THE COMPARISON OF HIGH-INTENSITY INTERVAL TRAINING AND HIGH-INTENSITY FUNCTIONAL TRAINING AMONG YOUTH DISCUS ATHLETES

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SULTAN IDRIS EDUCATION UNIVERSITY

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ABSTRACT

High-intensity Functional Training involves functional and dynamic movement integrated with high-intensity training to enhance performance in sports. The aim of this study was to investigate the effects of High-Intensity Interval Training (HIIT) and High-Intensity Functional Training (HIFT) on the Functional Movement Screen, physical, physiological, and performance outcomes among youth discus athletes. A true experimental design with a control group (pre, mid, and post-test) was employed in this study. Thirty-three youth discus athletes (male=17, female=16) were involved in this study and assigned into experimental [HIFT (n=11, Male=6, female=5) and HIIT (n=11, male=6, female=5] groups and control groups (n=11, Male=5, female=6). All Experimental groups underwent 12 weeks of High-Intensity Interval Training and High-Intensity Functional Training, while the control group performed routine discus throwing training. All the parameters were measured at pre-, mid-, and post-tests. Mixed Factorial ANOVA revealed a significant difference in functional movement screen, seated medicine ball throw, counter movement jump, McGill endurance tests, blood lactate, maximum heart rate, rating perceived of exertion, and standing discus throw outcomes for both experimental groups compared to the control ($p<0.05$). No significant differences were found between high-intensity interval training and high-intensity functional training, except for higher functional movement screen scores in the high-intensity functional training group at post-test. Both high-intensity interval training and high-intensity functional training groups were effectively to enhancing functional movement screen, physical, physiological, and performance outcomes. These findings support the use of HIIT and HIFT to optimise performance in youth discus athletes. It can be concluded that high-intensity functional training is preferable in enhancing functional movement for youth discus athletes.

PERBANDINGAN LATIHAN INTERVAL INTENSITI TINGGI DAN LATIHAN FUNGSIAN INTENSITI TINGGI DALAM KALANGAN ATLET LEMPAR CAKERA BELIA

ABSTRAK

Latihan fungsian berintensiti tinggi melibatkan pergerakan dinamik dan fungsian yang disepadukan dengan latihan berintensiti tinggi untuk meningkatkan prestasi dalam sukan. Tujuan kajian ini adalah untuk mengkaji kesan Latihan Jeda Berintensiti Tinggi (HIIT) dan Latihan fungsian berintensiti tinggi (HIFT) terhadap hasil pada saringan pergerakan fungsian, fizikal, fisiologi, dan prestasi dalam kalangan atlet cakera remaja. Reka bentuk eksperimen sebenar dengan kumpulan kawalan (pra, pertengahan, dan pasca-ujian) telah digunakan dalam kajian ini. Seramai tiga puluh tiga atlet cakera remaja (lelaki=17, perempuan=16) telah terlibat dalam kajian ini dan dibahagikan kepada kumpulan eksperimen [HIFT (n=11, lelaki=6, perempuan=5) dan HIIT (n=11, lelaki=6, perempuan=5)] serta kumpulan kawalan (n=11, lelaki=5, perempuan=6). Semua kumpulan eksperimen menjalani latihan selama 12 minggu iaitu latihan jeda berintensiti tinggi (HIIT) dan latihan fungsian berintensiti tinggi (HIFT), manakala kumpulan kawalan melakukan latihan rutin lontaran cakera. Semua parameter diukur pada pra, pertengahan, dan pasca-ujian. Analisa faktorial campuran varian menunjukkan perbezaan yang signifikan pada saringan pergerakan fungian, lontaran duduk bola segar, lompatan gerak balas, ujian daya tahan McGill, laktat darah, kadar maksimum denyutan jantung, penilaian upaya dirasai, dan lontaran cakera berdiri bagi kedua-dua kumpulan eksperimen berbanding kumpulan kawalan ($p<0.05$). Tiada perbezaan yang signifikan ditemui diantara kumpulan latihan jeda berintensiti tinggi dan latihan fungsian berintensiti tinggi kecuali skor saringan pergerakan fungsian yang lebih tinggi untuk kumpulan latihan fungsian berintensiti tinggi pada pasca-ujian. Kedua-dua kumpulan latihan jeda berintensiti tinggi dan latihan fungsian berintensiti tinggi berkesan dalam meningkatkan hasil pada saringan pergerakan fungsian, fizikal, fisiologi, dan prestasi. Dapatan kajian ini menyokong penggunaan latihan jeda berintensiti tinggi dan latihan fungsian berintensiti tinggi untuk mengoptimumkan prestasi dalam kalangan atlet cakera remaja. Disimpulkan bahawa latihan fungsian berintensiti tinggi adalah lebih berkesan untuk meningkatkan pergerakan fungsian pada atlet cakera remaja.

