Revisión

Body composition characteristics of handball players: systematic review

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Summary

Background: Handball play is complex and multifactorial, characterized by high-intensity explosive movements. Due to the high physical demands of handball, players require highly developed anthropometric and physical qualities. The evaluation of body composition (BC) is a key issue, especially the body content of fat and skeletal muscle.

Purpose: The aim of this systematic review is to determine the anthropometric and BC characteristics of handball players according to different characteristics such as age categories, playing position and gender.

Search strategy: The search for articles for this study was carried out in three different databases, PubMed, SPORTDiscus (EBSCO) and Web of Science.

Study selection: The inclusion criteria were: Studies recruiting male and female handball players at any age category and competitive level as participants, original investigations that present and compare anthropometric characteristics between handball players of different gender, competitive levels, playing positions, and/or age categories, and articles that present anthropometric characteristics as body weight, height, % fat mass, % muscle mass or % lean body mass, skinfolds and somatotype.

Results: 486 articles were identified after the searching process, 38 articles were selected and assessed for eligibility. This review presents the anthropometric characteristic of handball players, males and females of all ages. Height, body mass, BMI, fat mass, muscle mass, lean body mass and sum of skinfolds are presented and differentiate between gender, age and playing position.

Conclusions: This review provides a framework to help professionals effectively prepare players for the physiological demands of handball. Although the results are not very homogeneous, since elite athletes have better characteristics, the goal of every handball player would be to present similar results and by coaches evaluate players accordingly. But due to the limitations detected in the reviewed studies it is suggested that future research should adopt a longitudinal and multidimensional perspective.

Key words: Body composition. Handball. Anthropometry. DEXA. Bioimpedance.

Características de la composición corporal en jugadores de balonmano: revisión sistemática

Resumen

Antecedentes: El balonmano es un deporte complejo y multifactorial caracterizado por movimientos explosivos de alta intensidad. Debido a las altas exigencias físicas que se presentan, los jugadores requieren cualidades antropométricas y físicas específicas. Evaluar la composición corporal (CC) es esencial, especialmente el contenido de grasa y de masa muscular.

Objetivo: El objetivo de esta revisión sistemática es determinar las características antropométricas y CC de los jugadores de balonmano según edad, posición de juego y sexo.

Estrategia de búsqueda: La búsqueda se realizó en tres bases de datos diferentes, PubMed, SPORTDiscus (EBSCO) y Web of Science.

Selección de estudios: Los criterios de inclusión fueron: estudios que reclutan a jugadores y jugadoras de balonmano de cualquier categoría de edad y nivel competitivo como participantes, investigaciones originales que presentan y comparan antropométricas y CC de jugadores y jugadoras de balonmano de diferentes géneros, niveles competitivos y categórias de edad, y artículos que presentan características antropométricas como el peso corporal, la altura, el porcentaje de masa grasa, el porcentaje de masa muscular, los pliegues cutáneos e somatotipo.

Resultados: La búsqueda inicial fue de 488 artículos, tras la selección, eliminación de duplicados, y evaluación de los criterios de inclusión y exclusión, se evaluaron 38. Se presentan características antropométricas de los jugadores y jugadoras de balonmano de todas las edades: altura, masa corporal, IMC, masa grasa, masa muscular, masa corporal magra y suma de pliegues cutáneos según sexo, edad y posición de juego.

Conclusiones: La presente revisión proporciona un marco para ayudar a los profesionales a preparar de forma eficaz a sus jugadores. Aunque los resultados no son muy homogéneos, el objetivo de todo jugador de balonmano sería presentar resultados similares a los de élite. Debido a las limitaciones detectadas en los estudios revisados, se sugiere que las investigaciones futuras adopten una perspectiva longitudinal y multidimensional.

Palabras clave: Composición corporal. Balonmano. Antropometría. DEXA. Bioimpedancia.

