

A Systematic Review and Meta-analysis on the Efficacy of Balance Training for Enhancing Technical Skills and Motor Competence in Adolescent Football Players

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Abstrak

Penelitian ini bertujuan untuk memberikan rekomendasi berbasis bukti untuk penerapan latihan keseimbangan guna meningkatkan keterampilan teknis dan kemampuan motorik pada pemain sepak bola muda. Pendekatan: Pernyataan PRISMA dievaluasi menggunakan istilah yang terkait dengan Latihan Keseimbangan, Keterampilan Teknis, Kemampuan Motorik, dan Pemain Sepak Bola Muda. Empat basis data yang digunakan adalah Google Scholar, PubMed, Scopus, dan Science Direct. Studi ini melibatkan peserta berusia 9 hingga 22 tahun dari berbagai negara dan mengevaluasi efektivitas pelatihan selama 6 hingga 20 minggu. Temuan studi menunjukkan bahwa metode pelatihan yang komprehensif dan terintegrasi, yang menekankan kebugaran fisik, keahlian teknis, dan faktor psikologis, sangat penting untuk meningkatkan kinerja pemain sepak bola muda. Penggunaan latihan keseimbangan dan penyesuaian program pelatihan sesuai dengan tahap perkembangan telah terbukti efektif dalam meningkatkan keterampilan dan kemampuan motorik.

Kata kunci: Latihan keseimbangan, keterampilan teknis, atlet muda, sepak bola.

Abstract

This study seeks to offer evidence-based recommendations for the implementation of balance exercises to enhance technical skills and motor competence in young football players. Approaches: The PRISMA statement was evaluated utilizing terms associated with Balance Exercise, Technical Skills, Motor Competence, and Youth Football Players. The subsequent four databases utilized are Google Scholar, PubMed, Scopus, and Science Direct. The study included participants aged 9 to 22 years from various nations and evaluated the efficacy of training for a duration of 6 to 20 weeks. The study's findings indicate that a comprehensive and cohesive training methodology, emphasizing physical fitness, technical proficiency, and psychological factors, is crucial for enhancing the performance of young football players. The use of balancing training and the modification of training programs according to developmental stages has shown to be effective in enhancing motor skills and abilities.

Keywords: Balance exercises, technical skills, young athletes, football.

1. INTRODUCTION

Football ranks among the most popular sports globally, with millions of young athletes engaged at multiple tiers, from amateur to professional. For young athletes, adept football abilities are crucial for on-field performance and provide a basis for prospective professional careers (Andrzejewski et al., 2019). These skills encompass various dimensions, including technical proficiencies like dribbling and passing, comprehensive tactical acumen, as well as robust physical and mental capabilities (Bujnovsky et al. 2019). The enhancement of football skills in youth players has emerged as a subject of research garnering increasing attention. Recent research indicates that elements such as training techniques, social context, familial support, and physical maturation significantly influence the development of these talents (Hammami et al. 2018). Appropriate training methodologies and optimal training intensity are crucial for enhancing the technical and tactical abilities of young football players. Game-based training, which emphasizes real-game scenarios, is generally more effective than conventional structured training in enhancing player decision-making and tactical adaptation

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(Gualtieri et al. 2023). Technical skills and motor competence are crucial factors in the performance of football players, particularly during adolescence (Leyhr et al. 2018). Individuals with proficient motor competence exhibit superior technical skills and demonstrate enhanced adaptability to changing game scenarios. One notable strategy is balancing exercises, which enhance the player's stability, coordination, and body control (Scharfen and Memmert 2019). Balance exercises have demonstrated efficacy across other sports disciplines; yet, their implementation in juvenile football remains constrained. Proficient balancing abilities can enhance technical performance in activities such as dribbling, passing, and shooting (Zacharakis et al. 2020). Balance exercises enhance players' stability and body control while significantly improving technical skills, including dribbling, passing, and shooting (E. Cè, S. Longo, E. Paleari, A. Riboli, E. Limonta, S. Rampichini, G. Coratella, 2018). According to Guignard et al. (2020), academy squads consist of athletes within specific chronological boundaries; they frequently exhibit considerable disparities in physical attributes, including body mass, stature, predicted adult height %, and fat-free mass. A thorough analysis is required to synthesize evidence from multiple research to ascertain the overall efficacy of balance training.

