

CHAPTER I

INTRODUCTION

A. Background

Volleyball is a high-intensity, intermittent team sport that demands a complex blend of physical attributes (explosive vertical power, sprint speed, agility), technical-tactical skill, and psychological readiness. Elite performance requires coaches and sport scientists to integrate physiological periodization, sport-specific strength and conditioning, technical skill mastery, tactical preparation, injury-prevention strategies, and talent-development systems into an evidence-based training model (Akyildiz et al., 2022).

Shandong Province occupies a prominent place in Chinese sport structures: it has large population pools, substantial school-sport systems, and provincial sports administrations that historically feed national teams. In China's multi-tiered athlete development system, provincial training centers (such as those in Shandong) serve as critical nodes for talent identification, systematic training, and coach development. The Chinese sports-education integration model emphasizes early talent identification, long-term athlete development, and centralized periodized preparation for national and international competitions (Yang et al., 2024).

Within this context, developing a province-specific, evidence-based training model is necessary for several reasons. First, the physiological and technical demands of modern elite volleyball have evolved (higher block and attack speeds, greater jumping frequency), requiring up-to-date strength & conditioning approaches. Second, provincial programs must reconcile mass participation and talent filtering with individualized training plans for elite prospects. Third, injury prevention and athlete longevity are essential given extended competition calendars (domestic leagues plus international commitments). Reviews and bibliometric analyses show a surge of research (2020–2025) on volleyball training practices, periodization, plyometrics, and monitoring of training load — trends that should inform provincial program design.

Match analysis and physiological studies demonstrate that volleyball performance hinges on repeated explosive efforts (jumps, accelerations, directional changes) interleaved with short rest periods. Elite players perform frequent maximal or near-maximal vertical jumps, and repeated jumping capacity (and recovery between jumps) differentiates high-level performers from lower levels. Consequently, strength and power development (especially lower-limb concentric and eccentric capability), reactive strength, and plyometric efficiency are foundational training targets (Strength & Conditioning reviews 2022–2025).

Empirical interventions (2020–2024) repeatedly show that structured plyometric programs, combined with targeted resistance training and sprint/power work, increase vertical jump height, spike speed, and serve velocity. These findings recommend mixed training modalities (Olympic-style lifts or their derivatives where appropriate, combined with sport-specific plyometrics) and progression from general strength to more explosive, specific actions as the season advances. Such periodized progression reduces interference effects and maximizes transfer to game actions.

Periodization remains a core organizing principle for elite programs. Contemporary research comparing traditional, block, and flexible periodization models in team sports — and volleyball specifically — suggests no one model fits all teams; rather, models must be adapted to competition schedules, athlete profiles, and resource constraints. Block periodization and concentrated loads can produce rapid neuromuscular adaptations in pre-season phases, while maintenance and tactical refinement dominate competition phases. Microcycle design must manage external and internal training loads to avoid overreaching while preserving technical-tactical practice time. Practical studies of national youth teams show the distribution of content across macrocycles varies by age and competition targets and must be transparently linked to monitoring systems (e.g., session RPE, external load metrics).

For Shandong's elite program, periodization must integrate: (1) a robust off-season hypertrophy/strength phase, (2) a power/plyometric conversion phase, (3) pre-competition tactical integration combined with tapered neuromuscular sharpening, and (4) in-season load management employing objective monitoring

(GPS/IMU when available) and subjective tools (RPE, wellness questionnaires). The research supports flexible implementation: microcycles within the season should be adjusted according to match frequency and athletes' readiness, using within-week load differences to guide content placement.

High-quality contemporary programs adopt comprehensive monitoring: objective external load (accelerometry, jump counts), internal physiological load (heart rate, lactate when needed), and perceptual measures (session RPE, mood, muscle soreness). Studies in elite volleyballers show within-week variation in external loads tied to microcycle design and that monitoring can identify high-risk periods for performance decrements and injury. Monitoring data should feed coach decisions on session content, intensity, and recovery strategies. This data-informed approach supports Shandong's coaches by providing individualized adjustments amid team training constraints.

Beyond physical preparation, technical and tactical skills (spiking, blocking, serving, serve-receive systems) require high-quality, high-intensity task-specific practice. Periodized physical conditioning must not displace technical practice; rather, it should be scheduled to maximize skill acquisition and retention (e.g., complex training where strength/power work precedes technical drills when physiological readiness allows). Recent models combine biomechanical analysis of spiking and serving with targeted drills to improve accuracy and speed, indicating advantage in integrating biomechanical feedback and video analysis into provincial training centers.

