

The Application Value of Functional Training in Volleyball: Rational Reflection Based on Literature Review

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Abstract

This study employed the methods of literature review, logical analysis, and comparative analysis. By searching for various relevant literature on functional training and volleyball in recent years, a systematic analysis was conducted on the application value of functional training in enhancing the competitive ability of volleyball. The research shows that functional training can effectively improve the athlete's jumping ability, movement speed, and movement control ability by enhancing core stability, dynamic balance ability, and multi-joint coordination. As a result, it optimizes key technical performances such as spiking, blocking, and defending. At the same time, its emphasis on the training of action pattern integration and neuromuscular control can significantly reduce the injury risks of joints such as the shoulder, knee, and ankle. Moreover, integrating functional training into the volleyball project can further promote the specialized transfer of athletic performance. Based on the above conclusions, the study suggests that by systematically integrating functional training into the athlete's training, both the competitive level and the sports lifespan can be significantly improved, thereby fully leveraging the unique value of functional training.

Keywords

Functional training; volleyball; competitive sports; application val.

1. Introduction

The rapid advancement of competitive sports has raised stricter standards for the physical fitness, technical skills and on-court performance of volleyball athletes. Traditional physical training generally concentrates on isolated muscle group development, while neglecting the coordination of human kinetic chains and the optimization of sport-specific movements, which leads to a separation between training content and competition requirements. Centered on improving athletic performance, optimizing movement patterns and preventing sports injuries, functional training highlights multi-joint collaboration, core stability and neuromuscular control. Its training characteristics are highly consistent with high-intensity technical movements in volleyball, including jumping, direction changing and spiking. Therefore, exploring the application value of functional training in volleyball training is of great significance for enhancing athletes' competitive capacity and lowering injury risks. On the basis of elaborating the connotation of functional training, this paper analyzes the relationships between functional training and other training methods, and discusses the application of functional training in volleyball from four aspects: warm-up activities, core stability and anti-rotation training, plyometric training and PNF stretching. This research aims to provide references for the scientific development of volleyball training and related academic studies.

2. Research Objects and Methods

2.1. Research Objects

This study takes domestic and foreign literature concerning the application of functional training to improve volleyball competitive ability as the research object.

2.2. Research Methods

2.2.1. Literature Review

Relevant literature, monographs and experimental reports over the past 20 years were retrieved from databases including CNKI, Web of Science, VIP and Google Academic, with the key words of functional training, CrossFit, traditional physical training, volleyball and competitive ability. The theoretical basis, concepts and movement patterns of functional training, as well as its application value in volleyball (such as improving athletes' jumping ability, service reception, spiking, mobility and sports injury prevention) were summarized and analyzed to provide theoretical support for this research.

2.2.2. Logical Analysis

Based on the collected literature, logical methods including induction, deduction, analysis and synthesis were adopted to carry out the research. Firstly, the advantages of functional training were summarized by comparing it with traditional physical training and CrossFit in terms of movement pattern integration, kinetic chain force transmission, neuromuscular control and sport-specific adaptability. Secondly, the physical characteristics, metabolic systems, physical fitness indicators and common sports injuries of volleyball players were concluded. Combined with volleyball techniques and tactics such as spiking, blocking, defending and moving, the application links and key points of functional training in volleyball were discussed to verify the compatibility between functional training and volleyball. Thirdly, the integration of training methods and volleyball special events was interpreted from the perspectives of sports biomechanics (kinetic chain transmission), sports physiology (muscle movement) and sports injury prevention (joint stability).

2.2.3. Comparative Analysis

A comparative analysis was conducted among functional training, CrossFit and traditional physical training. The unique advantages of functional training in efficiently improving the competitive performance of volleyball players were summarized to illustrate its distinctive application value.