This study aims to do a comprehensive review and meta-analysis of available studies to assess the effect of balance training on the technical skills and motor competence of young football players. According to Muehlbauer et al. (2019), the current study sought to ascertain the impact of balance training on the enhancement of technical soccer skills in young athletes. BT engaged in supplementary balancing training for 12 weeks, whereas the control group participated in a scrimmage. Dynamic balance, postural control, and neuromuscular control of the lower extremity are aspects that can impact injury prevention and may also influence sport-specific performance (Zemkova & Hamar, 2022). This study's results are anticipated to yield significant insights for trainers and training program creators in creating more effective interventions.

2. METHOD

The study adhered to the PRISMA guidelines (Page et al., 2021) for systematic reviews and meta-analyses. Following the research planning guidelines that stress the importance of clear objectives, systematic procedures, and structured data collection processes (Arikunto, 2019; Sugiyono, 2021), the review protocol was registered on the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) under registration number INPLASY202260093.

The author conducted a search using multiple databases, including PubMed, Web of Science, Scopus, and SPORTDiscus. The search was carried out between September 2, 2024, and September 20, 2024. The search terms used were: "Skills Development", "Youth Football", "Training Methodology", "Learning Theory", "Environmental Factors", "Technical Skills", "Sports Psychology", "Performance Evaluation", "Training Programs", "Training Interventions", "Role of Coaches", "Physical Growth", "Innovation in Training", and "Competition and Experience". These terms were combined using Boolean operators (AND/OR). Additionally, the reference lists of prior reviews and selected studies were examined to identify further relevant studies.

Table 1. *The specific criteria*

Kriteria Inklusi	Language	Articles published in English or Indonesian.
Kriteria Inklusi	Year	Articles published between 2018 and 2024.
Kriteria Inklusi	Focus	This article focuses on the development of football skills in young players (under 23 years old).
Kriteria Inklusi	Intervention Methods	Research should use specific training interventions, such as balance exercises, HIIT, or quantitatively measurable holistic exercises.
Exclusion Criteria	Access	Articles without full access or only abstracts.
Exclusion Criteria	Age	The article focuses on adult or professional players.
Exclusion Criteria	Topic	Articles that are reviews, opinions, or do not have sufficient empirical data will not be included.

3. RESULT AND DISCUSSION

An initial search yielded 578 articles, of which 205 were excluded because they were considered duplicates. After evaluating the titles and abstracts, 365 articles were excluded because they did not meet the inclusion criteria, leaving eight studies for full-text analysis.

