s
Upper Body Strength Training	Supine dumbbell bird	10KG	3	10-15	60s
	Back bar push up diagonally	65-75%1RM	3	10-15	60s
	Stand with keiser and pull both hands down	65-75%1RM	3	10-15	60s
	Stand with keiser and pull both hands flat	65-75%1RM	3	10-15	60s
Core Strength Training	Lie on your back and rotate quickly against your knee and elbow	——	3	15-20	60s
	Lie on your back and bend your knees and alternate hands and feet on the same side	——	3	15-20	60s
	Weight-bearing Russian twist	5KG	3	15-20	60s

Lower Limb Strength Training	Barbell half squat	65-75%1RM	3	12-15	60s
	Barbell lunge alternate squat	30-40KG	3	12-15	60s
	Lie prone and bend your knees	25-35KG	3	12-15	60s
	Sit with no resistance to knee extension	25-35KG	3	12-15	60s
Regenerative Recovery Training	Stretch training 10 movements	--	1	30s	5s
	Fascial relaxation		1	60s	5s

Table 15 Saturday of Week 5

Training Objective	**Training content**	**Groups**	**Duration/ times/ distance**	**Intermittent time**
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Plyometric Training	Hip turn	3	30s	30s
	Quadrant jump with both feet	3	30s	30s
	Burpee	3	30s	60s
	Bend your knees and pull in your stomach	3	12-15	60s
Aerobic Endurance	Power bike	1	30min	5min
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

Table 16 Tuesday of Week 6

Training Objective	**Training content**	**Groups**	**Duration/ times/ distance**	**Intermittent time**
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Agility And Coordination Training	Multiposture response activation	3	10m	30s
	Multidirectional start-braking	3	10m	30s
	M type running	3	1	30s
	Hexagon jump	4	1	30s
Speed Training	30 meter dash	5	30m	30s
	60 meter dash	4	60m	60s
Anaerobic Endurance	200 meter interval run	4	200m	60s
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

Table 17 Thursday of Week 6

Training Objective	Training content	Load	Groups	Duration/ times/ distance	Intermittent time
Warm-Up	6 dynamic movements	--	2	15m	15s
Dynamic Stretch	8 dynamic stretches	--	1	15m	15s
Upper Limb Muscle Activation	Elastic band bend elbow forward	——	2	15-20	30s
Upper Body Strength Training	Lift dumbbells on Swiss balls	10KG	3	10-15	60s
	Bench press	75-85%1RM	3	8-12	60s
	Barbell flip	75-85%1RM	3	8-12	60s
	Standing position bar blade head left and right arc	65-75%1RM	3	10-15	60s
Core Strength Training	Elbow Swiss ball over bridge	——	3	30s	60s
	Swiss ball down the bridge with legs	——	3	30s	60s
	Standing position lateral bending of weight body	15-20KG	3	15-20	60s
Lower Limb Strength Training	Dumbbell Bulgaria squat (left)	10-20KG	3	12-15	60s
	Dumbbell Bulgarian squat (right)	10-20KG	3	12-15	60s
	keiser resists hip abduction	65-75%1RM	3	12-15	60s
	keiser resists hip adduction	65-75%1RM	3	12-15	60s
Regenerative Recovery Training	Stretch training 10 movements	--	1	30s	5s
	Fascial relaxation		1	60s	5s

Table 18 Saturday of Week 6

Training Objective	Training content	Groups	Duration/ times/ distance	Intermittent time
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Plyometric Training	Skating step jump	3	20m	30s
	Level ten leapfrog	3	25m	60s
	Mountain climbing race	3	30s	60s
	Elastic band to resist sliding	3	20m*2	60s
Agility Training	5-10-5 Agile Run	4	1	30s
	Arc running	4	1	30s
Core Strength Training	Supine straight push up	3	15-20	30s
	Lie on your back and quickly rise at both ends	3	15-20	30s
Anaerobic Endurance	Variable speed running	1	2000m	5min

Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

Table 19 Tuesday of Week 7

Training Objective	**Training content**	**Groups**	**Duration/ times/ distance**	**Intermitt ent time**
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Agility And Coordination Training	M-shaped run	3	1	30s
	T-shaped run	4	1	30s
	米-shaped run	3	1	30s
Speed Training	3/4 basketball court speed up the run	5	22m	30s
	High leg lift with elastic band resistance	4	22m	60s
	Run with elastic straps against resistance	4	22m	60s
Anaerobic Endurance	Belly jump acceleration run	3	10	60s
	15m*17 Shuttle run	2	1	2min
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

Table 20 Thursday of Week 7

Training Objective	**Training content**	**Load**	**Groups**	**Duration/ times/ distance**	**Intermit tent time**
Warm-Up	6 dynamic movements	--	2	15m	15s
Dynamic Stretch	8 dynamic stretches	--	1	15m	15s
Upper Limb Muscle Activation	Standing position dumbbell side flat	5-10KG	2	15-20	30s
Upper Body Strength Training	Sitting dumbbell push up	10-20KG	3	12-15	60s
	Swiss bench press bar	65-75%1RM	3	12-15	60s
	Kettlebell one arm up	75-85%1RM	3	8-12	60s
	Lie on your back and pull horizontally	Own weight	3	8-12	60s
Core Strength Training	Lie on your back hip bend leg push Swiss ball	——	3	30s	60s
	Back foot on the Swiss ball and hip	——	3	30s	60s
	Lying on your back with weights on your hips	30-40KG	3	12-15	60s
Lower Limb Strength Training	Three-way lunge with weights	10-20KG	3	12-15	60s
	Barbell squats	65-75%1RM	3	12-15	60s
	Kettlebell hard pull	75-85%1RM	3	8-12	60s

Regenerative Recovery Training	Stretch training 10 movements Fascial relaxation	--	1 1	30s 60s	5s 5s

Table 21 Saturday of Week 7

Training Objective	**Training content**	**Groups**	**Duration/ times/ distance**	**Intermit tent time**
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Plyometric Training	Standing jumping jacks	3	30s	30s
	Vaulting box	3	12-15	60s
	Drop jump	3	12-15	60s
	Level ten leapfrog	3	25m	60s
Core Strength Training	Lie on your back and bend your knees	3	15-20	30s
	Sit-up tripartite throw gravity ball	3	15-20	30s
Aerobic Endurance	YOYO run	1	1	5min
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

Functional physical training special motor function training class training arrangement (8-10 weeks)

Table 22 Tuesday of Week 8

Training Objective	Training content	Groups	Duration/ times/ distance	Intermit tent time
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Special Speed and Agility Training	2 players free of the ball	4	28m	30s
	Rope ladder multiple dribble	4	12m	30s
	Rope ladder a variety of passes	4	12m	30s
	No dribbling offense in the half court	1	15min	60s
Special Endurance Training	Guards and forwards resist sliding	3	30s	60s
	Center block movement defense	3	30s	60s
	Guards and forwards accelerate off the dribble	3	28m	60s
	Center in the limit zone against the block catch	3	60s	60s
	Fast break with 2 players	4	4 balls	90s
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

Table 23 Thursday of Week 8

Training Objective	Training content	Groups	Duration/ times/ distance	Intermi ttent time
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Special Strength Training	Turn with gravity ball resistance	3	15-20	60s
	Hold the gravity ball to resist the step	3	15-20	60s
	Lunge up with gravity ball	3	15-20	60s
	Step twist with gravity ball	3	15-20	60s
	Push and stretch with gravity ball	3	15-20	60s
Basic Strength Training	Jump with both feet forward in quick succession	3	12	30s
	Jump with both feet sideways in quick succession	3	12	30s
	Elastic band tripartite quick step up	4	15	60s
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

Table 24 Saturday of Week 8

Training Objective	Training content	Groups	Distance/ duration/ number	Intermit tent time
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Special Speed and Agility Training	Rope ladder a variety of dribbling and passing combination	6	12m	20s
	Two players dribble out of the court	4	28m	60s
	Guards and forwards resist sliding	3	28m	30s
Special Endurance Training	Center block movement defense	3	30s	30s
	Three players 8-figure fast break	4	6 balls	90s
	Guard, forward half 1V1 attack and defense	6	60s	60s
	Center zone 1V1 attack and defense	6	60s	60s
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

