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A NARRATIVE REVIEW

Physical Preparation of Handball Players

Slavka Durlević[1], Ina Marković[1], Marija Durlević[2]

[1]Faculty of sport and physical education, Novi Sad, Serbia, [2]Faculty of Sport and Physical Education, University of Priština in Kosovska Mitrovica

Abstract

Determining the most significant anthropological dimensions for success in handball is an important step in the selection process and in creating models on which the training process is based. Handball is a sport that both requires and influences the development of players' characteristics and abilities. The development of these characteristics and abilities is achieved through a well-planned, long-term, and comprehensive training process. With the modern trends in handball and increasingly better results on the public scene, handball players are required to have exceptional physical, technical, tactical, and psychological performance. Accordingly, the aim of this research was to revise the literature that defines and describes the physical preparation of handball players, as well as its main components and types that are applied during the preparatory period in the training process. Additionally, the goal was to describe the changes in the functional structure of handball players under hypoxic conditions, as well as to highlight that physical preparation is a significant factor in reducing the number and severity of injuries. Previous research emphasizes that the physical preparation of handball players is crucial for success in handball. Physical preparation represents a comprehensive, exhaustive, and well-planned training process that encompass methods aimed at developing, maintaining, and perfecting morphological characteristics, motor, and functional abilities, as well as preventing injuries in handball players.

Keywords: *physical preparation, motor abilities, success, handball, handball player*

Introduction

Handball is a relatively young ball sport that has undergone rule changes throughout its evolution, directly impacting the structure of the game. The improvement in the quality of handball has made it more attractive to spectators and less aggressive for participants (Simić et al., 2022). Handball belongs to the group of poly-structured contact sports with unpredictable dynamics of cyclic and acyclic activities (Bragazzi et al., 2020; Branković et al., 2012; Vuleta & Milanović, 2004). It is based on natural movements such as running, jumping, passing, catching, blocking, pushing, landing, shooting, and sprinting (Buchheit et al., 2009; Chelly et al., 2010). As a high-intensity and dynamic game, handball is one of the most widespread ball sports across all age groups and is played on every continent (Durlević et al., 2023). Modern handball is represented by powerful European clubs and national teams, and it can be said that it has reached the pinnacle of its development. Moreover, clubs and national teams are constantly innovating, pushing the limits of players' performance to the edge of possibility (Andersson et al., 2017; Muratović et al., 2014). Players are required to possess impressive physical predispositions, being strong, precise, fast, enduring, agile, skillful, and capable in all game situations. They must also have a good understanding of the game and be mentally strong and stable. The success of a handball player is determined by the level of development of abilities, skills, traits, and knowledge that can be measured, analyzed, and then developed and perfected to the limit during their sports career, all with the goal of solving specific tasks in both defense and attack phases (Karcher & Buchheit, 2014; Rogulj et al., 2007). As with other team sports, specific player positions in handball require athletes to have the appropriate anthropological profile. Numerous studies have been conducted to investigate the influence of the anthropological status of handball players on their success (Bon et al., 2015; Ilić et al., 2011; Lijewski et al., 2019). Players are required, and at the same time influenced, to develop their anthropological potential, especially in terms of morphological characteristics, motor, and functional abilities. For this reason, the majority of research has focused on the morphological characteristics, motor, and functional abilities of handball players (Bojić et al., 2019; Fernández-Romero et al., 2016; Fieseler et al., 2017; Massuça & Fragoso, 2015; Matthys et al., 2011; Milanese et al., 2011; Oxyzoglou et al., 2006; Póvoas et al., 2014). Motor abilities have the greatest impact on handball success (Aksović et al., 2021;

Correspondence:

I. Marković
University of Novi Sad, Faculty of Sport and Physical Education, Lovćenska 16, 21000 Novi Sad, Serbia
E-mail: inamaković997@gmail.com

Saavedra et al., 2020; Srhoj et al., 2002; Śliż et al., 2022) and are significant predictors of success in the game (Massuça & Fragoso, 2011; Matthys et al., 2011; Palamas et al., 2015; Rogulj et al., 2007).

