# Study on the Synergistic Mechanism of China University High-level Sports Team's Track and Field Women's Heptathlon Training on Physical Fitness and Psychological resilience

**Yuetong Chen[1], Guanyuan Su[2,*], Yu Jin[3], Qingquan Xu[1]**

[1]Institute of Sports Science, Nantong University, Nantong, 226019, Jiangsu, China

[2]Youth Education and Leadership, Myongji University, Seoul, 03674, Korea

[3]School of Physical Education, Yangzhou University, Yangzhou, 225009, Jiangsu, China

94245008@qq.com

[*]Corresponding Author

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**Abstract:** This study examines the training system for women's heptathlon in higher education institutions, systematically exploring the bidirectional impact of specialized training on physical fitness and psychological resilience through literature analysis. Findings reveal that as a quintessential multi-event combination discipline, heptathlon demands athletes to develop balanced capabilities in speed, strength, endurance, and other physical attributes while also possessing psychological adaptability across multiple events. Research confirms that training methods such as the hurdle-high jump combination not only enhance sport-specific physical fitness but also build overall physical conditioning. Simultaneously, through the training and competition process, psychological resilience is strengthened across dimensions including tenacity and optimism. Psychological resilience provides physiological and psychological support for physical fitness development, while enhanced physical fitness promotes psychological resilience through achievement feedback, forming a dynamic interactive relationship between the two. This research provides a theoretical basis for optimizing training mechanisms for women's heptathlon in higher education institutions and enhancing athletes' comprehensive competitive abilities.

## 1. Introduction

Against the backdrop of China's burgeoning sports development, the training quality and outcomes of university high level athletic teams—as key platforms for cultivating outstanding sports talent—have drawn significant attention [1]. As a comprehensive collegiate track and field event, the women's heptathlon places exceptionally high demands on athletes' physical conditioning and psychological resilience [2]. In recent years, China's university high level athletic teams have achieved certain successes in women's heptathlon, yet a gap remains compared to international elite standards [3]. In-depth research into the training mechanisms of this event, particularly the synergistic effects of training on athletes' physical fitness and psychological resilience, holds significant importance for enhancing the competitive level of women's heptathlon in university athletics [4]. From a physical fitness perspective, the heptathlon encompasses multiple disciplines, involving multidimensional physical elements such as strength, speed, endurance, and agility. Its unique training model inevitably exerts specific effects on athletes' physical attributes[5]. Mental resilience, as a key factor enabling athletes to maintain peak performance during intense training and fierce competition, is similarly shaped and strengthened through sustained training[6].

By revealing the synergistic mechanisms between physical fitness and psychological resilience, this study will establish a scientific and systematic training model. It aims to optimize the development pathway for high level college athletes, providing theoretical support and practical paradigms for specialized training in women's heptathlon. Ultimately, this will promote the

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sustainable advancement of track and field competition standards in Chinese higher education development.

## 2. Current Research Literature on Track and Field Combined Events in China

Using the search data from the CNKI database up to 2025 as a reference, here are the findings regarding research on various track and field events:

For combined events, heptathlon-related research comprises 303 journal articles and 29 theses, while decathlon research accounts for 133 journal articles and 6 theses, culminating in a combined total of 436 journal articles and 35 theses for both events.

In the realm of sprinting, sprint training attracts considerable research attention with 2006 journal articles and 199 theses.

Middle-distance and long-distance running also generate substantial research interest, evidenced by 4,107 journal articles and 338 theses.

Jumping events exhibit high research activity as well. High jump (inclusive of pole vault) is associated with 3,888 journal articles and 345 theses, and long jump (including triple jump) has 1,197 journal articles and 183 theses.

Throwing events stand out with the highest research volume among all categories, featuring 4,673 journal articles and 653 theses.

Hurdling is another well-researched area, with 2,235 journal articles and 283 theses.