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Introduction

Handball is an Olympic sports ball game that is characterized by a defensive action and a fast-paced offensive action during the game with the aim of scoring goals. Handball made its Olympic debut at the XI Olympic games in Berlin, 1936, but this was a grass version with 11 players. The sport was then not included on the program, and it reappeared in its indoor version with seven players at the XX Olympic games in Munich, 1972. Nowadays all clubs and federations are listed by the International Handball Federation (IHF), which regulates the rules of handball at a competitive level, and periodically holds competitions and events.

In handball there are five well-differentiated playing positions: 1) goalkeeper: in control of stopping the ball; he may not leave the six-meter area with the ball in his hand, but may touch it outside the area if it is passed by a teammate; 2) central: the axis of the team and the extension of the coach on the field; he is the one who commands in attack and defense, marks the plays, places the players and indicates where the static attacks should start from; 3) wing: are those who break the closed defenses from the goal area and assist, on most occasions, to the ends; 4) pivot: is responsible for getting into the defensive wall and open holes where possible, and 5) back: are those who begin the moves of static attack, moving the defense and throwing to goal, if there is space.

To score goals, offensive players (6 players and a goalkeeper) try to establish an optimal position for the throwing player through fast moves over short distances by making powerful changes in direction (with and without the ball), individual action against defensive players and passing the ball using different offensive tactics.

Describing team handball play, especially to determine the factors influencing performance, is difficult because team handball play is complex and multifactorial, characterized by high-intensity explosive movements. Handball team must coordinate well their movements to run, jump, push, change direction and specific movements of team handball to pass, catch, throw, control and block. The intensities during play always change between standing and walking, jogging and running moderately, running and advancing fast, sideways and backwards, therefore a high specific level of endurance is important to maintain a high level of play throughout the game, in concrete two parts of 30 minutes each.

However, considering the intermittent nature of handball, it has been stated that performance is associated with the ability to produce high power in short time periods (anaerobic power) and the ability to recover between such high-intensity activities (aerobic power). For that, due to the high physical demands of handball, players require highly developed anthropometric and physical qualities (linear speed, change-of-direction speed, aerobic capacity, muscular strength and power) to succeed.

The profiling of players can be a valuable tool when identifying talent, determining strengths and weaknesses, assigning playing positions, and optimizing the design of strength and conditioning training programs. Thus, the evaluation of body composition (BC) is a key issue in sports science as well as sports practice with special reference to the body content of fat and skeletal muscle. Previous research has indicated that certain physical characteristics are related to high level handball performance. A high body mass and stature is commonplace among players. Granados et al. showed that the higher values of fat free mass resulted in a higher performance, especially because of the increase in the muscular power and strength. There are findings that also indicate relatively heterogeneous physical characteristics across all player positions in the team.

Examination anthropometric profiles could have great importance for optimal construction of training regimens to improve handball performance. Therefore, the collation of existing research to provide a clear understanding of the importance and development of physical qualities for handball players would be beneficial for research and practice. For this reason, the purpose of this review was to present the anthropometric qualities of handball players by gender, and critically appraise the literature surrounding body composition using different methods, drawing information based on population characteristics (age, playing positions or performance level).

Methods

Search strategy

The present systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines. Database searches were performed independently by three authors (AM, MM and MH). The reviewed articles were selected from an extensive search process including major computerized databases: PubMed (all database), SPORTDiscus (EBSCO) and Web of Science (all database), since their inception until now. Search strategy was developed to identify all relevant studies assessing the BC on handball athletes and it was: “handball” AND (“body composition” or “DXA” or “anthropometry” or “Impedance”). The review was registered in the prospective international register of systematic reviews, PROSPERO.

Inclusion and Exclusion Criteria

The inclusion criteria was according to the Population/Intervention/Comparison/Outcome(s) (PICOs) criteria: a) Studies recruiting male and female handball players at any age category and competitive level as participants (population), b) original investigations that presents anthropometric characteristics between handball players of different gender, competitive levels, playing positions, and/or age categories (intervention), c) articles comparing anthropometric characteristics between handball players of different gender, competitive levels, playing positions, and/or age categories (comparison) and d) articles that present anthropometric characteristics as body weight, height, % fat mass, % muscle mass, skinfolds and somatotype (outcomes).