Table 25 Tuesday of Week 9

Training Objective	Training content	Groups	Duration/ times/ distance	Intermit tent time
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Special Speed and Agility Training	Listen to the signal and dribble	4	28m	30s
	Dribble continuously over the marker bucket	4	28m	30s
	Stretch-band resistance dribble run	4	28m	30s
Special Endurance Training	Passing and receiving the ball from the corners of the half court	1	150	60s
	Guard and forward resist breaking layup	3	10 balls	60s
	The center takes more shots in the restricted area	3	10balls	60s
	Full court 1V1 attack and defense	4	2	60s
	Full court 2V2 quick attack and defense	4	6 balls	90s
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

Table 26 Thursday of Week 9

Training Objective	Training content	Groups	Duration/ times/ distance	Intermit tent time
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Special Strength Training	Heavy basketball pass	3	15-20	60s
	Heavy basketball dribble	3	15-20	60s
	Heavy basketball layup	3	15-20	60s
	Heavy basketball shot	3	15-20	60s
Basic Strength Training	One leg forward quick continuous jumpers	3	12	30s
	One leg side quick continuous jumpers	3	12	30s
	Stand on the bar and push on the chest	4	12-15	60s
	Holding solid ball (left and right)	4	Each15	30s
	Kneeling position abs wheel	3	12-15	30s
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

Table 27 Saturday of Week 9

Training Objective	Training content	Groups	Distance/ duration/ number	Intermit tent time
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Special Speed and Agility Training	Rope ladder a variety of dribbling and passing combination	6	12m	20s
	No dribbling in all court	1	15min	60s
Special Endurance Training	8 players run the whole court continuously hit the rebound	1	120	60s
	Guard, forward running outside the 3-point line to catch and shoot (2 players)	2	40 balls	60s
	Center reasonable outside the collision zone multi-point catch and shoot (2 players)	2	45 balls	60s
	Guard, forward half 1V1 attack and defense	6	60s	60s
	Center zone 1V1 attack and defense	6	60s	60s
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

Table 28 Tuesday of Week 10

Training Objective	Training content	Groups	Duration/ times/ distance	Intermittent time
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Special Speed and Agility Training	Two men in half free of the ball	6	10	30s
	Rope ladder multiple dribble	4	12m	30s
Special Endurance Training	Guards and forwards resist sliding	3	30s	60s
	Center block movement defense	3	30s	60s
	Full court 1V1 attack and defense	4	2	60s
	Full court 2V2 quick attack and defense	3	6 balls	90s
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

Table 29 Thursday of Week 10

Training Objective	Training content	Groups	Duration/ times/ distance	Intermittent time
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Special Strength Training	Elastic band resists longitudinal jump	3	12-15	60s
	Elastic band against resistance dribble	3	60s	60s
	The guard and forward take off to make a layup against a foul	3	10	60s
	The center dribbled back-to-back	3	10	60s
Basic Strength Training	Four-pronged support	3	2min	30s
	Dumbbell Romanian hard pull	3	12-15	30s
	Standing keiser Logging (left)	3	12-15	60s
	Standing keiser Logging (right)	3	12-15	60s
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

Table 30 Saturday of Week 10

Training Objective	Training content	Groups	Distance/ duration/ number	Intermit tent time
Warm-Up	6 dynamic movements	2	15m	15s
Dynamic Stretch	8 dynamic stretches	1	15m	15s
Special Speed and Agility Training	Listen to the signal dribble chase run practice	4	28m	30s
	T-shaped dribble	4	1	30s
Special Endurance Training	8 players run the whole court continuously hit the rebound	1	120	60s
	All 3v3 running catch and shoot game	2	30 balls	90s
	All 3V3 quick attack and defense	6	6 balls	60s
Regenerative Recovery Training	Stretch training 10 movements	1	30s	5s
	Fascial relaxation	1	60s	5s