In recent years, much attention has been dedicated to the connection between motor abilities and success in handball. Long-term training processes, with proper orientation, selection, and specialization, lead to the formation of an optimal and specific motor structure responsible for achieving top performance in handball (Pavlović et al., 2013; Pori et al., 2012; Sporiš et al., 2010). Elite handball players are characterized by a high and stable level of the most important components that make up sports form. Throughout the season, they participate in numerous competitions, and elite players with many appearances must not only maintain a high level of fitness but continually improve it. Coaches, therefore, implement a periodization of sports training throughout the year, aiming to achieve the best results during the most important competitions. To achieve optimal results, handball players must be prepared physically, technically, tactically, and psychologically (Popović et al., 2024).

The intense demands of modern handball require players to have a high degree of physical fitness. The success achieved by the most successful clubs and national teams today is attributed to the high level of physical preparation, which is the result of well-planned and organized training periods over the years (Bjelica et al., 2012; Gómez-López et al., 2020). A high level of physical fitness in handball is achieved through systematic and patient work, maintaining and improving the basic and specific motor abilities of players. Physical preparation in handball training is one of the most important aspects, forming the foundation for tactical, technical, and psychological preparation (Bompa et al., 2005; Fulgozi, 1994; Granados et al., 2008; Koprivica, 2013; Milanović, 2010; Milanović et al., 2012; Stojanović et al., 2009). This area of training covers various domains, such as the overall development of players, health improvement, development and perfection of motor abilities, and the ability of players to endure high levels of physical exertion during training and games. With the evolution of handball and rule changes, such as the shortened attack time and the substitution of the goalkeeper for an additional player during attacks, the pace and rhythm of the game have significantly accelerated. This requires players to master technical and tactical skills, be psychologically prepared, and possess both general and specialized physical fitness (Karimov & Sh, 2020; Marques & González-Badillo, 2006).

Accordingly, the aim of this study was to revise the scientific literature that defines and describe the physical preparation of handball players, its main components, and the types applied during the preparatory period in the training process. Additionally, the study aimed to describe changes in the functional structure of handball players under hypoxic conditions, while highlighting that physical preparation is a significant factor in reducing the number and severity of injuries.

Methods

A descriptive method and theoretical analysis were applied for the collection, classification, and analysis of targeted research.

Inclusion Criteria

The following inclusion criteria were defined for the selection of papers to be included in the final analysis: (1) original scientific papers; (2) papers written in English and Serbian; (3) papers related to the physical fitness of athletes; (4) sample of respondents - handball players.

Exclusion Criteria

Based on the following criteria, papers were excluded from further analysis: (1) papers not written in English or Serbian; (2) the problem of inadequate workforce; (3) papers in which the results for analysis were not adequately presented; (4) an inadequate sample of respondents.

Search Strategy

The material was gathered through internet databases and search engines such as Google Scholar, PubMed, Web of Science, and ResearchGate. The key terms used during the search included: physical preparation, motor abilities, success, handball, and handball player. Only studies relevant to the purpose of this research were considered. The search was limited to studies conducted on handball players who were in a continuous training process. Studies that were excluded from the analysis either did not meet the criteria for an adequate sample size, or the results were not sufficiently presented for further analysis.

Results

The research results are shown in Figure 1.