3. Connotation of Functional Training

3.1. Concept of Functional Training

The prototype of functional training originated from the field of rehabilitation medicine in the early 20th century. German physical therapist Herman Kabat firstly applied functional movement patterns to clinical rehabilitation to help patients recover basic motor abilities, and proposed Proprioceptive Neuromuscular Facilitation (PNF) stretching, which laid a theoretical foundation for functional training. Afterwards, functional training was systematically popularized, and numerous scientists and physical conditioning experts defined its concept, supplemented theoretical foundations and applied it to professional sports.

From the anatomical perspective, the functionality of training refers to the body's capacity to perform specific tasks. To realize these specific functions, the human body must complete natural and functional movements. Boyle M pointed out that functionality equals objectives, and sports functional training refers to targeted training modes designed for specific goals. Lowery L held that the core purpose of functional training is to improve people's physical well-

being, and the training arrangements should be adjusted according to different practical goals, which shares similar viewpoints with Boyle M.

Chinese scholars Li Danyang and Hu Xin proposed that functional training is a training method to comprehensively improve the working function of the motor system and further enhance competitive level through all-round and full-chain training. Yan Qi, Ren Manying and Shi Yutao stated that the ultimate goal of functional physical training is explosive power training and explosive endurance training, and most movements require athletes to perform at high speed. Dong Delong divided functional training into functional strength, functional speed and functional endurance, and emphasized that functional training must be closely combined with sport-specific events to achieve optimal effects. Sports training experts Vern Gambetta and Gary Gray indicated that single-joint movements targeting individual muscles are barely functional, which proves that functional training is dominated by multi-joint movement patterns.

Combined with the viewpoints of various scholars, this paper defines functional training as a training method aiming to improve the body's practical performance in daily life, sports or specific tasks. It focuses not only on muscle development and body shaping, but also on cultivating the coordination, stability and flexibility of various body parts by simulating daily activities. In competitive sports, functional training refers to targeted movement training, which can improve athletic performance, consolidate the foundation of long-term training and extend athletes' peak competitive period.

3.2. Basic Principles and Movement Patterns of Functional Training

Human movements can be classified into four core pillars: locomotion, level change, push & pull, and rotation. These four pillars constitute basic daily human movements and are closely related to major motor skills. As shown in.

(1) Locomotion: As the primary pillar of human movement, locomotion is characterized by single-leg stability and rotational capacity. This basic motor skill integrates all four functional pillars. During the gait cycle, the center of gravity produces horizontal and vertical displacement synchronously, which corresponds to the pillar of level change. When locomotion is combined with upper limb push and pull movements, it can counteract the rotational torque generated by lower limbs. The rotational kinetic energy formed by cross movements of upper and lower limbs is the key to efficient linear movement.

(2) Level change: It is the second major pillar of human movement, manifested as vertical displacement achieved by trunk flexion and extension, lower limb movement or the coordination of both. In most functional scenarios, level change relies on the coordinated flexion linkage between trunk and lower limbs. In volleyball, lowering the center of gravity and bending knees to dive for a low ball at the net is a typical level change movement.

(3) Push & pull: Dominated by upper limbs, push and pull movements adjust dynamic balance by shifting the overall center of gravity. Due to the contralateral innervation of the nervous system, the contralateral limb will extend naturally when one limb performs flexion reflex. This coordination pattern is widely seen in swimming, throwing and running. Volleyball spiking is a typical push-pull movement.

(4) Rotation: Rotation occupies a core position in motor pillars, because most explosive movements rely on the coordination of three anatomical planes (sagittal plane, frontal plane and horizontal plane). Rotation is essential to maintain stable center of gravity and ensure efficient and coordinated movements.

Table 1 Motor Skills, Basic Movements and Sport-specific Examples of Four Functional Pillars

Motor Skills	Basic Movements	Sport-specific Examples
Locomotion	Any movement that transports the body from point A to point B	Walking, jogging, sprinting, shuffling and jumping
Level Change	Bending and stretching legs to raise or lower the body’s center of gravity, including lifting objects from the ground	Lowering gravity and diving to save a drop shot at the net in volleyball
Push & Pull	One limb performs movements while the contralateral limb moves in the opposite direction	Throwing in baseball, serving in tennis, spiking in volleyball and javelin throwing
Rotation	Movements involving hip or shoulder rotation	Rotating hips by 180 degrees to dodge opponents in rugby

Gray Cook, a famous American physical therapist, designed the Functional Movement Screen (FMS), an effective assessment system for functional movement patterns. It can evaluate human basic range of motion, balance, body control and stability, and screen restricted movements .As shown in Figure 1.