The exclusion criteria included: a) comments, opinions, and commentaries, interviews, letters to the editor, editorialis, posters, conference abstracts, book chapters, and books; b) studies not present anthropometric characteristics of handball players of different gender, competitive levels, playing positions and/or age categories; c) studies which present players with diseases or injuries and d) lacking quanti-
Data collection and analysis

A critical review of the papers was done to confirm the validity of the studies and to verify that they answered the research question, that design and sample were correct and if there were variables, or characteristics that could influence the interpretations and conclusions. The purpose was to collect the most relevant information from each included article. Three reviewers (AM, MM and MH) independently extracted data from included studies. The following variables were abstracted into a preformatted spreadsheet: authors, year of publication, characteristics of study participants (n, age, years, category), anthropometric variables (height, body mass, BMI, % fat mass, % lean body mass) and results.

Risk of bias across studies

To assess the methodological quality, the main tools were used according to the type of study44. Articles included in this review are cross-sectional studies, the scale used was ARHQ Methodology Checklist. Data extraction, quality assessment and risk of bias were performed independently and in duplicate by two investigators.

Results

The search strategies yielded a preliminary pool of 486 possible papers. The full text of 65 articles were retrieved and assessed for eligibility according to the inclusion criteria. After a careful review of their full texts 27 articles were excluded and the remaining 38 articles were eligible for inclusion in the review (Figure 1). Particularly, 38 papers examined anthropometric profile of handball players according to their age categories45–50,7,12,16,27,30–32,37,41,43–45,51, playing positions15,16,20–22,24,28,31,32,37,38,41,43–45,51, gender13,18 or competitive levels12,13,17,19,22,23,27,29,31–33,36–38. A number of the studies described the players body compartments using different formulas, however six studies used bioimpedance with TANITA7,12,17–19,26 and two used DXA20,21. The results of Risk of bias have been showed at Figure 2.

Table 1 shows an overview of articles included in the qualitative synthesis, presents the sample size, nationality, playing position (if analyzed), category, genus of the sample, age, height (cm), weight (kg), BMI, sum of skin folds (mm) (if there has been measurement of skin folds that allow it), fat mass (%), muscle mass (%), bone mass (%) and free fat mass (kg) of male players who were measured BC with anthropometry. Table 2 presents the same data described above but for female players who were measured BC by bioimpedance or only with DXA. Table 3 presents the same data described above but for female players who were measured BC with anthropometry and DXA or bioimpedance. Table 4 presents the same data described above but of female players who were measured BC with anthropometry and DXA or bioimpedance or only with DXA or bioimpedance.

Nationality

Most of the studies performed on handball players were made in Spanish12,17,19,31,44,47,49, in both females and males. In the case of men, the second most repeated nationality among the studies is Serbian45,27,30,34,46,49, followed by Portuguese25,26,27. Four of the studies were performed on players of different nationalities18,32,38,51, but all of them Caucasian race. Only two studies did not specify the nationality of the players15,46.

Elite team

Data on the anthropometric characteristics of elite handball players provides specific information that can help lead players to the most appropriate game46. In addition, coaches and researchers may be able to use this data in the talent selection process. Analyzing the type of sample chosen by the different studies, a total of 32 of the studies present elite/professional players in their sample, namely 21 studies of male players and 11 of female players.

Body composition

The basic anthropometric variables analyzed in female players under 18 years of age present an average height (cm) of 167.53 ± 5.63, a weight (kg) of 60.56 ± 7.90 and a BMI of 21.58. For the general variables in female players over 18 years of age, they present an average height (cm) of 170.59 ± 6.33, a weight (kg) of 66.89 ± 8.78 and BMI of 23.18. Female goalkeepers had an average height (cm) of 173.77±5.06 and a weight of 71.06±8.70 (kg). The wings show an average height (cm) of...
<table>
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<th>Reference, Year</th>
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<th>Nationality</th>
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<th>Body mass (kg)</th>
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<th>Sum. of Skinfold (mm)</th>
<th>Body fat (%)</th>
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<th>Bone mass (%)</th>
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<td>Men (49/1)</td>
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<td>186.5±0.64</td>
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<td>Jakovljevic, 2018</td>
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<td>Hopper, 2017</td>
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<td>18.3</td>
<td>184±0.3</td>
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</table>