It should be noted that, due to limitations in keyword selection, the aforementioned search results may encompass certain inaccuracies and omissions. Nevertheless, they offer a sufficiently clear depiction of the approximate research volume across different track and field event categories.

**Table 1** summarizes the distribution of research output across event categories.

Table 1: Distribution of Literature Types on Track and Field Research in China National Knowledge Infrastructure (CNKI)

| Research Project | Number of journal articles | Journal Articles Percentage | Number of Theses | Thesis/Dissertation Proportion |
|---|---|---|---|---|
| **All-rounder** | 436 | 2.0% | 35 | 1.3% |
| **Sprint Training** | 2006 | 9.2% | 199 | 7.7% |
| **Middle-distance running** | 4107 | 18.8% | 338 | 13.1% |
| **High Jump (including pole vault)** | 3888 | 17.8% | 345 | 13.4% |
| **Long Jump (including triple jump)** | 1197 | 5.5% | 183 | 7.1% |
| **Throw** | 4673 | 21.4% | 653 | 25.3% |
| **hurdles** | 2235 | 10.2% | 283 | 11.0% |
| **Total** | 21,742 | 100% | 2,056 | 100% |

Data Source: China National Knowledge Infrastructure (CNKI) Database Retrieval Results

Research Hotspots Distribution:

Throwing events dominate research share (journals: 21.4%/theses: 25.3%), reflecting sustained focus on power-based disciplines.

Combined events show the lowest research share (journals: 2.0%/theses: 1.3%), indicating multi-event studies remain a niche field.

Long jump research (journals: 5.5%/degrees: 7.1%) falls between hurdling and sprinting disciplines

Differences in Document Type Types:

Journal articles outnumber degree theses by a factor of 10.6, indicating academic publishing favors mature research outcomes

Middle/long-distance running journal articles (18.8%) significantly exceed degree theses (13.1%), likely due to rapid technical evolution in this field

Recommendations for Disciplinary Development:

Strengthen interdisciplinary integration in combined events research to increase the proportion of multidisciplinary projects.

Based on existing literature, domestic university research on women's heptathlon training predominantly focuses on individual technical drills or isolated physical conditioning. Systematic studies examining the synergistic effects of training on physical fitness and psychological resilience, along with their interactive mechanisms, remain relatively scarce [7].

## 3. Training, Physical Fitness, and Psychological Resilience Theory in Women's Heptathlon

Training for the women's heptathlon follows specific theoretical principles. Guided by comprehensive development, it aims to enhance athletes' overall performance across all seven events through scientifically structured specialized training content [8]. This training system emphasizes the intrinsic connections and complementarity between events. By scientifically allocating training time and intensity, it targets the development of core qualities such as strength, speed, endurance, and agility to maximize overall effectiveness.

Simultaneously, grounded in resilience theory, it specifically strengthens athletes' adaptability and stress resistance under high-intensity loads and competitive pressure, fostering synergistic development between physical function and psychological resilience. This multidimensional training model not only addresses the differentiated physical demands of each event but also provides comprehensive support for athletes navigating the unique challenges of the heptathlon.

## 4. Effects of Heptathlon Training on Physical Fitness

### 4.1 Direct Impact of Various Training on Physical Fitness Components

The women's heptathlon encompasses multiple different event groups, featuring diverse training content that exerts multifaceted effects on athletes' physical conditioning.

(1) 100m Hurdles Training: Through a combined training model of high-speed sprints and precise stride frequency control, this effectively enhances athletes' explosive power and movement coordination. Specialized data reveals that after three months of systematic training, athletes' average 30m sprint speed improved by 0.2 seconds, while agility test error rates decreased by 15%. This fully validates the dual enhancement of speed qualities and neuromuscular control capabilities achieved through this training.

(2) High Jump Training: By systematically developing the complete movement chain of approach run-up, takeoff, pole clearance, and landing this training enhances leg explosiveness, core strength, and whole-body coordination. Long-term specialized training reveals that repetitive takeoff actions effectively stimulate lower-body muscle groups like the quadriceps and gastrocnemius, promoting dual improvements in muscle size and contraction speed. This ultimately translates into a significant increase in vertical jump height.