Appendix D

Data collection

CG group pretest

序号	姓名	肺活量	安静心率	最高心率	即刻心率	运动后 1min	2min	4min	17折返跑（s）	3200m (min)
1	[redacted]	4615	63	185	183	167	148	123	62.3	13.42
2	[redacted]	4307	58	178	178	160	140	114	58.5	13.02
3	[redacted]	4456	62	186	185	168	149	123	63.2	14.18
4	[redacted]	4232	60	182	182	165	143	115	59.4	13.27
5	[redacted]	4035	62	185	183	165	145	118	62.6	14.12
6	[redacted]	4618	60	182	181	162	141	114	61.7	13.24
7	[redacted]	5127	62	184	183	166	147	119	63.5	14.08
8	[redacted]	4774	63	188	185	169	150	126	64.5	14.36
9	[redacted]	4539	61	182	181	164	143	118	61.2	13.52
10	[redacted]	4428	63	185	185	167	147	118	65.3	14.54
11	[redacted]	4757	65	192	189	171	150	125	68.3	16.46
12	[redacted]	4539	64	186	184	166	146	119	66.4	15.38
13										
14										
15										

CG pre test

序号	姓名	立定跳远 (cm)	原地双脚起跳摸高 (cm)	助跑单脚起跳摸高 (cm)	双手胸前传重力球 (m)	1RM卧推 (kg)	1RM深蹲 (kg)	90s 卧推	90s 深蹲	1min 屈膝仰卧起坐	平板支撑 (s)	3/4 篮球场加速跑 (s)	T字型跑 (s)	六边形跳跃 (s)	坐位体前屈 (cm)
1		250	298	302	8.2	85	125	13	12	41	255	3.87	11.38	13.57	9
2		265	306	311	6.7	70	110	6	9	42	302	3.46	10.73	12.45	15
3		254	297	302	7.2	75	115	7	10	52	361	3.63	11.25	13.42	12
4		283	312	317	7.3	75	115	8	10	51	136	3.52	10.68	12.65	8
5		257	308	312	7.5	85	120	11	11	54	237	3.72	11.17	13.16	13
6		265	311	316	7.4	80	123	10	12	58	268	3.55	10.85	12.8	18
7		253	307	311	8.5	90	135	14	16	47	219	3.92	11.64	13.7	5
8		262	314	317	8.1	85	130	12	14	52	215	3.86	11.92	13.3	12
9		270	310	315	7.4	80	120	9	12	55	233	3.72	11.23	13.35	15
10		270	316	321	7.8	85	123	11	13	45	155	3.73	12.35	13.85	16
11		265	315	317	8.6	90	125	14	13	38	118	4.02	12.8	14.65	8
12		278	319	324	8.8	95	130	16	14	44	157	3.85	13.13	14.3	14
13															
14															
15															

CG group post test

序号	姓名	肺活量	安静心率	最高心率	即刻心率	运动后1min	2min	4min	17折返跑(s)	3200m(min)
1	[redacted]	4723	61	183	183	165	146	120	61.7	13.27
2	[redacted]	4467	56	176	176	159	139	109	57.8	12.51
3	[redacted]	4525	61	184	184	166	146	119	62.8	14.03
4	[redacted]	4288	58	180	180	164	142	113	59.1	13.1
5	[redacted]	4176	61	183	182	165	143	117	61.7	13.53
6	[redacted]	4739	59	181	180	161	140	112	61.5	13.02
7	[redacted]	5089	61	182	182	164	145	117	62.9	13.46
8	[redacted]	4860	62	185	184	166	147	122	64.6	14.23
9	[redacted]	4622	60	181	181	163	141	115	61.4	13.38
10	[redacted]	4472	62	184	184	166	142	116	64.8	14.35
11	[redacted]	4837	64	190	187	169	148	123	68.7	16.28
12	[redacted]	4575	63	185	184	166	144	115	66.8	15.24
13										
14										
15										