BMI: Body Mass Index; 6 Sum of 6 skin folds (Triceps, Subscapular, Abdominal, Supraspinatus, Front thigh and Medial calf); 7 Sum of 7 skin folds (Triceps, Subscapular, Abdominal, Breastplate, Axillary medial, Thigh and Supraspinatus); 8 Sum of 5 skin folds (Biceps, Triceps, Subscapular, Supraspinatus and Anterior thigh); 9 Sum of 8 skin folds (Triceps, Chest, Mid-Axillary, Subscapular, Supraspinous, Abdominal, Anterior thigh, and calf); 10 Sum of 2 skin folds (Triceps, Mid-Axillary, Subscapular, and Supraspinous); 11 Sum of 3 skin folds (Triceps, Mid-Axillary, and Supraspinous); 12 Sum of 4 skin folds (Triceps, Chest, Mid-Axillary, Subscapular, and Supraspinous).
Figure 2. Analysis methodological quality studies present review. Checklist for cross-sectional studies.

Table 3. Body composition characteristics of handball female players measured with anthropometry.

<table>
<thead>
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<th>Reference, Year</th>
<th>Mean (n)</th>
<th>Nationality</th>
<th>Position (n)</th>
<th>Category (n)</th>
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<th>Height (cm)</th>
<th>Body mass (kg)</th>
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<th>Sum. of Skinfolds (mm)</th>
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<th>Lean Body Mass (Kg)</th>
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<td>Croatia</td>
<td>Goalkeepers /6/</td>
<td>Goalkeeper /6/</td>
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<td>18.2 ±1.5</td>
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<td>Léemie et al., 2010*</td>
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<td>Croatian First league /3/</td>
<td>Wing /12/</td>
<td>Back court /12/</td>
<td>Female</td>
<td>24.4 ± 1.4</td>
<td>174.76 ± 6.75</td>
<td>69.46 ± 6.57</td>
<td>22.7 ± 1.09</td>
<td>-</td>
<td>-</td>
<td>19.9 ± 4.5</td>
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<tr>
<td>Vla et al., 2012*</td>
<td>130</td>
<td>Spanish</td>
<td>Elite /13/</td>
<td>Goalkeeper /10/</td>
<td>Female</td>
<td>25.74 ± 6.84</td>
<td>171.36 ± 7.42</td>
<td>67.55 ± 8.06</td>
<td>22.97 ± 1.86</td>
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<td>Granados et al., 2013*</td>
<td>30</td>
<td>Spanish</td>
<td>Elite team in 2003 /16/</td>
<td>International team in 2009 /14/</td>
<td>Female</td>
<td>23.56 ± 1.6</td>
<td>175.4</td>
<td>69.3</td>
<td>22.51</td>
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<td>-</td>
<td>19.6</td>
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<tr>
<td>Bon et al., 2015*</td>
<td>28</td>
<td>Slovenian</td>
<td>Junior /16/</td>
<td>Goalkeeper /3/</td>
<td>Female</td>
<td>22.52 ± 6.7</td>
<td>175.43 ± 6.68</td>
<td>69.85 ± 8.81</td>
<td>22.81</td>
<td>-</td>
<td>-</td>
<td>20.03 ± 4.44</td>
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<tr>
<td>Mon, 2015*</td>
<td>120</td>
<td>English</td>
<td>Non-elite/7</td>
<td>European league /8/</td>
<td>Female</td>
<td>15.7 ± 1.1</td>
<td>165.4 ± 6.58</td>
<td>61.2 ± 8.7</td>
<td>22.31</td>
<td>94.82 ± 21.59</td>
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<td>-</td>
<td>15.82 ± 2.04</td>
<td>49.5, 5.39</td>
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<tr>
<td>A.B. Rumes-Angulo, 2018*</td>
<td>19</td>
<td>Spanish</td>
<td>Senior /19/</td>
<td>Honor elite /19/</td>
<td>Female</td>
<td>22.8 ± 5.24</td>
<td>168.3 ± 5.9</td>
<td>63.64 ± 6.79</td>
<td>22.4 ± 1.37</td>
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<td>-</td>
<td>16.66 ± 2.66</td>
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<tr>
<td>Bojic, 2018*</td>
<td>48</td>
<td>Croatian</td>
<td>Pivot /23/</td>
<td>Back /23/</td>
<td>Female</td>
<td>13.88 ± 1.46</td>
<td>165.5 ± 6.49</td>
<td>56.95 ± 7.43</td>
<td>22.35 ± 1.9</td>
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<td>-</td>
<td>17.44 ± 0.2</td>
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<tr>
<td>C. Ferug, 2018*</td>
<td>28</td>
<td>Spanish</td>
<td>Top elite /1/</td>
<td>Elite /1/</td>
<td>Female</td>
<td>26.4 ± 4.5</td>
<td>174.37 ± 7.7</td>
<td>70.6 ± 9.7</td>
<td>22.1 ± 1.5</td>
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<td>-</td>
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</tr>
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</table>