Volleyball has distinct injury patterns — ankle sprains, patellar tendinopathy, shoulder overload — often linked to repetitive jumping and spiking. Contemporary literature highlights preventive exercises (eccentric loading for tendons, neuromuscular ankle stability drills, shoulder rotator cuff conditioning) and workload moderation as key prevention strategies. Integrating preventive sessions into warm-ups and weekly microcycles reduces injury incidence and supports athlete availability across long seasons — a crucial objective for Shandong's elite athletes, whose participation in national leagues and international tournaments increases exposure.

Effective regional systems balance mass participation with careful selection and long-term athlete development (LTAD) frameworks. Recent Chinese research emphasizes cultural, nutritional, coaching quality, and self-efficacy factors in athlete progression. Modern talent ID incorporates multi-domain profiling (anthropometrics, motor skills, power measures, perceptual/cognitive tests) and increasingly uses machine learning to integrate large data sets (though applications in volleyball youth systems remain emergent). For Shandong, formalized talent pathways — school-club-provincial links, standardized testing batteries, and coach education — will facilitate a sustainable elite pipeline.

High-level volleyball performance is influenced by concentration, decision-making under pressure, and team cohesion. Systematic reviews indicate cognitive training and mental skills interventions improve performance consistency. For provincial programs, integrating sports psychology services, decision-making drills, and pressure-conditioned practice (e.g., small-sided constrained games) helps translate physical capacity into match performance. Recent proceedings and reviews highlight concentration training as an emerging area for volleyball practice.

Translating evidence into provincial practice faces logistical and human-resource barriers: limited access to monitoring technology, coach time constraints, heterogeneous athlete ability levels, and institutional priorities. Studies of strength & conditioning practices show coaches adopt a wide variety of methods; quality improves with targeted education and clear, implementable templates. Thus, an effective Shandong model must include coach development modules, practical templates for periodization, and simple monitoring tools that produce actionable insights (session RPE, jump counts, wellness questionnaires).

Volleyball is a competitive team sport characterized by repeated high-intensity actions such as jumping, spiking, blocking, and rapid changes of direction. Success in elite volleyball performance largely depends on the athlete's ability to generate maximal force in minimal time, particularly through lower-limb explosive power (Sheppard, Gabbett, & Stanganelli, 2009). As the level of

competition increases, physical conditioning becomes a decisive factor influencing technical execution and tactical effectiveness.

Explosive strength, especially vertical jumping ability, is a key physical quality for elite volleyball athletes. Research indicates that match performance variables such as spike height, block reach, and jump frequency are strongly associated with lower-limb power output (Ziv & Lidor, 2010). Consequently, training methods aimed at enhancing neuromuscular power have become a primary focus in volleyball conditioning programs.

Plyometric training is a widely used method designed to improve explosive strength by utilizing the stretch-shortening cycle (SSC) of muscles. This training approach involves rapid eccentric-concentric muscle actions that enhance elastic energy utilization, neuromuscular coordination, and motor unit recruitment (Komi, 2000). Studies have consistently demonstrated that plyometric training can significantly improve vertical jump height, rate of force development, and sport-specific performance in volleyball athletes (Markovic, 2007; Sáez de Villarreal et al., 2009).

Despite its proven effectiveness, the outcomes of plyometric training are highly dependent on appropriate program design, including exercise selection, training volume, intensity, frequency, and progression. In elite athletes, inappropriate plyometric loading may lead to overuse injuries or diminished performance due to accumulated fatigue (Chu, Myer, & McBride, 2016). Therefore, the development of scientifically structured and sport-specific plyometric training models is essential, particularly for high-level volleyball players.

In recent years, volleyball performance in Shandong Province has shown continuous improvement, supported by increased investment in athlete development and scientific training methodologies. Elite volleyball athletes in this region typically undergo high training loads and long-term specialized training, which places greater demands on physical preparation and injury prevention strategies. However, current plyometric training practices are often based on generalized or imported models that may not fully reflect the specific physical

characteristics, training backgrounds, and competitive demands of elite volleyball athletes in Shandong Province.

From a scientific training perspective, region-specific and athlete-specific conditioning models are crucial for maximizing performance adaptation (Bompa & Buzzichelli, 2019). The absence of a structured plyometric training model tailored to elite volleyball athletes in Shandong Province highlights a gap between training theory and practical application. Addressing this gap may contribute to improved explosive performance, optimized training efficiency, and reduced injury risk.