5

序号	姓名	立定跳远（cm）	原地双脚起跳摸高（cm）	助跑单脚起跳摸高（cm）	双手胸前传重力球（m）	1RM卧推（kg）	1RM深蹲（kg）	90s卧推	90s深蹲	1min屈膝仰卧起坐	平板支撑（s）	3/4篮球场加速跑（s）	T字型跑（s）	六边形跳跃（s）	坐位体前屈（cm）
1	[redacted]	252	300	305	8.5	88	128	14	13	44	263	3.78	11.24	13.32	10
2	[redacted]	268	309	314	7.1	75	110	5	10	46	314	3.52	10.66	12.13	16
3	[redacted]	256	299	304	7.5	78	120	9	11	55	373	3.55	11.13	13.11	12
4	[redacted]	288	315	321	7.7	78	118	10	11	55	145	3.48	10.54	12.43	9
5	[redacted]	260	311	315	7.9	88	123	12	13	56	251	3.57	11.22	13.02	13
6	[redacted]	270	313	318	7.8	85	125	13	13	60	256	3.42	10.83	12.55	19
7	[redacted]	255	308	312	8.8	93	138	16	17	69	252	3.79	11.78	13.42	6
8	[redacted]	265	316	318	8.6	90	135	13	16	54	224	3.93	11.86	13.15	13
9	[redacted]	272	312	317	7.6	85	123	11	13	58	246	3.65	11.22	13.23	17
10	[redacted]	273	319	323	8.1	90	125	12	14	47	162	3.69	12.35	13.7	18
11	[redacted]	267	317	318	8.8	95	130	16	16	62	134	4.14	12.74	14.76	8
12	[redacted]	280	322	327	9.2	98	135	17	18	48	165	3.9	13.2	14.42	14
13															
14															
15															

EG group pretest

序号	姓名	肺活量	安静心率	最高心率	即刻心率	运动后 1min	2min	4min	17折返跑 (s)	3200m (min)
1	[redacted]	4539	61	182	182	165	143	119	60.3	13.17
2	[redacted]	4137	64	188	187	168	148	122	63.3	14.27
3	[redacted]	4326	62	185	183	165	144	118	58.5	12.52
4	[redacted]	3964	63	187	185	166	145	120	63.2	13.45
5	[redacted]	4342	58	177	177	159	138	111	59.5	13.51
6	[redacted]	4268	61	180	178	161	142	117	61.4	13.38
7	[redacted]	4635	61	178	178	160	139	115	59.5	13.54
8	[redacted]	4318	63	190	188	169	148	121	62.3	14.18
9	[redacted]	4477	62	185	183	165	146	120	62.3	14.12
10	[redacted]	4632	63	189	188	167	146	119	64.4	14.55
11	[redacted]	4463	65	193	191	171	151	125	67.5	18.53
12	[redacted]	4847	63	188	188	167	146	120	64.4	16.28
13										
14										
15										

2

序号	姓名	立定跳远(cm)	原地双脚起跳摸高(cm)	助跑单脚起跳摸高(cm)	双手胸前传重力球(m)	1RM卧推(kg)	1RM深蹲(kg)	90s卧推	90s深蹲	1min屈膝仰卧起坐	平板支撑(s)	3/4篮球场加速跑(s)	T字型跑(s)	六边形跳跃(s)	坐位体前屈(cm)
1		280	314	318	8.4	90	140	16	15	61	304	3.82	11.15	13.12	20
2		250	296	300	6.8	70	130	4	11	40	262	3.85	11.56	13.25	17
3		263	304	310	8.1	85	125	13	12	58	283	3.58	10.64	12.28	14
4		255	309	315	7.2	76	115	8	11	62	165	3.71	10.79	12.1	20
5		258	303	308	7.5	80	120	11	12	52	266	3.42	10.22	12.58	13
6		265	310	315	7.7	80	120	12	12	48	257	3.64	11.2	12.4	11
7		270	307	313	8.5	100	140	16	16	65	270	3.83	11.95	13.18	10
8		295	325	329	6.6	70	105	4	7	51	197	3.81	10.84	12.62	13
9		268	312	315	7.6	80	120	10	14	54	384	3.75	10.97	12.35	7
10		272	318	321	7.8	85	120	13	11	44	130	3.72	12.14	13.87	26
11		253	306	308	8.5	95	125	13	12	39	127	4.42	13.2	14.87	3
12		282	323	327	7.9	80	120	10	11	43	145	3.97	12.65	14.26	8
13															
14															
15															