BMI Body Mass Index; * Sum of 6 skin folds (Triceps, Subscapular, Abdominal, Supraspinous, Front thigh and Medial Calf); † Sum of 7 skin folds (Triceps, Subscapular, Abdominal, Breastplate, Axillary medial, Thigh, and Suprailiac); ‡ Sum of 5 skin folds (Biceps, Triceps, Subscapular, Suprailiac, and Anterior Thigh); § Sum of 8 skin folds (Triceps, Chest, Mid-Axillary, Subscapular, Suprailiac, Abdominal, Anterior thigh, and Calf).
Table 4. Body composition characteristics of handball female players measured with anthropometry and DXA or bioimpedance or only with DXA or bioimpedance.

<table>
<thead>
<tr>
<th>Reference, Year</th>
<th>Mean (n)</th>
<th>Nationality</th>
<th>Position (n)</th>
<th>Category (n)</th>
<th>Gender</th>
<th>Age (years)</th>
<th>Height (cm)</th>
<th>Body mass (kg)</th>
<th>BMI (m²/kg)</th>
<th>Sum. of Skinfold (mm)</th>
<th>Body fat (%)</th>
<th>Muscle mass (%)</th>
<th>Bone mass (%)</th>
<th>Lean Body Mass (Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milanesi et al., 2011</td>
<td>43</td>
<td>Italian</td>
<td>All Elite level</td>
<td>All sub-elite</td>
<td>Female</td>
<td>26.4±5.77</td>
<td>109.2±6.04</td>
<td>67.3±7.91</td>
<td>23.4±5.33</td>
<td>112.9±26.06</td>
<td>21.3±5.33</td>
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<td>-</td>
<td>47.98±4.66</td>
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<td></td>
<td></td>
<td></td>
<td>Elite level</td>
<td>Sub-elite level</td>
<td></td>
<td>17.3±4.25</td>
<td>166.5±11.64</td>
<td>64.4±10.47</td>
<td>23.3±4.01</td>
<td>133.3±22.8</td>
<td>20.4±3.41</td>
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<td>42.97±5.32</td>
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<td></td>
<td></td>
<td>24.6±6.31</td>
<td>169.3±7.41</td>
<td>74.9±11.16</td>
<td>25.9±2.29</td>
<td>109.0±22.7</td>
<td>29.7±4.5</td>
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<td>48.89±5.38</td>
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<td>21.8±4.49</td>
<td>165.2±6.04</td>
<td>61.7±6.6</td>
<td>22.3±2.16</td>
<td>113.5±22.5</td>
<td>24.4±5.0</td>
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<td>43.25±4.72</td>
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<td>22.7±4.07</td>
<td>171.5±8.24</td>
<td>67.2±7.35</td>
<td>23.1±1.78</td>
<td>114.0±24.62</td>
<td>25.1±5.56</td>
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<td>-</td>
<td>64.99±7.4</td>
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<td></td>
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<td>23.7±6.24</td>
<td>167.4±3.22</td>
<td>66.6±4.95</td>
<td>23.9±1.44</td>
<td>114.2±32.2</td>
<td>22.7±6.62</td>
<td>-</td>
<td>-</td>
<td>65.99±4.99</td>
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<tr>
<td>Milanesi et al., 2012</td>
<td>43</td>
<td>Italian</td>
<td>All Elite level</td>
<td>Italian national championships</td>
<td>Female</td>
<td>22.8±6.49</td>
<td>167.9±5.84</td>
<td>65.6±8.89</td>
<td>23.2±2.49</td>
<td>102.5±22.15</td>
<td>25.3±6.2</td>
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<td>43.02±5.84</td>
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<td></td>
<td></td>
<td></td>
<td>Sub-elite level</td>
<td>Italian national championships</td>
<td></td>
<td>22.8±6.49</td>
<td>167.9±5.84</td>
<td>65.2±9.58</td>
<td>23.0±2.32</td>
<td>105.4±26.2</td>
<td>24.9±5.59</td>
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<td></td>
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<td>169.2±6.04</td>
<td>67.0±7.91</td>
<td>24.0±5.33</td>
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<td>-</td>
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<tr>
<td></td>
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<td></td>
<td></td>
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<td>17.3±2.25</td>
<td>166.5±1.1</td>
<td>64.4±10.47</td>
<td>23.7±4.01</td>
<td>-</td>
<td>-</td>
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<td>-</td>
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</tr>
<tr>
<td>Postelli, 2015</td>
<td>24</td>
<td>Italian</td>
<td>All Elite level</td>
<td>Female</td>
<td>21.2±4.3</td>
<td>186.2±7.0</td>
<td>62.2±12.0</td>
<td>22.3±3.4</td>
<td>-</td>
<td>-</td>
<td>26.6±5.8</td>
<td>-</td>
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<td></td>
</tr>
</tbody>
</table>