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LIST OF ABBREVIATIONS

BL	Blood Lactate
CMJ	Counter Movement Jump
FMS	Function Movement Screen
HIFT	High-Intensity Functional Training
HIIT	High-Intensity Interval Training
HR_{max}	Maximal Heart Rate
LMT	Lateral Musculature Test
NT	Normal Training
RM	Repetition Maximum
RPE	Rating of Perceived Exertion
SMBT	Seat Medicine Ball Throw
SPSS	Statistical Package for Social Sciences
TET	Trunk Extensor Test
TFT	Trunk Flexor Test

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CHAPTER 1

INTRODUCTION

1.1 Introduction

In the contemporary track and field event, discus throwing is a highly attended event at the twice-yearly World Athletics Championships and has been included in the Olympic Games. The discus event has evolved significantly since its ancient origins in Greece, where it was part of the pentathlon in the Olympic Games. Today, the event involves throwing a heavy disc, the discus, as far as possible. The winner is determined by the farthest throw out of a series of attempts, typically six, with the best throw recorded. Over time, advancements in training, technique, and equipment have led to increasingly impressive sports performances (Schiffer, 2009).

China has augmented its emphasis on providing training and assistance to discus throw athletes due to the continuous advancement of domestic sports initiatives. As a consequence, China has achieved a multitude of victories in discus throw events. In the women's discus competition at the 2012 London Olympics, Li Yanfeng, for instance, finished in second place (IAAF, 2012). In addition, Chen Yulong concluded the 2014 Youth Olympic Games Asian Trials as the victor in the discus for men. This success thus led to the focus on improving the training regimen of young athletes who specialize in throwing events, increasing their level of participation, and equipping them to represent China in prestigious international competitions.

The physical, technical, mental, tactical, and physiological characteristics of an athlete often determine the level of performance in a sport. Physically, strength and speed are the foundation for discus throwing. In order to develop superior discus-throwing skills, athletes should strengthen their training in body rotation speed to apply force through rotation and transfer this action to the discus to achieve the desired throwing effect. The nature of discus training encompasses various aspects, including strength conditioning, technical drills, and mental preparation (Enoksen, 2011).

Athletes in the shot put, discus throw, and chain sports in track and field have to make full use of muscular explosive power, body coordination, and stability in order to complete the sport technique in a short distance (Young et al., 2015; Stone et al., 2003). Victory can only be achieved by throwing the discus the most significant distance, and factors such as the athlete's physiological, psychological, technical, tactical, and physical condition directly affect the outcome of the competition (Linthorne, 2001). Centripetal force and moment are the keys in the discus throwing technique, which is

acceleration by rotating the body at a fixed point, thus completing the mechanical movement and dropping the discus at the right time to complete the movement.

The technique for throwing the discus must consider factors such as shoulder-arm separation, the positioning of the torso, and the degree of elevation of the throwing arm. Additionally, rotational velocity is a critical technical parameter (Alexander, Lindner, & Whalen, 1996; Leigh & Yu, 2007). As the athlete exerts greater force on the discus, the displacement of that force is also increased, which allows for an enhancement in the velocity of the throw and aids in selecting the optimal throwing angle, ultimately maximizing distance. This technique allows the athlete to achieve a higher shoulder release point at maximum speed, leading to longer throws. The ideal throwing angle is maintained at 30-40° when throwing the discus, which depends on the acceleration force generated by the lower extremities during the throw (Bartonietz, 2000).