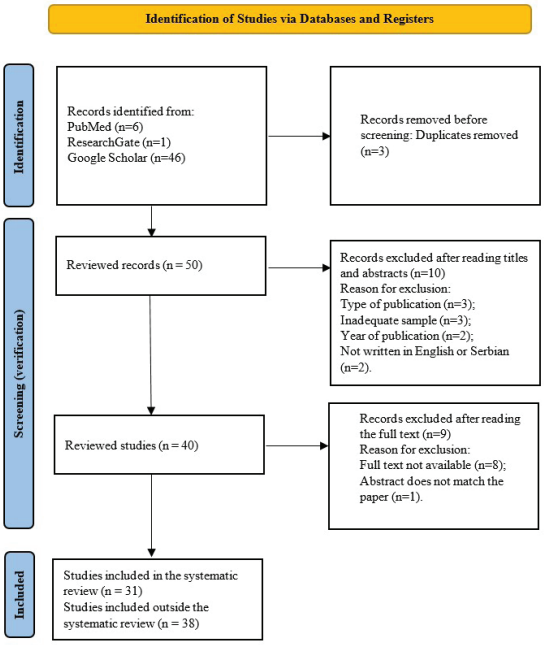

FIGURE 1. Schematic representation of the selection of collected studies

Physical preparation of handball players

Physical preparation is an integral and indispensable part of the preparatory period for athletes. According to Karimov & Sh (2020) and Željaskov (2004), physical preparation is defined as a complex process involving the application of various programs and methods to develop, maintain, and enhance the morphological characteristics, motor, and functional abilities of athletes. Malacko (2002), Metvejev (2000), and Jalolovich (2022) emphasize that the primary task of physical preparation is to improve fitness and sports performance by increasing the basic and specific abilities necessary for handball. According to Koprivica (2013), physical preparation should be understood as a long-term training process, where load and rest, stress and adaptation to effort are constantly alternated. Physical preparation is a system of specific means, loads, methods, and forms of work aimed at developing and improving the capacities of handball players. This system is closely linked with the main factors for success in handball. It is crucial to determine the direction of training activities during physical preparation.

Motor Abilities as a Key Factor in Achieving Top Results

Motor abilities are one of the most important dimensions that significantly influence the efficiency of handball players in specific and situational conditions across all segments of the game (Hussein & Hrebid, 2023; Karišik & Goranović, 2010). Basic motor abilities form the foundation for the further development of specific motor skills, which are directly responsible for achieving high-level results (Šeparović et al., 2015). A detailed analysis of movement during handball games reveals defensive positioning, quick counterattacks, short and long accelerations, movements and changes of direction with or without the ball, passing and catching, shooting on goal, and jumping. This shows that all motor abilities, to varying degrees, play a crucial role in a player's success. Červar et al. (2004) highlight that precision, strength, aerobic and anaerobic endurance dominate as key factors for success in handball. Additionally, speed and endurance have become essential for every player position due to the increased pace and rhythm of the game. Research by Rogulj et al. (2007) and Pavlović et al. (2013) conclude that four motor abilities are of critical importance for handball players: strength, speed, coordination, and precision. Ingebrigtsen et al. (2013) characterize the dynamics of handball through movements on the field, alternating between high-intensity sprints and continuous aerobic activity of somewhat lower intensity. This further emphasizes that, alongside strength, speed, coordination, and precision, endurance is a primary motor skill crucial for success in handball. Similar findings were reached by Vuleta et al. (2003) and Marković et al. (2003), who proposed a hypothetical model of basic motor abilities responsible for handball performance. According to this model, strength accounts for 28%, endurance 23%, speed 20%, precision 14%, coordination 10%, and flexibility 5%. Strength in handball serves various functions: accelerating, sprinting, throwing the ball when shooting, jumping, goalkeeper actions, duels, and defensive movements. A more precise analysis of the hypothetical model by Marković et al. (2003) revealed that explosive strength manifests through jumping and ball-throwing, crucial in shooting, while speed and agility, evident in quick reactions and movements, are highly ranked for success. On average, a handball player performs 190 rhythm changes, 16+ jumps, and 279 direction changes during a match, underscoring the importance of explosive strength (Chelly et al., 2011; García-Sánchez et al., 2023). In handball, speed is displayed in complex ways. For example, sprinting during a counterattack depends on the start (reaction time), foot contact during running (speed of individual movements), and step frequency in sprinting. Additionally, besides strength and speed, a player must possess agility for sudden changes in direction, which is vital in handball (Hojka et al., 2016). Flexibility, often overlooked in training, is essential, especially for goalkeepers. It also benefits outfield players, particularly for shooting and passing, by improving mobility in the spine, shoulder, and hip joints. Given the dynamic nature of handball, balance is critical for evading opponents. Since the primary goal in handball is scoring more goals than the opponent, a high level of precision is necessary. High motor abilities enable handball players to execute movements faster, more efficiently, and more effectively, essential for performance in this sport. General and specific motor abilities are developed and refined during the preparatory period, primarily through physical training (Wagner et al., 2017).