BMI: Body Mass Index; a Sum of 6 skin folds (Triceps, Subscapular, Abdominal, Supraspinal, Front thigh and Medial Calf); b Sum of 7 skin folds (Triceps, Subscapular, Abdominal, Breastplate, Axillary medial, Thigh and Suprailiac); c Sum of 5 skin folds (Biceps, Triceps, Subscapular, Suprailiac and Anterior Thigh); d Sum of 8 skin folds (Triceps, Chest, Med-Axillary, Subscapular, Suprailiac, Abdominal, Anterior thigh, and Calf).

167.18 ± 4.87, and an average weight (kg) of 61.99±5.61. The back shows an average height (cm) of 174.97±5.94, and an average weight (kg) of 70.18±7.48 and fat percentage 13.94±4.36. As for male players, used the bioimpedance method to measure the BC of athletes. In the case of the female handball players the average height (cm) was 172.38±5.99; weight (kg) 69.69±6.7 and fat percentage 22.74±5.7. In the case of the male players the average height (cm) was 186.68±4.07; weight (kg) 89.93±7.89 and fat percentage 13.94±4.36.

Regarding the sum of skin folds, it was observed that most of the studies that calculated this parameter calculated the sum of 6 skin folds, (triceps, subscapular, supraspinal, abdominal, front thigh and medial calf). Specifically, the average sum of 6 skin folds in elite female players was 93.81±22.36 and non-elite 94.8±21.59. As for elite male players the average of this value was 68.37 and non-elite 87.35.

Discussion

The aim of this review was to present the anthropometric qualities of handball players from different nationalities, drawing comparisons between age categories, and playing positions. Generally, the results show that in terms of BC, female handball players have a proportion of fat mass of around 20%, being somewhat lower in elite players. As for male players the proportion of fat mass is considerable, around 14%, being higher in non-elite players.

Evaluating and monitoring BC is a key issue in sports practice due to its link to performance and injury risk prevention. In fact, body mass...
can influence an athlete’s speed, endurance, and power, whereas BC can affect an athlete’s strength and agility. A greater muscle mass is often an advantageous characteristic in sports, as in team handball, where speed is so much of the essence.