Therefore, the purpose of this dissertation is to construct and evaluate a plyometric training model specifically designed for elite volleyball athletes in Shandong Province. By applying principles of sports training theory, biomechanics, and periodization, this study aims to investigate the effects of the proposed model on key performance indicators such as vertical jump ability, lower-limb explosive power, and movement efficiency. The findings of this research are expected to provide theoretical support and practical guidance for coaches and strength and conditioning professionals, promoting the scientific development of elite volleyball training in Shandong Province.

Although recent studies (2020–2025) have confirmed the effectiveness of plyometric training in improving vertical jump performance and explosive power in volleyball athletes, several critical gaps remain in the existing literature. First, most contemporary research has examined generalized plyometric training protocols applied to youth, recreational, or mixed-level volleyball players, with limited focus on elite athletes who possess advanced neuromuscular adaptations and distinct training demands. As a result, the applicability of these findings to elite volleyball populations remains uncertain. Second, current plyometric interventions are often implemented as short-term, isolated training blocks without systematic integration into periodized training frameworks that reflect the competitive schedules of elite teams. This limits understanding of how plyometric training can be optimally structured across different training phases to sustain performance and manage fatigue.

Furthermore, existing studies rarely account for regional or contextual differences in athlete development systems, training environments, and competition structures. In particular, there is a lack of evidence-based plyometric training models tailored to elite volleyball athletes in Chinese provincial programs, such as those in Shandong Province, where training loads, athlete characteristics, and performance objectives may differ from those reported in international literature. Additionally, many studies prioritize performance outcomes such as vertical jump height while neglecting comprehensive monitoring of neuromuscular fatigue, injury risk indicators, and individual response variability. This narrow focus restricts the practical value of plyometric training prescriptions for high-performance settings.

Moreover, limited research has explored the transfer effects of specific plyometric exercise selections on volleyball-specific performance measures, including approach jump, spike jump, and blocking reach. The absence of biomechanical and movement-based analyses further constrains understanding of the mechanisms through which plyometric training enhances volleyball performance. Consequently, there remains a need for a scientifically structured, region-specific, and performance-oriented plyometric training model that integrates periodization principles, individualization strategies, and sport-specific outcomes. Addressing these gaps will contribute to more effective and sustainable physical preparation strategies for elite volleyball athletes in Shandong Province.

B. Research Restriction Focus

The focus of this research is Plyometric Training Model For Elite Volleyball Athletes In Shandong Province.

C. Problem Formulation

Based on the limitations of the study, the problem formulation in this study is as follows:

1. What is the Plyometric Training Model For Elite Volleyball Athletes In Shandong Province?

2. Is the training model plyometric effective for elite athletes volleyball in Shandong Province?

D. Research Objectives

Based on the limitations of the study, the research objectives in this study are as follows:

1. To create a plyometric training model for elite athlete volleyball that is in accordance with the characteristics of athlete in Shandong Province.
2. To determine the effectiveness of the plyometric training model volleyball for Athletes Shandong Province.

E. Research Benefits

This research is expected to benefit lecturers, elite athlete and sports teachers as a reference and serve as an alternative plyometric training model in athletes, clubs and coaches. The benefits of this research are:

1. For Athletes
The results of this study are expected to be able to improve the plyometric training model for elite athletes in volleyball.
2. For Clubs
The results of this study are expected to be used as training model guidelines, especially the stages of plyometric volleyball in elite athlete in Shandong Province.
3. For the Coaches
The results of this study are expected to be used as a reference in plyometric volleyball training model and are expected to improve the quality of training programs.
4. For Researchers
The results of this study are expected to increase self-knowledge in preparing to become a professional coach with integrity. Training plyometric models that can be used by researchers as coaches in training volleyball . It is a self-reflection for researchers and colleagues involved to develop other training models.

F. State of the Art

In recent years, plyometric training has become a central component of physical conditioning programs for volleyball athletes due to its proven effectiveness in enhancing explosive power, vertical jump performance, and neuromuscular efficiency. Contemporary research emphasizes the role of the stretch-shortening cycle in improving force production and movement economy during volleyball-specific actions such as spiking and blocking. Meta-analytical and systematic review studies published since 2020 consistently report significant improvements in vertical jump height, reactive strength, and lower-limb power following structured plyometric interventions in volleyball players.