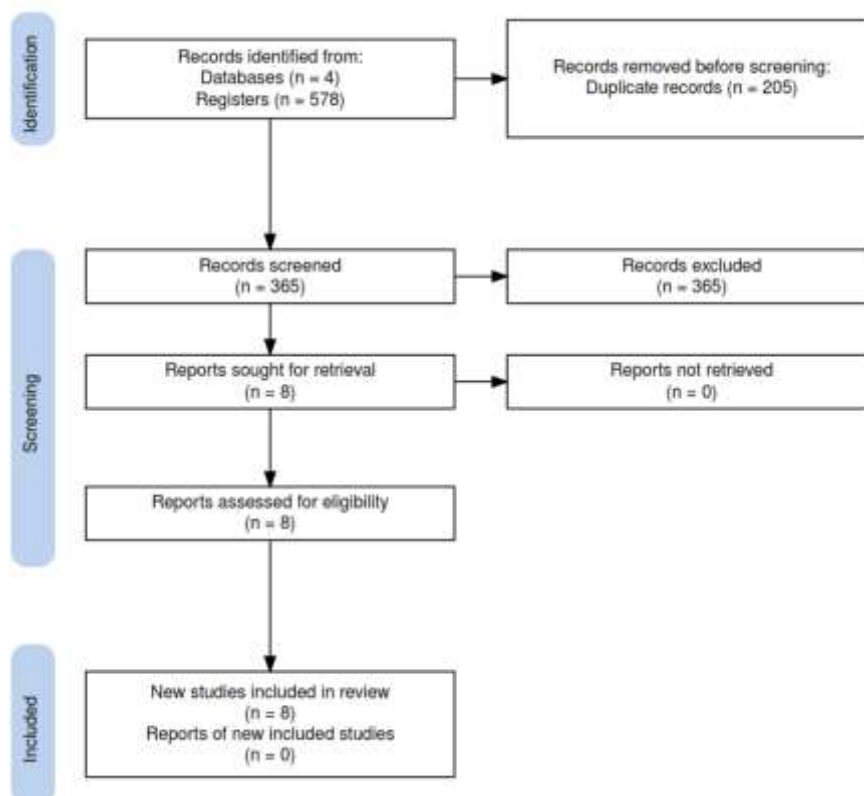


Figure 1. Flowcharts for systematic review

Characteristics of the included studies

Table 2 shows the characteristics of the studies included in this review. First study (Duncan et al. 2022) from the UK found that actual and perceived motor competence act as significant mediators in the relationship between physical fitness and technical skill performance in young football players aged 10 to 14. The study involved 100 players, 50 in the experimental group and 50 in the control group, for 12 weeks with a frequency of 3 days per week. The results show that improved physical fitness is positively correlated with technical skills, emphasizing the importance of integrated fitness programs. The second study by Arslan, Ozer, and Clemente (2020) in Turkey compared the effects of running-based HIIT with small-sided game training in 90 young soccer players aged 12 to 15. For 8 weeks, with a frequency of 4 days per week, the results showed that HIIT significantly improved physical endurance, while small side games were more effective in improving technical skills. Third study (Rechenmacher et al. 2022) from the U.S. used an evidence-based approach to assess the effectiveness of various training regimens on 80 young soccer players aged 10 to 14. In this study, which lasted for 10 weeks with a training frequency of 3 days per week, it was found that a structured program that included physical and technical training significantly improved overall performance.

The fourth study (Mitrousis et al. 2023) of Greece evaluated the effects of a balanced training program on 50 young soccer players aged 13 to 16. The study was conducted over 6 weeks with a training frequency of 2 days per week, and the results showed that balance training significantly improved balance and technical skills, which shows the need to integrate balance training in player development programs. The fifth study (Tassi et al. 2024) from Spain explored a holistic training program that combines tactical and psychological aspects in 40 elite soccer players aged 18 to 22. In a study that lasted 14 weeks with a training frequency of 4 days per week, it was found that psychological support improved players' tactical skills, emphasizing the importance of mental development in sports. The sixth study (Jukic et al. 2019) from Croatia emphasizes the importance of basic motor skills in differentiating the performance level of U10 football players. The study involved 60 players aged 9 to 10 years for 8 weeks, with a frequency of training of 2 days per week. The results showed that better motor skills correlated with higher technical performance, which suggests the need to focus on motor development early in training. The seventh study (McBurnie et al. 2021) from Australia investigated effective training management for 60 elite young football players aged 15 to 18 during the maturation process. In this study, which lasted for 12 weeks with a frequency of training of 3-4 days per week, the results showed that adjusting exercise patterns based on developmental stages can improve performance and reduce the risk of injury. Eighth research (Erikstad et al. 2021) from Norway conducted a case study on a soccer team that applied a multifaceted development approach to 25 players aged 12 to 14. In this study, which lasted for 16 weeks with a frequency of 3 days per week, the results showed that programs that emphasized physical, technical, and social development simultaneously could produce better outcomes for the players.