Relation Between Physical Preparation and Other Components of Sports Form

During competitions, physical, technical, tactical, psychological, and other aspects of handball readiness form a complex, integrated whole, never operating in isolation. Each aspect depends significantly on the others, collectively contributing to achieving top sports results. Functional and motor abilities are prerequisites for any movement, including activities in handball. The duration, intensity, repetitions, and variety of movements in handball determine the importance of physical preparation (Karimov & Sh, 2020). Executing technical elements in handball requires a certain level of physical conditioning. For example, strong leg muscles and good torso mobility are necessary for successful feints. Technical preparation allows athletes to utilize their biological potential effectively. Proper execution of jumps, throws, or other techniques optimizes the use of strength, speed, and endurance capacities. The level of technical proficiency impacts the efficient use of motor and functional abilities, especially in the later stages of a match when fatigue sets in. Also, the success of tactical action depends to a large extent on physical preparation, but also on the level of execution of technical elements. Successful tactical solving of tasks is possible only if there is an optimal level of physical preparation and technical knowledge. The tactics of the handball game, both in the attack phase and in the defense phase, require a large investment of energy and strength from the handball player in the given time.

Physical, technical, tactical and psychological preparation are defined, measured and developed individually, but in competitive conditions these four components of preparation appear together. Success in a handball competition is not decided by just one component of preparation, but by their mutual interaction, which gives a higher quality. Therefore, handball coaches must respect the relationship between physical, technical, tactical and psychological preparation and therefore focus on their integral development during the training process. This type of development is easiest and best implemented through a program of situational physical preparation.

Types of Physical Preparation for Handball Players

As in other sports, handball also has various types of physical preparation, including: General physical preparation, Basic physical preparation, Specific physical preparation, and Situational physical preparation (Karimov & Sh, 2020; Željaskov, 2004).

General or multilateral physical preparation for handball players involves the development of a wide range of abilities, which may not be directly manifested in handball but serve as a foundation for the later development of specific and situational qualities. General physical preparation focuses on improving the abilities of all body regions, enhancing functional and motor capacities (Karimov & Sh, 2020; Željaskov, 2004). This type of preparation primarily improves aerobic capacity, key motor skills

relevant to handball, as well as body composition.

Basic physical preparation for handball players refers to the development of the most important motor abilities necessary for success in handball (Karimov & Sh, 2020; Željaskov, 2004). In addition to improving the primary motor abilities essential for handball, other motor skills are also maintained.

Specific physical preparation for handball players is directly related to performing various technical elements under physical conditions (Karimov & Sh, 2020; Željaskov, 2004). This type of physical preparation integrates physical and technical training. Within specific physical preparation, the focus narrows down to the most crucial attributes that need to be improved.

Situational physical preparation for handball players integrates tactical and physical training. The difference between situational and specific physical preparation lies in the conditions of cooperation and opposition (Karimov & Sh, 2020; Željaskov, 2004). This type of preparation typically occurs in real competitive situations, integrating all aspects of handball player preparation.

With the evolution of handball, the need arose to redesign the structure of physical preparation. The reason is simple: the purpose of physical preparation is to meet the demands of the sport. The idea behind the different types of physical preparation is essentially to integrate all areas where physical preparation plays a role.