If athletes get low scores in FMS, training should prioritize basic functional movements. When athletes’ flexibility and stability are improved with higher FMS scores, the proportion of functional competitive training should be increased, while appropriate functional pattern training is retained to maintain physical flexibility and stability.

The test items of Functional Movement Screen are listed as follows: Deep Squat, Hurdle Step, In-line Lunge, Shoulder Mobility, Active Straight-Leg Raise, Trunk Stability Push-up, and Rotary Stability.

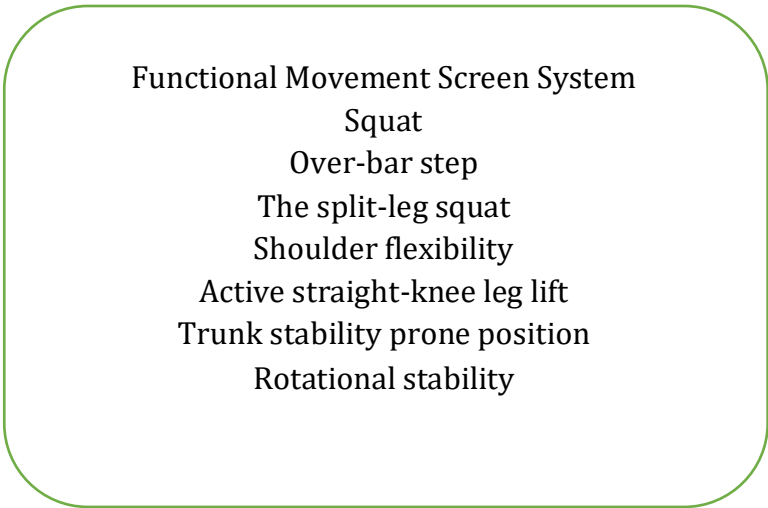


Figure 1 Gray Cook Functional Movement Screen System

Functional training is goal-oriented, so diversified training methods and movements can be adopted for different training objectives. Its core purpose is to help athletes adapt to sport-specific demands rather than cross-training with other sports. It emphasizes the optimization of movement patterns instead of training isolated muscles. The priority of functional training is to improve athletic performance through integrated movements, rather than simply enhancing the strength of a single movement.

3.3. Relationships between Functional Training and Other Training Methods

3.3.1. Functional Training vs. CrossFit

CrossFit is a high-intensity and comprehensive fitness system integrating weightlifting, gymnastics, aerobic exercise and other sports elements. Founded by Greg Glassman in 2000, it aims to achieve all-round physical fitness and improve strength, endurance, speed and flexibility. CrossFit mainly adopts full-body compound movements involving multiple joints and muscle groups, and has become a popular fitness mode worldwide. Functional training and CrossFit share similarities as well as obvious differences in concepts, methods and applications.

Similarities

- Both adopt compound multi-joint movements such as squat and deadlift.
- Both focus on practicality and aim to improve physical functional capacity.
- Both include high-intensity training modes such as interval training and circuit training.
- Both use overlapping training equipment, including kettlebells, battle ropes and barbells.