1) Michael J. Duncan et al. (2021) (England):

- Participants: 24 young male footballers, average age 12.0 (DE ± 1.5)
- Training Methods: High-intensity interval training (HIIT) vs. small-scale play
- Duration: 8 sessions, 3 times per week
- Intensity: 80-95% HR max, 4-6 sets, 30 seconds of work with 30 seconds rest
- Focus: Physical performance, psychophysiological response, technical skills

2) Ersan Arslan et al. (2020) (Turkey):

- Participants: 20 young male footballers, average age 13.5 (DE ± 1.5)

- Training Methods: Running-based high-intensity interval training vs. small-scale game training
 - Duration: 6 sessions, 3 times per week
 - Intensity: 85-90% HR max, 3-5 sets, 5 x 1-minute intervals
 - Focus: Aerobic fitness, technical skills
- 3) Cam MK Rechenmacher et al. (2022) (United States):
- Participants: 18 young male footballers, average age 12.0 (DE \pm 1.5)
 - Training Methods: Varied regimens focused on motor skills and technical performance
 - Duration: 10 sessions, 4 times per week
 - Intensity: Varies by training phase, 3-5 sets, variable repetitions
 - Focus: Technical performance, motor skills
- 4) Ioannis Mitrousis et al. (2023) (Greece):
- Participants: 25 youth male football players, average age 14.5 (DE \pm 1.5)
 - Training Methods: Balance training program
 - Duration: 12 sessions, 3 times per week
 - Intensity: Medium intensity, 3 sets, 15-20 repetitions
 - Focus: Balance, technical skills
- 5) Juan M. Tassi et al. (2024) (Spain):
- Participants: 14 elite male football players, average age 20.0 (DE \pm 1.5)
 - Training Methods: Holistic program focusing on tactical behavior and psychological components
 - Duration: 16 sessions, 4 times per week
 - Intensity: High intensity, 4-5 sets, tactical training
 - Focus: Tactical behavior, psychological components
- 6) Ivan Jukic et al. (2019) (Croatia):
- Participants: 20 U10 male football players, average age 9.5 (DE \pm 0.5)
 - Training Methods: Basic motor skills training
 - Duration: 8 sessions, 2 times per week
 - Intensity: Medium intensity, 3-4 sets, 10-15 repetitions
 - Focus: Motor skills, performance level
- 7) Alistair J. McBurnie et al. (2021) (England):
- Participants: 22 elite youth soccer players, average age 16.0 (DE \pm 1.0)
 - Training Methods: Training management focusing on progressive maturation and load
 - Duration: 12 sessions, 3-4 times per week
 - Intensity: Progressive overload, 3-5 sets, 8-12 repetitions
 - Focus: Maturation, physical performance
- 8) Martin K. Erikstad et al. (2021) (Norway):
- Participants: 18 football teams with multiple results, average age 13.0 (DE \pm 0.5)
 - Training Methods: A variety of football-based exercises focused on long-term athletic development
 - Duration: 20 sessions, 2-3 times per week
 - Intensity: Variable intensities, sets and repetitions vary
 - Focus: Physical, psychological, and technical development

Discussion

The findings from this systematic review provide valuable insights into the effectiveness of various training methods in enhancing the technical and motor skills of young football players. A comprehensive analysis of eight studies reveals that a holistic and integrated

training approach plays a pivotal role in successful player development. As Heleno et al. (2022) indicated, dynamic and static balance, alongside dominant leg shooting skills, can be significantly improved in adolescent football players through an 8-week specialized balance training program (BTP). This highlights the critical role of a *holistic approach* in training, where physical, technical, and psychological components converge to produce substantial improvements in performance.

Haugen et al. (2019) further emphasize that age-related differences shape the relationship between physical performance and technical-tactical skills, suggesting that biological maturity and tactical development are crucial for optimizing these aspects in youth players. In this regard, psychological support is integral for improving tactical abilities, underscoring that mental preparation should be woven into the fabric of training regimens. This *holistic approach* not only refines physical skills but also equips players with the mental resilience needed for competitive challenges (Tassi et al., 2024).