While trunk and upper body muscles play a role in performance, the speed of leg force generation is particularly vital. This suggests that rapid muscle contraction speed and significant muscle strength are essential for optimizing output power, which is crucial for a thrower's technique. A study by Kraemer and Looney (2012) demonstrated that athletes must develop speed and explosive power to produce considerable force in a brief period. Furthermore, mastering specific technical elements such as grip, stance, and rotational technique is also essential for discus athletes aiming to maximize the distance of their throws.

In comparing elite and youth discus throwers, elite athletes typically display more refined techniques, greater strength, and superior mental focus, developed through

years of dedicated training. On the other hand, Juniors are often in the learning phase, focusing on mastering the basics and gradually increasing their physical and technical prowess (Judge et al., 2008). Mechanics of movement in discus throwers involve a complex interplay of balance, rotational speed, and explosive strength. The thrower must maintain a low center of gravity, execute a smooth and rapid spin, and release the discus at the optimal angle and speed (Lanka et al., 2000).

The best strategy for developing youth discus throwers involves a comprehensive training program that balances physical conditioning, technical skill development, and psychological preparation. Training development should focus on progressive overload, periodization, and specificity. Effective training methods for youth discus throwers include general strength training, specific throwing drills, and plyometric exercises to build explosive power. Additionally, mental conditioning to enhance focus and resilience, alongside tactical training to understand competitive strategies, is crucial for holistic development (Judge, Bellar, & Blucker, 2011).

The effectiveness of an athlete's training is influenced by various factors, including the method, training load, and type of training (Haff & Nimphius, 2012). During competition, an athlete's physiological potential comes into play, optimizing performance and improving physical function. Therefore, it is important to pay attention to the level of physiological adaptations in training, which may affect the effectiveness of tactics and increase the risk of accidents (Haff & Nimphius, 2012). Implementing best practices in training involves regular assessment and adjustments to training loads, ensuring recovery and preventing injuries, and fostering a supportive environment for young athletes to thrive

1.2 Research Background

High-Intensity Interval Training (HIIT) is a strategy that alternates short periods of intense anaerobic exercise with less intense recovery periods. This type of training is characterized by its ability to improve aerobic and anaerobic fitness in a relatively short time. The typical HIIT session involves a warm-up period, followed by several repetitions of high-intensity exercise separated by medium-intensity exercise for recovery, and concluded with a cool-down period (Gibala et al., 2012).

HIIT has been widely adopted across sports due to its efficiency and effectiveness. It has been shown to significantly improve cardiovascular health, increase metabolic rate, and enhance athletic performance. Athletes in sports such as soccer, basketball, and track and field have benefited from HIIT by developing better endurance, speed, and overall fitness. The rapid changes in intensity during HIIT help athletes adapt to the unpredictable and varied demands of competitive sports (Laursen & Jenkins, 2002).

Research indicates that HIIT can yield substantial improvements in cardiovascular and metabolic health. For instance, a Nybo (2010) study found that after just seven weeks of HIIT, participants had significantly improved $\dot{V}O_2$ max and reduced body fat. Similarly, Buchheit and Laursen (2013) reported that enhanced muscle oxidative capacity and endurance performance were found in athletes who incorporated HIIT into their training regimens.

High-Intensity Functional Training (HIFT) is a training modality that combines high-intensity exercises with functional movements. Functional movements mimic real-life activities and engage multiple muscle groups simultaneously. HIFT emphasizes movements that improve overall strength, coordination, and balance, making it particularly beneficial for improving daily functional abilities and athletic performance (Feito et al., 2018).

HIFT is particularly advantageous for sports requiring a high degree of functional fitness, such as gymnastics, CrossFit, and obstacle course racing. This training improves athletes' strength, agility, and power, enabling them to perform complex movements efficiently and effectively. HIFT also enhances core stability and flexibility, crucial for injury prevention and optimal performance in various sports (Tibana et al., 2017).