Differences

The main difference between the two can be seen from the following five aspects(As shown in Table 2)

Table 2 The main difference between functional training and CrossFit		
Comparison Dimensions	Functional Training	CrossFit
Training Objectives	Optimize movement patterns; improve movement efficiency or physical rehabilitation	Develop all-round physical fitness (strength, endurance, speed, etc.)
Movement Design	Prioritize stability and control (e.g. single-leg training, anti-rotation training)	Prioritize explosive power and high repetitions (e.g. snatch, burpee)
Load Intensity	Adjustable intensity, suitable for trainees at all levels including rehabilitation patients	Extreme intensity, suitable for advanced trainees with good physical fitness
Training Plan	Personalized design for specific functional demands and sports events	Standardized training with daily varied contents
Applicable Population	Rehabilitation patients, athletes and general fitness enthusiasts	Fitness lovers pursuing high-intensity challenges

In short, functional training takes movement quality as the core, while CrossFit focuses on all-round physical fitness and competitive performance. The two are complementary: functional training lays a solid foundation for CrossFit. Many complex movements in CrossFit require standard movement patterns, and functional training can correct movement postures and reduce injury risks. On the other hand, CrossFit is a high-intensity extension of functional training. Based on standard movement skills, CrossFit adds high load and high intensity to further improve overall physical fitness. Reasonable combination of the two can realize injury-free training and all-round physical improvement.

3.3.2. Functional Training vs. Traditional Physical Training

Derived from military training and competitive sports systems, traditional physical training is based on classic anatomy and sports physiology. It focuses on quantitatively improving single physical qualities through isolated and standardized movements, such as squat for lower limb strength and long-distance running for endurance. Traditional physical training is carried out under relatively stable conditions, taking load weight and repetitions as core evaluation

indicators, while ignoring flexibility and balance. Different from traditional modes, functional training aims to improve movement efficiency in daily life and sports. It adopts holistic multi-joint and multi-planar training, and attaches importance to core stability, neuromuscular coordination and movement practicality.

Similarities

Both are committed to improving physical capacity with different priorities.
Partial basic movements overlap, such as squat, deadlift and lunge.
Both follow basic sports principles including overload principle and progressive principle.

Differences

The main difference between the two can be observed from the following six aspects(As shown inTable 3)

Table 3 The differences between functional training and traditional physical training		
Comparison Dimensions	Traditional Physical Training	Functional Training
Training Objectives	Improve single physical indicators such as maximal strength and endurance	Improve movement efficiency and practical performance
Movement Design	Isolated and standardized movements (e.g. bench press, machine training)	Compound and multi-planar movements (e.g. medicine ball throwing, TRX training)
Load Control	Take weight, sets and repetitions as core variables	Take movement patterns, stability and coordination as core variables
Neuromuscular Participation	Focus on force generation of single muscle groups	Emphasize core stability and coordination of multiple muscle groups
Joint Participation	Isolated single-joint training	Compound multi-joint training relying on kinetic chains to generate power
Applicable Population	Athletes, soldiers and fitness enthusiasts	Rehabilitation patients, athletes and general fitness enthusiasts

Traditional physical training is equivalent to "building walls by blocks", which improves individual physical qualities separately, while functional training is like "overall construction", which focuses on the whole kinetic chain and movement integration to improve athletic performance and prevent injuries. Traditional physical training is the foundation of functional training, and functional training is the extension and innovation of traditional training. In practical training, athletes should first accumulate basic physical fitness through traditional training, and then transform physical qualities into sport-specific capacity via functional training. Functional training can realize the transformation from general physical quality to on-court performance, and it is more innovative, diversified and effective than traditional training.

3.4. Advantages of Functional Training

Holistic Training Concept: Functional training advocates balanced strength of the whole body. Different from traditional training which targets individual muscles, it trains the whole kinetic chain to enhance neuromuscular coordination and overall body sense.
Enhanced Neuromuscular Control: Functional training improves the nervous system’s precise regulation on muscle contraction, including motor unit recruitment, inter-muscle coordination and proprioception. It integrates the power of trunk and limbs, and amplifies kinetic energy through kinetic chains to generate greater strength and faster speed.

Multi-planar Training: Human movements involve three anatomical planes. Breaking the limitation of single-dimensional training, functional training designs multi-joint, multi-direction and large-range training schemes based on biomechanics and sport characteristics. It promotes the coordinated development of various physical qualities and reduces injury risks.