EG group post test

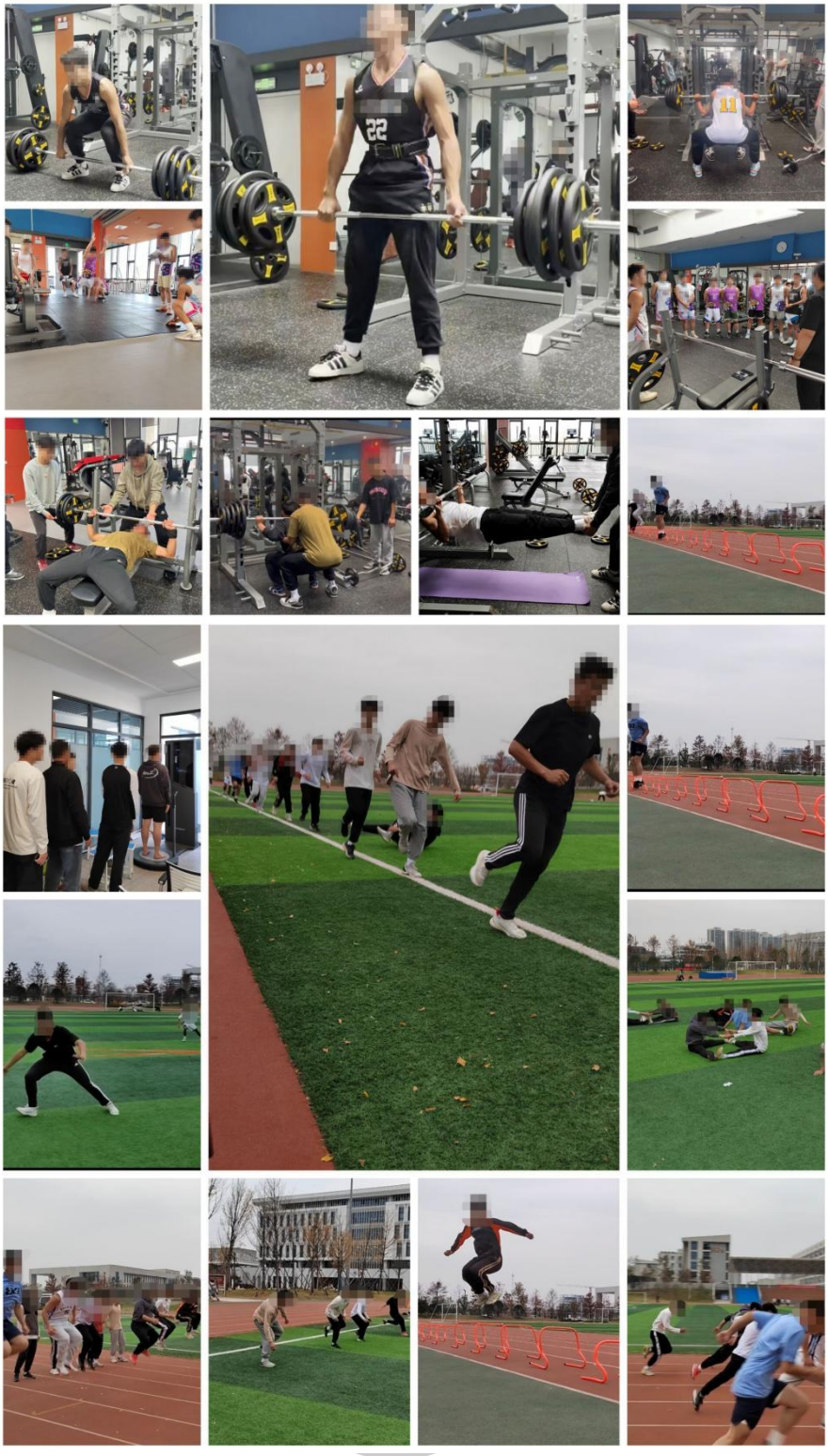
序号	姓名	肺活量	安静心率	最高心率	即刻心率	运动后 1min	2min	4min	17折返跑 (s)	3200m (min)
1	[redacted]	4727	60	180	180	160	139	110	57.5	12.43
2	[redacted]	4528	62	185	184	164	141	112	60.3	13.34
3	[redacted]	4695	60	182	180	161	140	109	56.1	12.58
4	[redacted]	4403	60	183	181	163	141	113	59.4	12.04
5	[redacted]	4627	57	174	173	154	133	108	56.2	11.67
6	[redacted]	4536	59	176	175	156	135	110	58.2	12.36
7	[redacted]	4959	60	175	175	155	133	107	56.1	12.38
8	[redacted]	4706	60	186	185	164	142	110	60.4	13.36
9	[redacted]	4740	59	183	181	160	138	108	60.7	13.37
10	[redacted]	4975	61	185	184	163	148	108	62.3	14.26
11	[redacted]	4740	63	190	187	168	145	115	66.1	18.15
12	[redacted]	5122	62	186	185	163	141	109	63.5	14.57
13										
14										
15										