Studies have demonstrated that HIFT can significantly improve physical and physiological outcomes. A study by Heinrich, Patel, O`Neal, and Heinrich (2014) showed that HIFT participants experienced greater muscular strength and endurance gains than those engaged in traditional exercise routines. Moreover, Buckley, Knapp, and Lackie (2015) found that HIFT was more effective than traditional training in improving body composition and metabolic health markers.

HIIT and HIFT have unique advantages and limitations when it comes to enhancing physical, physiological, and performance outcomes. HIIT improves cardiovascular endurance and metabolic rate, while HIFT enhances functional strength, coordination, and balance (Buckley et al., 2015). The HIIT has been shown to significantly improve $\dot{V}O_{2max}$ and anaerobic threshold, whereas HIFT enhances muscle hypertrophy, core stability, and overall muscular endurance. Athletes using HIIT can expect to see improvements in speed and endurance, which are crucial for sports like running and cycling. In contrast, HIFT can improve overall athleticism, making it ideal for sports requiring complex movements and high functional fitness levels (Feito et al., 2018; Laursen & Jenkins, 2002).

The primary advantage of HIIT is its efficiency, which can produce significant fitness gains in a short period (Gibala et al., 2012). However, the high intensity of HIIT may increase the risk of injury if not performed correctly. HIFT training's advantage lies in its comprehensive approach to fitness, which addresses strength, coordination, and flexibility. However, the disadvantage is that it may require more varied equipment and potentially more complex movement patterns, which can be challenging for beginners (Heinrich et al., 2014).

The decision to focus on HIFT in this study stems from its holistic approach to improving functional movement patterns, which are crucial for youth discus athletes (Heinrich et al., 2014). Discus throwing requires raw strength, power, precise

coordination, balance, and core stability. The HIFT emphasis on functional movements ensures that athletes develop these essential skills more effectively than they might through traditional HIIT alone (Murawska et al., 2015).

In conclusion, while both HIIT and HIFT offer substantial benefits, where the comprehensive approach to fitness makes it particularly suitable for enhancing the performance of youth discus athletes. By integrating high-intensity functional movements, athletes can improve strength, coordination, and overall athletic performance, ultimately leading to better competitive outcomes.

Whatever the training modality, various body components can be at risk during training. The factors contributing to these risks may include a variety of factors, such as joint range of motion, strength, movement patterns, and proprioception (Bradley & Postas, 2007; Knapik et al., 1991; Van Dillen et al., 2008). This is especially true for growing youth, where injuries during training appear particularly frequent. Physical injuries in youth athletes are often found in the ankles, lower back, elbows, and other joint and muscle areas, and once injured, are often accompanied by the risk of recurrence of old injuries (Waller et al., 2014; McMullen, 2000). The parts of each individual's body are interconnected. The basic mechanics concepts can reduce injuries during training when the body is turned on in motion mode. For example, in the discus throw, the speed of the throw is related to the connection of all body parts, and athletes can only effectively improve their throwing technique by enhancing the quality of all

body parts.

According to Boyle (2016), functional training is the achievement of movement through the accomplishment of a specific goal or the completion of an activity by an individual. Meanwhile, Liu (2014) argue that functional training is primarily the training of muscles, using coordinated, multi-planar movement patterns to improve function through the integration of multiple joints and consistent changes in dynamic tasks. This suggests that any type of training can be functional, as long as it aims to enhance a movement or activity, even in the absence of external loading. It has also been argued that the basis of functional training is closely linked to the daily function of the body and is relevant to the actual goal (La Scala Teixeira et al., 2017). In turn, everyday functions are the types of activities that people perform in their daily lives, including both simple static postures and complex activities (Silva Grigoletto et al., 2020).