Current training approaches highlight the importance of exercise specificity and progression. Modern plyometric programs increasingly incorporate multiplanar movements, unilateral exercises, and volleyball-specific jump patterns to improve transfer to competitive performance. Researchers have also begun to examine variations in plyometric intensity, such as drop jump height, ground contact time, and external loading, to optimize adaptations while minimizing injury risk. These developments reflect a shift from generic jump training toward more sport-specific and biomechanically informed plyometric prescriptions.

Another notable advancement in the field is the integration of monitoring tools to assess training effectiveness and athlete readiness. Recent studies have utilized force-plate analysis, reactive strength index, countermovement jump force-time characteristics, and subjective wellness measures to evaluate neuromuscular fatigue and training response. This data-driven approach allows for more precise load management and supports individualized training adjustments, which are increasingly recognized as essential in elite sport environments.

Despite these advancements, much of the current literature remains focused on short-term training interventions, often lasting between six and twelve weeks, and primarily involving non-elite or mixed-level athletes. While these studies provide valuable evidence for the efficacy of plyometric training, they offer limited insight into long-term implementation within elite, high-load training systems. Additionally, most state-of-the-art research originates from Western or

non-Asian contexts, with minimal representation of Chinese provincial elite volleyball programs.

Overall, the state of the art demonstrates that plyometric training is an effective and scientifically supported method for improving explosive performance in volleyball athletes. However, the application of these contemporary findings to elite athletes within specific regional contexts remains underexplored. Advancing the field requires the development of structured, periodized, and context-specific plyometric training models that align with the demands of elite volleyball competition. Such an approach will bridge the gap between current scientific knowledge and practical application in high-performance volleyball settings, particularly within Shandong Province.

Study / Source	Year	Population / Sample	Focus / Variables	Key Findings	Gaps / Limitations
<i>Analysis of Plyometric Training in Volleyball</i> (Systematic Review, Scopus-based)	2025	41 articles from Scopus (Volleyball)	Plyometric effects on performance (vertical jump, leg strength, agility, serve/smash/block)	Plyometric training improves vertical jump, jump direction, leg strength, explosive jumps, and skill outcomes (serve/smash/block). (Competitor)	Most studies short-term; limited on elite specific programs; regional gaps (few China/Asia focused). (Competitor)
<i>Plyometric Training Program on Vertical Jump Ability</i> (Quasi-experimental)	2024	High school volleyball players (Bekasi)	Vertical jump height pre/post plyometric program	Plyometric group had significantly greater vertical jump improvements vs control. (ResearchGate)	Not elite adult athletes; short duration; lacks neuromuscular/fatigue metrics. (ResearchGate)
<i>Effects of Plyometric Training on Volleyball Smash Performance</i>	2025	Sports elite athlete volleyball	Box jump vs squat jump influence on spike/smash	Plyometric exercises showed numerical gains in spike performance, especially box jumps. (PTJI)	Small sample, not statistically significant, and not Scopus indexed; limited to school context. (PTJI)

Study / Source	Year	Population / Sample	Focus / Variables	Key Findings	Gaps / Limitations
<i>4-Week Plyometric Intervention for Fitness Components</i>	2025	U21 novice volleyball players	Short plyometric program effects	Short-term plyometric training significantly enhances fitness components key to volleyball. (Sport Pedagogy)	Novice athletes; short timeframe; no elite group comparisons. (Sport Pedagogy)
<i>Scopus-Indexed Systematic Evidence (umbrella perspectives)</i>	2025	Mixed athlete samples (incl. volleyball)	Plyometric vs routine/resistance training	Plyometric can significantly improve countermovement jump (CMJ). Mixed or non-significant for vertical jump vs routine training; variable results depend on protocol. (Frontiers)	Heterogeneity in design, outcomes, and sport specificity; limited volleyball-only subgroup analysis. (Frontiers)

G. Road Map Research

The Road Map in the research with the title "Plyometric Training Model For Elite Volleyball Athletes In Shandong Province" is:

Tabel 1. 2 Road Map

2024-2024	2025	2025
1. Conduct a literature study and look for supporting theories for research 2. Conduct an audience with the Sports Study Programme 3. Making operational planning in research	1. Develop a research proposal under the guidance of the promoter and co-promoter. 2. Make a research presentation in the form of FGDs 3. Make a product design	1. Product implementation 2. Product evaluation 3. Presentation of results 4. Product distribution