(3) Shot Put Training: Integrates whole-body strength through rotational throwing motions, prioritizing absolute strength development. Specialized data reveals: After 12 months of systematic training, athletes' bench press strength increased by 10 kilograms and squat strength by 15 kilograms, confirming this training's dual enhancement of muscle growth and explosive power.

(4) 200m Training: Utilizes high-intensity interval and sprint drills to effectively enhance athletes' speed endurance. Specialized data reveals: Following systematic training, athletes' 300m times improved by an average of 1.5 seconds, confirming this training's efficacy in strengthening anaerobic metabolic capacity and sustained muscular output.

(5) Long Jump Training: By executing the complete movement chain—approach run, take off, flight, and landing—athletes comprehensively enhance speed qualities, explosive power, and body coordination. Specialized data shows: After systematic training, athletes' 100-meter start reaction time improved by 0.03 seconds, standing triple jump distance increased by 20 centimeters, and coordination test scores rose by 5 points. This confirms the training's simultaneous enhancement of speed, strength, and coordination.

(6) Javelin Training: Utilizing a compound power generation pattern involving leg drive, trunk rotation, and arm whipping motion, this focuses on enhancing upper-body explosiveness and shoulder strength. Specialized data reveals that after systematic training, athletes' javelin throw distances increased by an average of 3 meters, while grip strength improved by 5 kilograms, effectively validating the training's impact on strengthening upper-body power.

(7) 800-meter training: Sustained aerobic load significantly enhances athletes' cardiorespiratory function and muscular endurance. Systematic training increases maximum oxygen uptake by 5% and improves 1500-meter times by 10 seconds, validating its effectiveness in strengthening aerobic metabolic capacity.

### 4.2 Holistically Shaping Overall Physical Abilities through Synergistic Mechanisms

The heptathlon, as a “multi-event combination group,” employs a holistic training model that transcends the simple accumulation of specialized disciplines. It requires integrated, mutually reinforcing approaches to comprehensively develop athletes' physical capabilities (Figure 1). Through diversified training protocols, athletes achieve balanced development in strength, speed, endurance, agility, and coordination [9].

The event group score distribution of current world record holder Jackie Joyner-Kersee (7291 points) reveals:

(1) Speed Event Group (100m hurdles, 200m)

Contributes approximately 28% of the total score. The 100m hurdles (12.69 seconds) alone accounts for 1,228 points (16.8%), while the 200m (23.27 seconds) contributes 1,042 points.

(2) Power Events Group (Shot Put, Javelin Throw)

Combined contribution of approximately 24%, with Shot Put (15.8m) scoring 914 points (12.5%) and Javelin Throw (45.66m) scoring 879 points.

(3) Jumping Events Group (High Jump, Long Jump)

Accounting for approximately 31%, the high jump (1.91m) scored 1171 points, and the long jump (7.27m) scored 1089 points, both exceeding world record levels for individual events.

(4) Endurance Group (800m)

Accounting for 17%, the 800m (2:14.15) scored 1097 points, a performance approaching that of professional middle-distance runners.

The standard deviation of scores across the seven individual events was maintained within approximately 150 points, demonstrating exceptional balance among event groups. The group-specific characteristics of this event necessitate a “modular integration” training strategy. This approach focuses on developing the “synergistic mechanism effects” between event groups while preserving the specialized capabilities of each sub-group.


Figure 1: Events of the Women's Heptathlon Track and Field Competition and Group Photo After the Event. Source: 2025 National College Students Track and Field Championships. This photo features the author.

Figure 1 presents a comprehensive view of all the heptathlon events at the competition venue, showcasing the layout of the competition and highlighting the tradition of group photos after the competition.