The main features of Activities of Daily Living (ADL) include multiple physical abilities, and in discus throwing event, a combination of applied abilities are used simultaneously to ensure the completion of skills such as strength, balance and coordination. (La Scala Teixeira et al., 2017). To enhance joint stability, improve neuromuscular control, and increase muscle strength, functional training has been extensively utilized in sports therapy and physical rehabilitation. Recent research indicates that functional training can significantly enhance postural control, movement

quality, and rehabilitation outcomes for both athletic and clinical populations (Xiao et al., 2025; Xiong et al., 2025). The primary components of an effective rehabilitation program encompass spinal stability training, balance training, flexibility training, and resistance training, as noted by Thompson et al. (2007).

Given the important impact of rehabilitation interventions in helping athletes regain pain-free function and prevent recurrence of old injuries, functional training has been cited in training programs to help athletes excel in the sports environment. Hashidate, Shimada, and Matsuda (2011) believe functional training is a new form for athletes. It has previously been used with the elderly, stroke patients, and post-operative patients. It can be used to train in golf, tennis, soccer, martial arts, basketball, and other sports (Hashidate et al., 2011).

Studies have shown that it can be compared to traditional training methods for athletes. It can be found that functional training has a more obvious effect on improving sports scores. Based on that, Song et al. (2014) found that functional training effectively improved the flexibility and strength of high school baseball players after 16 weeks of training (Song et al., 2014). These functional training methods include various methods such as high-intensity circuit training, high-intensity interval training, high-intensity functional training, and traditional strength training. All these training methods can effectively strengthen the body and improve the performance of athletes (Yildiz et al., 2018).

Integrating functional movements into the technical training of young athletes can efficiently enhance their coordination, stability, and strength (Lloyd et al., 2015). This approach also helps to minimise muscle damage, improve the athlete`s body control, and establish a solid foundation of physical literacy (Oliver et al., 2018). This study addresses the lack of research on high-intensity functional training for youth discus throw athletes in China. It also aims to fill the gap in the literature regarding the effects of high-intensity functional training on youth discus throw athletes. Focusing on the physiological characteristics, physical fitness, and skill training of youth athletes, this study aims to identify the problems in youth discus throw sports training in China and propose high-intensity functional training and high-intensity interval training as potential solutions. This study further seeks to determine the effect of High-intensity Functional Training and High-intensity Interval Training on the performance outcomes of the Functional Movement Screen (FMS) and the physical fitness and physiological functioning of youth discus athletes.

1.3 Problem Statement

As the level of sports competition rises, scientific training, management, and selection become important factors affecting the development of the level of competition. To occupy an important position in the world sports platform, it is necessary to train athletes scientifically. By selecting athletes with potential, basic training lays an

important foundation for developing higher sports talents. In the case of countries that have won Olympic gold medals so far, they usually focus on the training of talented athletes. Based on the characteristics of discus throw, and understanding the relationship between the physical quality and psychological state of youth athletes and high-intensity skill training, the selection of youth discus training methods that meet the reality is conducive to the cultivation of a group of excellent throwing athletes who catch up with the world's advanced level. Youth athletes face challenges in achieving optimal performance during early training due to the complexity of throwing technique skills. In order to ensure optimal enhancement of physical characteristics and reaction speed, such as explosive power, flexibility, coordination, stability, and strength, athletes must possess excellent physical fitness and follow a well-designed training regimen in advance.

In review of these requirements, this study focuses on analyzing the characteristics of the discus throw and evaluating the physical and physiological effects of high-intensity skill training on youth discus throw athletes. The result of this study may help in the development of exceptional youth discus throw athletes. The present study aims to evaluate further the effect of High-Intensity Functional Training (HIFT) and High-Intensity Interval Training (HIIT) on the functional movement screen (FMS), physical abilities, physiological responses, and athletic performance of youth discus throwers, which were previously covered in developing upon prior research. This will allow the researcher to identify the differences in the effects of these training methods on the

physical and performance components of the athletes.

1.4 Objective

The research objectives of this study include general and specific objectives, as follows:

a) General objective

The general objective of this study is to compare the effects of the two training modalities (HIIT and HIFT) on the FMS, physical, physiological, and performance outcomes among youth discus athletes.

b) Specific objective

The specific objectives of this study are below;

(1) To investigate the effects of 12-week High-Intensity Interval Training (HIIT) and High-Intensity Functional Training (HIIT) on Functional Movement Screen (FMS) outcomes (Deep Squat, Hurdle Step, In-line Lunge, Shoulder Mobility, Straight Leg Raise, Trunk Stability Push Up, and Rotary Stability).