Integration of Physical Qualities and Motor Functions: Functional training formulates targeted training plans according to sport characteristics and athletes' physical conditions, which helps convert trained physical qualities into sport-specific abilities and stabilize technical movements.

4. Event Characteristics of Volleyball

4.1. Technical Characteristics

Volleyball techniques refer to reasonable hitting movements and cooperative actions permitted by competition rules. Volleyball technical systems are divided into ball-handling techniques and non-ball-handling techniques. Ball-handling techniques include digging, setting, spiking, blocking and serving; non-ball-handling techniques mainly include footwork and ready position. With the rapid development of world volleyball, teams have continuously updated their technical and tactical systems. Modern volleyball techniques present the following characteristics: coordinated development of techniques and tactics, diversified and practical offensive and defensive skills, high proficiency, concealment and velocity of setting, higher height, comprehensiveness, speed and variability of spiking, higher height and longer airborne time of blocking, as well as higher hitting point, velocity, accuracy, power and aggressiveness of serving.

4.2. Special Physical Fitness Characteristics

4.2.1. Somatic Characteristics

Height is a decisive somatic indicator for volleyball players due to the net height (2.43 m for men and 2.24 m for women). Hitters, middle blockers and opposites are generally taller to expand offensive and defensive range and enhance the threat of blocking, serving and spiking. Frequent jumping movements require well-developed lower limb muscles and outstanding jumping ability. Spiking and serving demand strong shoulder, arm and core strength, so volleyball players usually have balanced upper and lower limb strength and well-developed core muscles. The maximum velocity of professional serving can reach 138 km/h, which requires athletes to have rapid reaction and precise body control. Excellent volleyball athletes are generally tall, strong, explosive, with slender and elastic muscles, coordinated limbs, long arm span and low body fat rate.

4.2.2. Physiological Characteristics

Volleyball is a high-intensity intermittent sport characterized by fast pace, fierce confrontation and repeated competitions. Three energy supply systems work collaboratively during matches: **ATP-CP System:** It provides energy for short-duration and high-intensity explosive movements such as rapid jumping, spiking and blocking. It features fast energy supply with a duration of only several seconds.

Anaerobic Glycolysis System: It dominates in repeated rapid movements and continuous jumping. Lactic acid will be produced during metabolism, leading to muscle fatigue and soreness.

Aerobic Oxidation System: It mainly functions during time-outs and substitutions with low exercise intensity. It lasts for a long time without lactic acid accumulation, and helps athletes recover physical strength.

The three energy supply systems coordinate with each other throughout volleyball competitions.

4.2.3. Special Sport Physical Fitness Characteristics

Strength: Strength in volleyball is mainly reflected in explosive power, strength endurance and coordinated full-body force generation. Explosive power of lower limbs is required for jumping, while upper limb and core explosive power are essential for spiking and serving. Strength endurance guarantees continuous jumping and long-time low-center-of-gravity defending. All technical movements rely on coordinated force transmission from lower limbs to trunk and upper limbs via kinetic chains.

Speed: Speed consists of reaction speed, movement speed and locomotor speed. Athletes need rapid reaction to judge the trajectory of incoming balls. Fast movement speed is required for arm swinging in spiking and ground recovery after diving. Short-distance acceleration and lateral movement speed are critical for blocking and tactical running.

Endurance: Anaerobic endurance plays a leading role in repeated high-intensity movements such as continuous spiking and blocking. Aerobic capacity serves as the foundation to support athletes to maintain competitive state in long-duration matches (best-of-five sets).

Coordination and Agility: Volleyball requires excellent limb coordination for the combination of run-up, toss and swing in serving and spiking. Athletes also need strong spatial perception to adjust spiking routes according to opponents' blocking.

5. Application of Functional Training in Volleyball

5.1. Warm-up Activities

Warm-up refers to planned physical exercises before training or competitions, with the functions of raising body temperature, reducing muscle viscosity, activating the nervous system, improving oxygen transport and preventing sports injuries. The suitable duration of warm-up is 10–30 minutes with the intensity of 45% VO_2max and heart rate of 100–120 bpm.