## 5. The Impact of Women's Heptathlon Training on Psychological Resilience

### 5.1 Training Process for Strengthening Psychological Resilience Dimensions

Women's heptathlon training systematically builds psychological resilience through a trinity model: - Cultivating adversity tolerance via high-intensity repetitive drills (e.g., dozens of hurdle starts daily) to continuously push physiological limits; - Establishing positive feedback loops through phased goal mechanisms (e.g., raising the high jump bar by 5 cm each attempt); - Rapidly adjusting mental and physical states through diverse event transitions (e.g., switching from shot put to high jump), creating a synergistic virtuous cycle. Research confirms that heptathletes, who must manage seven distinct stressors, demonstrate fatigue resistance 23% superior to single-event athletes.

### 5.2 Forging Mental Resilience through Competition

The competition arena serves both as a stage for testing training outcomes and a battlefield for tempering mental resilience. Heptathletes must maintain consistent performance during consecutive events, where each result impacts final rankings—demanding exceptional mental regulation. Facing intense competitive pressure, athletes must overcome nervousness to sustain focus, manifested as: (1) Emotional control to rapidly recover after a failed high jump attempt; (2) Mental transition ability during event changes (e.g., hurdles → shot put); (3) Sustained willpower throughout 2-3 days of competition. Data shows that after competing in multiple provincial-level or higher events, athletes' pre-competition anxiety levels decrease by an average of 15% as experience accumulates. The duration they maintain over 90% focus during events increases by 20%, confirming that competitive pressure effectively hones psychological resilience.

## 6. Synergistic Mechanism between Physical Fitness and Psychological Resilience

### 6.1 Mechanism of Physical Fitness Enhancing Psychological Resilience

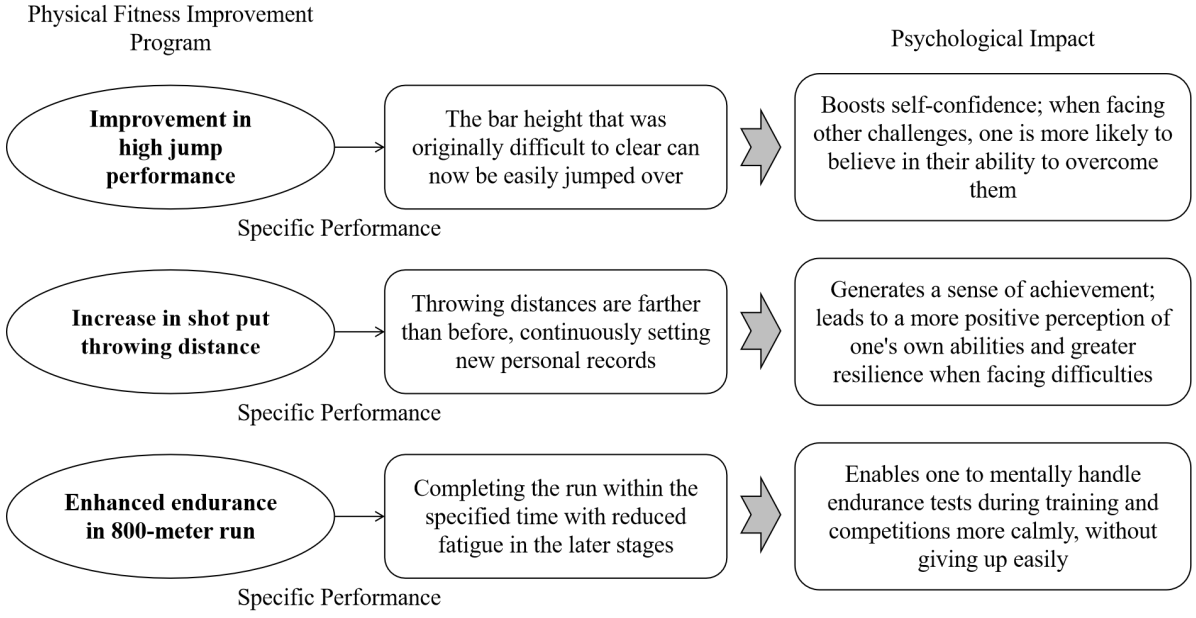


Figure 2 Physical Fitness Improvement Programs and Their Psychological Impacts

Physical fitness and mental resilience form a bidirectional relationship in women's heptathlon. Superior physical attributes (such as strength, speed, and endurance) establish the material