(2) To investigate the effects of 12-week High-Intensity Interval Training (HIIT) and High-Intensity Functional Training (HIIT) on physical (Speed, Strength, Power, and Stability).

(3) To investigate the effects of 12-week High-Intensity Interval Training (HIIT) and High-Intensity Functional Training (HIIT) on physiological (Heart rate, RPE, and blood lactate).

(4) To investigate the effects of 12-week High-Intensity Interval Training (HIIT) and High-Intensity Functional Training (HIIT) on performance (Discus standing throw).

1.5 Research Hypothesis

In order to achieve the purpose of this study, the following hypothesis are made.

Theoretically speaking, functional training can improve the shortcomings of youth athletes in discus throwing, especially the HIFT group and HIIT group, which can improve the FMS, physical, physiology, and performance of youth athletes in a short time, making it an effective training method to improve the final performance of youth athletes in discus throwing. Therefore, the following assumptions are established:

Null Hypothesis ($H0^1$): There are no significant differences in Functional Movement Screen (FMS) after 12 weeks using HIIT and HIFT across the experimental groups.

Alternative Hypothesis (Ha^1): There are significant differences in Functional

Movement Screen (FMS) after 12 weeks using HIIT and HIFT across the experimental groups.

Null Hypothesis ($H0^2$): There are no significant differences in 3-RM scores after 12 weeks using HIIT and HIFT across the experimental groups.

Alternative Hypothesis (Ha^2): There are significant differences in 3-RM scores after 12 weeks using HIIT and HIFT across the experimental groups.

Null Hypothesis ($H0^3$): There are no significant differences in Counter Movement Jumping (CMJ) after 12 weeks using HIIT and HIFT across the experimental groups.

Alternative Hypothesis (Ha^3): There are significant differences in Counter Movement Jumping (CMJ) after 12 weeks using HIIT and HIFT across the experimental groups.

Null Hypothesis ($H0^4$): There are no significant differences in Seated Medicinal Ball Throwing (SMBT) after 12 weeks using HIIT and HIFT across the experimental groups.

Alternative Hypothesis (Ha^4): There are significant differences in Seated Medicinal Ball Throwing (SMBT) after 12 weeks using HIIT and HIFT across the experimental groups.

Null Hypothesis ($H0^5$): There are no significant differences in McGill endurance test after 12 weeks using HIIT and HIFT across the experimental groups.

Alternative Hypothesis (Ha^5): There are significant differences in McGill endurance

test after 12 weeks using HIIT and HIFT across the experimental groups.

Null Hypothesis ($H0^6$): There are no significant differences in 20-m Speed Test after 12 weeks using HIIT and HIFT across the experimental groups.

Alternative Hypothesis (Ha^6): There are significant differences in 20-m Speed Test after 12 weeks using HIIT and HIFT across the experimental groups.

Null Hypothesis ($H0^7$): There are no significant differences in Blood Lactate (BL) after 12 weeks using HIIT and HIFT across the experimental groups.

Alternative Hypothesis (Ha^7): There are significant differences in Blood Lactate (BL) after 12 weeks using HIIT and HIFT across the experimental groups.

Null Hypothesis ($H0^8$): There are no significant differences in Heart Rate (HR_{max}) after 12 weeks using HIIT and HIFT across the experimental groups.

Alternative Hypothesis (Ha^8): There are significant differences in Heart Rate (HR_{max}) after 12 weeks using HIIT and HIFT across the experimental groups.

Null Hypothesis ($H0^9$): There are no significant differences in Rating of Perceived Exertion (RPE) after 12 weeks using HIIT and HIFT across the experimental groups.

Alternative Hypothesis (Ha^9): There are significant differences in Rating of Perceived Exertion (RPE) after 12 weeks using HIIT and HIFT across the experimental groups.