5

序号	姓名	立定跳远(cm)	原地双脚起跳摸高(cm)	助跑单脚起跳摸高(cm)	双手胸前传重力球(m)	1RM卧推(kg)	1RM深蹲(kg)	90s卧推	90s深蹲	1min屈膝仰卧起坐	平板支撑(s)	3/4篮球场加速跑(s)	T字型跑(s)	六边形跳跃(s)	坐位体前屈(cm)
1	[redacted]	290	318	323	9.2	95	148	16	17	66	321	3.56	10.39	12.44	23
2	[redacted]	265	304	308	7.9	80	138	9	16	52	285	3.62	11.15	12.57	20
3	[redacted]	270	311	317	9	95	135	15	15	65	308	3.34	9.93	11.77	18
4	[redacted]	265	313	319	8.5	85	125	11	14	53	204	3.53	9.46	11.68	24
5	[redacted]	270	309	314	8.8	95	125	14	15	60	296	3.31	9.35	11.75	16
6	[redacted]	275	313	318	8.7	90	130	13	13	57	283	3.42	10.06	12.12	16
7	[redacted]	280	315	320	9.3	105	145	17	17	67	295	3.55	11.62	13.13	15
8	[redacted]	305	329	334	7.7	80	120	11	11	60	226	3.57	10.18	12.05	17
9	[redacted]	280	316	319	8.5	90	130	13	15	61	395	3.63	10.38	13.3	13
10	[redacted]	285	322	324	8.7	95	128	15	13	51	136	3.66	11.96	13.66	28
11	[redacted]	260	308	310	9.3	105	135	17	16	47	143	4.3	13.15	14.9	9
12	[redacted]	295	327	331	8.8	90	130	15	14	51	161	4.02	12.17	14.11	12
13															
14															
15															

Appendix E

Training photo




你未来的样样
就在你现在的努力里
LET FITNESS

BIOGRAPHY

NAME	Mr. Xiong Hui
DATE OF BIRTH	June 25,1982
PLACE OF BIRTH	Jingzhou City, Hubei Privince,China
ADDRESS	No. 407, Jiangjin West Road, Jingzhou District, Jingzhou City, Hubei Privince, China
POSITION	Associate Professor
PLACE OF WORK	School of Arts and Sciences, Yangtze University 1 Nanhuan Road Jingzhou Hubei CHINA Zip code: 434023
EDUCATION	2001-2005 Bachelor's Degree, Physical Education, Yangtze University 2012-2015 Master, Physical Education and Training, Yangtze University 2021-2024 Doctor of Philosophy, Exercise and Sports Science, Mahasarakham University