In indoor team sports, the BC depend on the playing position and the sport discipline, being the BC results of the specific game actions of each playing position. It seems to be that specific BC and morphometric parameters could be considered as an important factor contributing to the athlete’s respective performance in addition to the technique and sport experience. Morphological characteristics can influence the ability of players to respond better to the requirements of the certain position in the game.

**Body composition in females**

Women’s handball is a sport that has experienced an accelerated development in the last decade, although it is true that studies of anthropometric characteristics are scarce. The correlation between some morphological characteristics of the body of handball players and their playing position is evident. This is attributed to the different technical and tactical tasks that players occupying different playing positions must execute.

As far as the playing position is concerned (considering 4 positions: back, wing, pivot and goalkeeper), the wings are the ones that show the most pronounced differences in the morphological parameters of the body, in comparison with other groups of players. They are significantly smaller and have significantly lower body mass. The data observed in this review coincide with the above; the anthropometric values of the wings show the lowest weight and height compared to the other positions: height (cm) 167.180 and weight (kg) 61.98. This is due to the fact that the wings cover the largest field area and carry out most of the counterattacks, therefore they need lighter and faster bodies with the capacity for rapid changes of movement and agility.

Female back players are characterized by being tall, Bon et al., 2015 value that has also been reflected in the research of this review, as they have the highest value of height 174.968 cm. Female goalkeepers are the heaviest of all players according to their position in the game. Due to the function of saving the goal, they have a more static role in the game, with fast and short acyclic activities. The data observed for the female goalkeepers in this review corroborate this, as they have the heaviest weight compared to the rest of the playing positions, 71.064 kg.

As for pivots, during an attack, they must catch the passes and are hindered by high defense players, therefore, high body height values can give them an advantage over defense players. The robustness of the body is also particularly important as they must carry out different actions in direct physical contact with the guards of the opposing team. However, looking at the results of this review, there is some controversy as the values do not stand out from any other position. The position specifications of the rear court players propose tall and strong players who must make different tactical and play assignments to the opponent’s defense zones.

As for the changes that occur in BC throughout the season, Milanese, C., showed that the anthropometry of handball players does not change significantly during the competitive season, except for some redistribution of fat; however, BMC increases in the extremities and lean mass in the upper extremities after the season. These results are independent from the competitive level (elite/subelite) and playing position.

Comparing between the different competitive levels (elite; not elite), according to Milanese 2011, the results show that elite players have lower fat percentage, coinciding with what was observed in this review (Elite = 19.493%; No elite = 19.600%). In addition, it is also observed in relation to the sum of six folds of fat, elite players have lower values (93.81 mm) and non-elite players have higher values (94.8 mm). The current results suggest that the most experienced, powerful and aerobically conditioned players have an advantage in women’s handball at the international level. Therefore a greater amount and intensity of training is needed to achieve a physical and corporal composition similar to that of the most successful teams.

**Body composition in males**

In general, the most successful teams are higher and have less body fat than the least successful (Hasan et al., 2007). Gorostiaga et al. found that elite team-handball players were heavier and had a higher fat-free mass than the amateur team-handball players and concluded that this seems to be advantageous in team handball. As regards the upper limb lengths (i.e., radiale-dactylion length), it seems that these measures are important for a better handball shot execution (the larger the radius of action the greater the power of the technical gesture) and for some defensive actions (e.g., blocking). Massuca and Fragoso, 2011 also concluded that the best athletes are taller, heavier, had higher fat-free mass, lower fat mass, higher socioeconomic status and higher weekly energy expenditure. Additionally, they have a higher value in arm span and muscle mass.

The differences are manifested considerably in the circular measures of the body volume and in dimensions of the skeleton. Back court players and goalkeepers are superior in the mentioned measures. With the findings of this review, wings and pivots have somewhat lower values of longitudinal dimensionality wings and pivots under 18, height 173.8 cm and 176.63 cm and wings and pivots over 18 height 184.6 and 187.04. Height of goalkeepers and backs are bigger in all cases. In addition, it would seem that, handball goalkeepers show an advanced age of maturity.