Null Hypothesis ($H0^{10}$): There are no significant differences in standing discus throwing performance after 12 weeks using HIIT and HIFT across the experimental groups.

Alternative Hypothesis (Ha^{10}): There are significant differences in standing discus throwing performance after 12 weeks using HIIT and HIFT across the experimental groups.

1.6 Significance of the study

The research conducted in this study has three implications. Firstly, it is feasible to assess the effect of High-Intensity Functional Training (HIFT) and High-Intensity Interval Training (HIIT) on the Functional Movement Screen (FMS), physical abilities, physiology, and performance of youth discus throw athletes. By understanding this effect, coaches can enhance their training techniques for youth discus throw athletes in the future.

Secondly, after 12 weeks of training regimen, the effects of training on youth discus throw athletes' physical fitness and athletic performance were analysed. The results obtained provide valid evidence for this study.

Lastly, the data and results obtained from this study may be utilised as a foundation for determining future training methods for discus throw athletes, aiming to optimise the discus throwing abilities of youth discus throw athletes and promote the development of talented athletes.

1.7 Operational Definition

The following terms were used in this research as follows below:

1.7.1 Functional Movement Screen (FMS)

The FMS is an assessment system that measures the performance of motor-related skills, including strength, coordination, balance, motor speed, and physical endurance (Cook, 2011). This assessment can also measure an individual's potential risk for ongoing musculoskeletal disorders. This study used FMS to evaluate the baseline movement quality of youth discus throwers before and after the training intervention.

1.7.2 Physical

a) Strength

Strength refers to the ability of muscles or muscle groups to overcome external resistance through contraction, such as gravity, load or their weight (Santos, 2025). It is the core component of physical fitness, which directly affects sports performance, especially in sports that require explosive force, speed or resistance (such as weightlifting, sprinting, throwing events). This study uses the 3-RM test to determine the strength at pre, mid and post-test.

b) Power

Power combines strength and speed, emphasising the ability to release maximum strength in the shortest time (Smith, 2025). It is the core factor that determines performance in many sports (such as jumping, throwing and sprinting), and depends on neuromuscular coordination and power chain integration. Strength is the ability of muscles to overcome resistance, while explosive force is the combination of strength and speed, emphasising the ability to release strength quickly. This study uses the CMJ to evaluate lower body power, while the SMBT test evaluates upper body power.

c) Stability

Stability refers to the ability of the body to maintain balance and control posture in static or dynamic states (Fathi, 2024). It relies on the synergy of muscles, joints and the nervous system to ensure that the body can resist external interference and maintain an efficient action mode during exercise. Stability is divided into static stability (such as standing balance) and dynamic stability (such as posture control in running, jumping or

throwing). This study uses the McGill Endurance Test to evaluate the stability of youth discus athletes before and after training intervention.

d) Speed

Speed refers to the ability of the body or a part of the body to complete an action or move a distance in a unit of time. It is one of the key elements of sports performance, usually divided into action speed, which refers to the completion speed of a single action (Childs, 2024). For example, in discus throwing, the action speed directly affects the swing speed of the discus at the moment of its release. The other is acceleration, the speed increase rate from zero to the maximum, such as 100 m/s running. This study uses the 20-m Speed Test to evaluate the running speed of youth discus athletes before and after the training intervention.

1.7.3 Physiological

a) Blood Lactate

Blood lactate concentration is often present in performance tests for athletes and clinical exercise tests. The Accutrend Plus system (Roche, São Paulo, Brazil) validates a way to measure blood lactate using reflectance photometry. The blood sample is extracted using a disposable subcutaneous lancet at the medial position of the middle finger tip after a skin puncture to collect the blood sample from the capillaries. Measurements are taken once before and once after each exercise session (Michaelides, 2025). This study uses the Blood Lactate to assess training intensity and recovery efficiency.