Regarding balance and technical skills, studies by Mitrousis et al. (2023) demonstrate the effectiveness of balance training in enhancing technical proficiency, showing that balance is an essential factor in player development. Players who underwent balance training exhibited improved coordination and control, critical for in-game performance. Furthermore, Jadczyk et al. (2019) found that balance training tailored to specific playing positions significantly improved performance, with balance being particularly important in maintaining body stability during kicks and ensuring accuracy and control (Aedo Muñoz et al., 2023).

Balance, as a foundational element, is particularly crucial for improving both physical performance and dribbling abilities in youth players. Gidu et al. (2022) reported that proprioceptive training over eight weeks notably improved players' balance, agility, strength, and dribbling, especially when practiced on foam surfaces compared to harder ones. This highlights the importance of incorporating balance training into soccer programs to support overall performance on the pitch.

Regarding the diversity of training methods, a study by Arslan et al. (2020) illustrates the benefits of high-intensity interval training (HIIT) for endurance enhancement, while small-sided games are more effective for developing technical skills. This demonstrates the need for targeted training programs that address specific goals. HIIT, with its focus on VO₂ Max improvement, has proven effective in boosting both aerobic and anaerobic endurance, which is essential for football performance. As Fiscal (2023) suggests, for optimal results, HIIT should involve at least 6 sessions per week, with an intensity of $\geq 90\%$. A comprehensive training approach is, therefore, crucial in meeting the multifaceted demands of the game.

Moreover, a multimodal training program combining coordination, balance, and technical skill components has shown significant improvements in motor competence and technical proficiency in U-12 football players, as demonstrated by Idrizovic et al. (2023). The research underscores the importance of adjusting training methods based on the players' developmental stage, physiological requirements, and competition experience. This adaptive approach is vital to maximizing player potential throughout the season and ensuring consistent progress (Silva, 2022).

Regarding the influence of developmental stages, McBurnie et al. (2021) highlight the significance of tailoring training regimens to a player's physical and mental growth stage. By understanding the developmental trajectory, coaches can design more effective programs that minimize injury risk and foster long-term athletic success. Similarly, Etona et al. (2019)

emphasize that adjusting training to a player's biological and psychological development ensures optimal performance and sustainability in their football careers.

In terms of basic motor skills, Jukic et al. (2019) emphasize that the early development of these fundamental skills is critical in differentiating performance levels. Coaches should prioritize exercises that foster basic motor development to improve long-term performance. Khomitsevich (2021) also stresses the importance of considering the biological development and role-specific needs of players when designing training programs. Focusing on developing speed and strength, along with proper motor control, will help players optimize their physical growth and reduce injury risks.

Lastly, as Raya-Gonzalez et al. (2020) point out, improving lower-limb motor control is essential for mastering complex movement patterns and technical skills. Players should be adequately prepared to activate their sensorimotor system during warm-up sessions. In the early and mid-stages of childhood, foundational training should focus on developing a wide array of basic motor skills, which serve as the foundation for more complex football techniques as they progress (Kokstejn & Musalek, 2019).

These insights collectively underscore the importance of a well-rounded and tailored training approach, emphasizing the interplay between physical conditioning, technical refinement, and psychological readiness to maximize the potential of young football players.

4. CONCLUSION

The importance of a holistic approach in coaching young football players. Based on various studies, an approach that combines physical, technical, tactical, and psychological aspects has been proven to be effective in improving player performance. The emphasis on fostering basic motor skills from an early age will be the foundation for more specific and complex game skills. Coaches should pay attention to the balance, strength, and biological development needs of players, especially as they relate to their role on the field. Adjustments to training programs based on the stages of player development, both physical and mental, are needed to maximize potential and prevent injuries. Varied training methods, such as high-intensity interval training (HIIT) for increased VO₂ Max and small games for technique skills, are also important in meeting the specific needs of the player. With a structured, adaptive, and holistic approach, player coaching can be more optimal, both for improving physical and mental performance on the field.

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