However, there is a bit of controversy in some positions, as in another study, they determine that the goalkeepers, central and wing generally stand out for their high stature, with the central ones being more athletic (greater muscle mass) and the wing ones more corpulent, with a powerful shot. The back are fast, agile, lightweight players with great jumping capacity, so they often have less height, less weight and lower fat percentage. Pivots are robust players (higher weight, fat mass and volume) who function well in the body to body. These characteristics must be evaluated prior to the incorporation of the players to the team, since morphological optimization is fundamental to achieve the optimal development of the sports performance of each player.

Ramos-Sanchez F, 2016 analyzed the first team of the Valladolid squad. According to their results, it seems that pivots are the heaviest players (with the highest percentage of fat mass); the wings, together with the pivots, the highest. No BMI differences were observed in the
groups. The greatest differences between the pivots and wings were established in body height, leg length, arm length, ankle breadth, body weight and calves circumference\textsuperscript{14,48}.  

In terms of age, although comparison has been difficult, it appears that from 10 to 14 years, the percentage of fat mass decreases, and there is a change in the distribution of subcutaneous fat\textsuperscript{11}. In addition, in line with the results of this review, it has been shown that height and body mass increase with age. It can be seen, there is a bit of controversy in determining, depending on the playing position, which are the tallest and heaviest. According to our results, the highest are the wings and pivots, while the heaviest are the goalkeepers and backs.  

In terms of nationalities there are few studies that compare the same competitive level of teams from different countries, however Ilic, 2015\textsuperscript{59}, establishes comparison between some anthropometric results from nationalities such as Spanish, Serbian, English, kina, Japanese, Korean, Kuwait, Saudi Arabia, French, Italian, Croatian and Tunisian. According to this study, successful teams in the 1994 Asian games were higher and had less body fat than less successful teams. Compared with similar research, Serbian handball players had higher values of body height, body weight, and body fat than British, French, Asian, or Spanish division III handball players. The percentage of muscle mass was higher than that found in Saudi and Japanese handball athletes, but considerably lower than that found in Chinese, Korean, and Kuwaiti handball players. Despite the higher values of muscle mass, Kuwaiti players did not perform well during the Asian match period.  

On the other hand Milanese, 2011\textsuperscript{50} made the comparison in Italy between competitive levels (Elite vs. Sub-elite) as well as with players from other championships. The study suggested that players in Italian championships need a greater amount and intensity of training to achieve a physical and BC similar to those from the most successful national teams.  

From all the studies analyzed, it can be deduced that the higher the quality level of the players, the greater their height and body mass and the lower their percentage of subcutaneous fat. Although it is true that there is a degree of heterogeneity in the results, both height and weight seem to increase with age. The higher players should be oriented to the positions of the players at the back. As for the pivots, coaches must consider, in addition to the height of the body, robustness. For goalkeepers, body height is very important; however, robustness criteria are also important. In the case of wings, body height is not a decisive factor and smaller players can also occupy this position, but a lower weight is favorable for this position.  

Limitations  

The main limitation of the present study was the variation in BC formulas used by several studies to measure one parameter, making it difficult to compare the findings of the collected studies. For instance, body fat percentage has been calculated using different formulas that cannot be used interchangeably, making a comparison impossible between the studies. However, a strength of this study was that it reviewed a large number of studies and parameters. Despite the variety of methods used, conclusions on the variation of the parameters by age, performance level, and position can be safely drawn when considering the within-study comparisons.  

Future research  

Future research is required to optimize talent identification and development programs. Future research should include intervention-based studies and quantify the training burden of athletes to understand the most appropriate strategies for improving physical qualities. In addition, studies should understand the relationship between physical qualities and match performance, while providing further consideration of the holistic development of the handball player, including technical ability, tactical knowledge, psychological characteristics, and the occurrence and reduction of injuries.  

Conclusions  

This review provides a framework to help professionals effectively prepare players for the physiological demands of handball. Since elite athletes have better characteristics, the goal of any handball player would be to present similar results. But due to the limitations detected in the studies reviewed it is suggested that future research should adopt a longitudinal and multidimensional perspective.  

Conflict of interest  

The authors do not declare a conflict of interest.  

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Anthropometric characteristics of handball players: systematic review


Body composition characteristics of handball players: systematic review