Integrating functional movements into warm-up is highly recommended. Combined with functional training theories and the training videos of Japanese top hitter Ao Takahashi, the functional warm-up for volleyball is divided into four parts: hip and leg activation (scissor circling, lateral lunge, prone leg extension, lateral jump), spinal activation (plank, opposite elbow to knee, lateral trunk raise, the world's greatest stretch), upper limb and trunk activation (prone resistance band Y-hold, prone resistance band pull-down), and finger activation (finger push-up, wall passing).

5.2. Trunk Pillar Strength Training and Anti-Rotation Training

The trunk pillar, composed of lumbopelvic-hip complex and related muscle groups, is the central hub of human kinetic chains. It undertakes the key functions of stabilizing the spine, adjusting pelvic position, maintaining body posture and controlling balance. Volleyball athletes are frequently in moving or airborne states during competitions, and the completion of technical movements largely depends on trunk strength and stability. Excellent core stability and anti-rotation ability are required to standardize airborne movements and avoid body imbalance after landing, which can effectively prevent knee and ankle injuries.

In volleyball training, medicine ball diagonal chopping, medicine ball lunge rotation, ab wheel rollout and T-bar rotation are typical functional movements for trunk and anti-rotation training. These exercises can strengthen rectus abdominis, transverse abdominis, external oblique muscle, gluteus medius and gluteus maximus, and guarantee movement stability during competition.

5.3. Plyometric Training

Plyometric training is also known as stretch-shortening cycle (SSC) training. Based on the stretch reflex and elastic potential energy storage and release of muscles, it improves explosive power and endurance. The whole movement includes three phases: eccentric muscle stretching, eccentric-concentric transition and concentric contraction. The core of plyometric training is to shorten ground contact time, which can enhance explosive power, buffer capacity and muscle stiffness.

Given the characteristics of modern volleyball (high height, all-round skills, fast pace and variable tactics), plyometric training is classified into three categories for volleyball:

Upper limb and trunk exercises: Medicine ball overhead throw (simulating serving), medicine ball rotational throw (simulating spiking), explosive push-up and supine medicine ball toss, which improve upper limb swing speed and core force transmission.

Full-body coordination exercises: Catch jump, zigzag jump and hexagon jump, which enhance coordination and multi-directional movement reaction.

Lower limb exercises: Depth jump, continuous box jump and lateral jump, which improve jumping ability, continuous jumping capacity and lateral stability in defending.

5.4. PNF Stretching

Proprioceptive Neuromuscular Facilitation (PNF) stretching was originally applied to clinical rehabilitation, and later widely introduced into sports training. It combines muscle contraction and relaxation to stimulate proprioceptors, recruit more muscle fibers, improve flexibility and muscle strength, and accelerate muscle recovery after exercise.

The standard steps of PNF stretching are as follows: first, perform isometric contraction of target muscles; then fully relax the muscles; finally conduct static stretching under relaxed state. Volleyball puts forward high requirements on physical flexibility. PNF stretching can effectively improve athletes' flexibility, relieve muscle fatigue, prevent sports injuries, and prolong athletes' competitive career.

6. Conclusion

As a popular modern training method, functional training focuses on optimizing movement patterns and improving athletic performance, and has important application value in volleyball. Relevant research proves that functional training can effectively improve volleyball players' coordination, explosive power and flexibility, and reduce sports injury risks. Different from traditional training, it emphasizes multi-joint collaboration and core stability, which is highly compatible with volleyball's event characteristics. Integrating functional training into traditional volleyball training system can make physical training more systematic and comprehensive, and continuously improve athletes' competitive level.

Future research can further explore personalized functional training schemes combined with sports biomechanics and intelligent monitoring technology to realize scientific training. In addition, the rational application of functional training in youth volleyball training is also worthy of in-depth study. In general, functional training provides new ideas for the scientific development of volleyball training, and it has broad application prospects and promotion value.

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