Physical Preparation in High-Altitude Conditions – Hypoxia

When considering the effects of altitude on the human body, it is important to keep in mind several concepts related to altitude, weather conditions, and the duration of exposure. These concepts are closely tied to the physical characteristics of the environment and the acute and chronic physiological reactions of the body. In the field of sports physiology, and altitude training, altitudes above 2000 meters are typically considered, as it is at this elevation where atmospheric pressure decreases, leading to a proportional reduction in the partial pressure of oxygen in the air, triggering the desired physiological responses and changes (Burtscher et al., 2018). The physical characteristics of the atmosphere serve as stimuli for activating physiological adaptation mechanisms, which are the goal of altitude training (Saltin, 1996). Since air has its own weight, it exerts pressure on every point of the Earth's surface depending on the height of the air column above that point. In physiological terms, the partial pressure of oxygen-on which oxygen pressure in the lung alveoli, oxygen diffusion into the blood, blood oxygen saturation, and ultimately tissue oxygen demand (especially in the brain and muscles) depend-directly affects physical performance (Saltin, 1996). For every 1000 meters of altitude, the temperature drops by about 6.5°C. Additionally, temperatures fluctuate depending on the time of day and season (Saunders et al., 2018). In terms of physiological mechanisms, the lower temperatures at higher altitudes require more thorough warm-ups before sports activities. As altitude increases, the number of air molecules per unit of volume decreases, which reduces air density. This results in reduced respiratory resistance and therefore less work required by the respiratory muscles to ventilate a given amount of air (McLean et al., 2013). Reduced air density also decreases resistance during body movement, allowing for greater speeds, especially during short, intense efforts like sprints and jumps. At higher altitudes, as temperature drops further, the partial pressure of water vapor also significantly decreases. When inhaling cold, dry air, the respiratory mucosa reacts by secreting more mucus to ensure alveolar air moisture, which can cause the mucosa to dry out and lead to irritation, such as coughing (Ramchandani et al., 2024). At higher altitudes, sunlight passes through a thinner layer of the atmosphere, reducing its absorption, especially of ultraviolet rays (Saunders et al., 2018). If the mountain is covered in snow, radiation reflects, further intensifying the training under hypoxic conditions. This type of training is most often conducted to improve aerobic endurance (Saunders et al., 2018). The basis for generating the scientific hypothesis that high-altitude training is more effective for enhancing endurance compared to lowland training lies in the fact that at high altitudes, arterial oxygen saturation decreases due to a drop in the partial pressure of oxygen. The body adapts to this decrease by increasing hemoglobin concentration, capillarization, and the number of mitochondria. Additionally, a specific feature of altitude training is the relative increase in red blood cells, triggered by increased secretion of the hormone erythropoietin (EPO).

Physical Preparation as a Key Factor in Injury Prevention

Since physical preparation primarily affects the development, maintenance, and enhancement of psycho-physical abilities, delaying fatigue, and accelerating recovery, it also aims to reduce the number and severity of injuries in handball players. Recently, the impact of physical preparation on reducing the frequency and severity of injuries has gained more attention (Rasuli et al., 2012). Physical preparation helps prevent injuries through multilateral-basic and specific-situational forms of training (Ahsan & Ali, 2021). The higher the level of physical preparedness of handball players, the lower the likelihood of injuries (Vila et al., 2022). Key components of injury prevention in physical preparation include strengthening muscle and connective tissues, developing flexibility, and proprioceptive training (Laver et al., 2018). The improvement of muscle and connective tissue is a fundamental aspect of strength and speed training. While enhancing muscle tissue at both the structural and functional levels is a core part of physical preparation, it can certainly be viewed from an injury-prevention perspective as well. Moreover, a particularly important segment of preventive training focuses on improving the connective tissue of handball players. Ligaments, cartilage, tendons, and muscle fascia are critical points of the handball player's locomotor system, which lies between the muscles and bones. Joint stability and flexibility largely depend on the quality of connective tissue. Injury prevention is an unavoidable topic today. Reducing the number and severity of sports injuries is one of the primary goals, not only during physical preparation but throughout an athlete's career, whether they are handball players or athletes in other sports (Raya-González et al., 2020).

Conclusion

Handball, as a high-intensity and dynamic team sport with a ball, demands exceptional performance from players to achieve top results. In order to reach high-level success, players must be physically, tactically, technically, and psychologically prepared. All four components are interdependent, but physical preparation stands out as one of the most crucial factors for success. Physical preparation is a complex process that involves applying various programs and methods to develop, maintain, and improve morphological characteristics, motor skills, and functional abilities.

This scientific paper contributes to the existing knowledge on the physical preparation of handball players, its components, types, the impact of altitude on physiological changes in handball players, as well as its positive influence on reducing the severity and frequency of player injuries. Future research directions may focus on developing different programs within physical training and creating injury prevention programs.

Authors contributions

In this research, Ina Marković Obrenović proposed a topic for the elaboration of a scientific paper and wrote the first draft of the paper. Slavka Durlevic participated in writing the complete scientific paper. Marija Durlevic contributed to the technical editing of the entire paper. All authors approved the final submission for publication.

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