foundation for mental resilience: athletes with robust physical conditioning can more effectively mitigate fatigue during training and competition, thereby enhancing their psychological capacity to withstand adversity. This synergistic interaction between body and mind collectively underpins athletic performance. Figure 2 illustrates various physical training components and their psychological effects:

From a psychological perspective, physical enhancement fosters a heightened sense of accomplishment and self-confidence. By continually pushing past physical limits—such as improving high jump performance or increasing shot put distance—athletes develop a more positive perception of their capabilities. This enables them to face diverse challenges with confidence, firmly believing in their ability to overcome obstacles.

### 6.2 Mechanisms of Psychological Resilience in Enhancing Physical Performance

Psychological resilience also enhances physical fitness. By regulating cortisol and BDNF secretion, it optimizes neuromuscular control. During weighted running training, athletes with high psychological resilience adapt more quickly to loads equivalent to 6%-10% of their body weight, improving hip strength and ankle contraction capacity. Simultaneously, heightened focus and emotional regulation reduce competition distractions, leading to more consistent technical execution. Research indicates that a one-unit increase in psychological resilience reduces performance variability by 23%, with particularly pronounced effects in events like hurdling and high jumping.

Athletes with high psychological resilience significantly enhance recovery efficiency through self-talk and stress regulation. Studies indicate that psychologically trained swimmers clear blood lactate 15% faster post-race than untrained athletes, attributed to increased endorphin secretion. During critical competition moments, they effectively manage anxiety, maintain peak physiological function, and deliver higher-level athletic performance.

### 6.3 Synergistic Dynamic Development through Training Interventions

In heptathlon training, physical conditioning and psychological resilience form a positive feedback loop of spiraling improvement. Mental resilience enhances technical stability by optimizing neuromuscular control, while increased training intensity reciprocally strengthens mental resilience. This manifests as precise muscle activation in technical events like hurdles and high jump, and as tempered willpower in power events such as shot put and javelin. This dynamic, mutually reinforcing mind-body mechanism propels athletes toward a sustainable training model.

As training intensity escalates, mental resilience becomes the critical support for overcoming plateaus, enabling athletes to persevere and elevate their physical capacity during complex, high-intensity sessions. The synergistic effects between the two dimensions deepen progressively, ultimately translating into a stepwise growth in overall competitive ability. Coaches must precisely grasp this developmental pattern, scientifically designing training content and intensity to maximize the synergistic effects between mind and body. This dual-pronged approach provides athletes with a robust foundation for achieving outstanding results in competition.

## 7. Conclusion

This study examines the training of female heptathletes in Chinese universities, revealing the dynamic synergistic mechanism between physical fitness and psychological resilience. In training practice, each heptathlon event systematically develops physical attributes such as strength, speed, and endurance while cultivating athletes' optimistic traits and adaptability. Conversely, when facing competitive pressure and unexpected situations, psychological resilience helps athletes maintain a positive mindset. This synergy manifests as follows: enhanced physical fitness provides the material foundation for psychological resilience, mitigating the negative psychological impact of physical fatigue while strengthening psychological support through heightened achievement. Psychological resilience, in turn, stimulates intrinsic motivation and improves training performance. Under long-term training intervention, both elements form a virtuous cycle between physical fitness and psychological resilience.

In summary, this study systematically elucidates the complex relationship between physical fitness and psychological resilience in Chinese university female heptathlete during training and competition. It provides a theoretical foundation for universities to develop scientifically sound training programs and elevate athletes' competitive performance.

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