b) Maximum Heart Rate

The maximum heart rate (HR_{max}) refers to the highest number of heartbeats per minute that an individual can achieve during maximum physical exertion. It is a benchmark for setting training intensity and monitoring cardiovascular effort (Kasiak, 2023). This study uses the HR_{max} to assess the effort level during training and determine whether the participants were training within the expected intensity range.

c) Rating of Perceived Exertion (RPE)

Rating of Perceived Exertion, abbreviated as RPE, is mainly used to measure the intensity of physical activity subjectively. Perceived fatigue allows one to feel how hard their body works during physical activity (Kobi, 2025). It is generated based on the increased heart rate, muscle fatigue, shortness of breath, and increased sweating experienced by the athlete during sports activity. Although this measurement is somewhat subjective, this perceived fatigue measurement scale is rated on the Borg Scale. This study uses the Rating of Perceived Exertion (RPE) measuring degree of force during the training period.

1.7.4 Performance

Standing Discus Throw Performance refers to the ability of athletes to finish discus throwing only by standing in situ without running up or rotating. It is an important index for evaluating athletes' fundamental strength, explosive power, technical movements, and power chain efficiency. It is often used in beginners' training or technical decomposition exercises (Henjilito, 2025). Without considering rotational momentum,

this study uses Standing Discus Throw to evaluate the impact of training on strength, technique and power chain efficiency.

1.7.5 Training method

a) Functional Training

Functional training is a targeted training based on the desired goal. This form of training evolved from rehabilitation training and includes the completion of specific work tasks, training of specific motor skills and planning of activities of daily living. Many occupational therapists and chiropractors utilised this approach to treat patients with movement disorders (Gamble, 2006). This study uses Functional Training as the basis of the training methodology.

b) High-Intensity Functional Training (HIFT)

The high-intensity functional training, abbreviated as HIFT, allows for the desired fitness level by emphasising the coordination of functional movements of multiple joints when performing exercises again using this training modality. This type of training significantly affects muscle recovery compared to traditional workouts (Yuri et al., 2018). This study uses HIFT as a key intervention to enhance physical and physiological performance.

c) High-Intensity Interval Training (HIIT)

High-intensity interval training is defined as a low-intensity recovery exercise program in which the time is relatively short and rest periods are spread out. However, strenuous

activity is performed (Hannan et al., 2018). This study uses HIIT to compare the difference in its effect with HIFT.

d) HIFT VS HIIT

HIFT emphasises multi-joint, functional movements under high intensity, aiming to improve movement quality and overall athletic capacity (Wang et al., 2023). While high in intensity, HIIT primarily targets cardiovascular and metabolic efficiency through repetitive interval-based workloads (Meng et al., 2022). This study compares the effects of both methods on youth discus throwers to determine which yields greater benefits in strength, power, and physiological adaptation.

1.8 Limitations of the Study

There are several limitations that need to be highlighted when conducting the study; One limitation is the time constraint for training. Given that this study focuses on youth students who are not full-time athletes, ensuring that their regular schooling is not compromised while training is important. Therefore, the training sessions were scheduled from 4:00 to 7:00 pm. Second, it is important to consider the sample size of this study. The subjects recruited for this study are students attending a sports school in the city centre. Although there were only a limited number of athletes with years of experience, they still fulfilled the minimum effective sample size requirements, as a third point, diet and residence. Due to the fact that youth students were recruited for this study, it was not possible to adhere to a standardised diet, and it was also not

possible for them to stay and live together. Both of these factors had an impact on this study.

1.9 Chapter Summary

The discus throwing technique is a complex skill that requires excellent physical condition and a well-designed training regimen to enhance physical qualities and reaction time, including explosive power, flexibility, coordination, stability, and strength. However, during training, every body component might encounter possible risks, which can arise from many elements such as the range of motion in the joints, strength, movement, and proprioception. Training often leads to a high injury risk, especially among youth athletes.

This study investigates the effect of functional training on the physical fitness and physiological function of youth discus throw athletes in China. Given the limited research on this topic and a lack of literature on the effects of high-intensity functional training on youth discus throw athletes, this study will focus on examining the effects of functional training based on the athletes' physiological characteristics, physical fitness, and skill training.