Anthropometric profile of the top-class male handball players participating in the Olympic Games Tokyo 2020

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Purpose: The purpose of the study was to try to determine the factors that differentiate the height, weight, BMI and age of high-level handball players participating in the Tokyo 2020 Olympic Games. *Methods*: The study included handball players participating in the Tokyo 2020 Olympic Games. The study material consisted of data on athletes' body height, body weight, age and BMI. The collected study material was analyzed about the position of the game, quarter and semester of the birth, continental location of the country and geographical region. In parametric distribution, Student's t-test and ANOVA were used. In non-parametric variables, the Mann–Whitney U-test and the Kruskal–Wallis test were used. *Results*: The highest average heights, weights and BMIs were found in players playing in the pivot position, while the lowest were found in wing players. Interactions were shown within the body weight and BMI of the athletes. Players from Europe have the highest weight and BMI in the second semester of birth, while other players' highest results were in the first semester. *Conclusions*: The factors that most strongly differentiate body height, body weight, and BMI are playing positions. Factors that differentiate height and weight are the continental location and region of the country represented.

Key words: *handball, height, weight, BMI, relative age effect*

1. Introduction

The literature focusing on studies of body height, body mass and BMI in team games points to factors that differentiate them. Previous research indicates that one of them is the type of sport played [40].

The results of statistical analyses indicate that the athletic level of players and the level of games they participate in is one of the main factors differentiating body height, body weight and BMI among team game players. It should be pointed out that such a trend occurs in rugby [33], while in the group of futsal players, the body height of the core squad players is higher than that of the reserve players [35]. Longitudinal studies in handball show that players playing at the sport's highest level have significantly higher body heights than the results obtained for the general population [3]. The results obtained in youth handball groups showed differences between the genders of the players [32], and

there is also a noticeable trend that indicates higher parameters of height, body weight and BMI in groups depending on the age of the players among both men and women [2], [10], [32], [38]. Reference to the performance of female and male handball players at the senior level indicates that higher scores of the anthropometric variables in question occur at a higher sporting level [6], [7], [19], [23].

Analysis of previous research results indicates differences in anthropometric characteristics that occur within team game players depending on their position in the game. It should be pointed out that such differences have been demonstrated in rugby [33] and soccer [36]. Longitudinal studies relating to handball players indicate increasing values of parameters (body height, body weight, BMI) for players performing in particular positions of the game at the international level of play [18]. This trend does not apply to the body height and weight of goalkeepers, which remain relatively constant [18]. The occurring differences in body height,

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body weight and BMI mainly indicate that the highest parameters were registered for pivot players [7], [22], while the lowest – for wing players [25]. In addition, it can be pointed out that there are significant differences between playing positions at the junior and senior levels [2], [20]. The same differences have been shown in a group of female handball players at the Olympic Games, and it has been shown that the continent of the country represented and the geographic region of the world are factors that translate into the level of the mentioned anthropometric characteristics [15]. Differences in the body height of players playing in different positions vary according to the level of the game, where at the higher level pivot players are characterized by their highest level, while at the lower level, the highest results were registered for backcourt players [7].

Previous research in handball identifies correlative relationships between body height, body mass, and BMI and players' actions. At the junior level of competition, body height, body mass and BMI are correlated with the speed imparted to the ball by the player when making a throw [38], and body mass is a predictor of jump height [10]. At the senior level, body height and BMI are also correlated with an athlete's ball-throwing speed [7], [34], [38]. Studies also indicate that the correlative results vary depending on the level of play, namely, at a lower level of play there is a negative correlation between BMI and ball velocity during throwing [7].

The literature on team games contains research results that indicate that one of the factors that differentiate the height and weight of players is their quarter of birth (relative age effect [RAE]). It should be pointed out that such results were obtained on a group of soccer [1] and basketball [30] players. The search for factors that differentiate the height and weight of soccer and basketball players is also important because their level is taken into account as one of the elements of talent identification [27]. RAE in handball is not a factor that differentiates the anthropometric characteristics of players at the junior level for both men and women [37]. Studies relating to RAE at the highest sports level (Olympic Games) show that there are interactions between it and body height, body weight and BMI in a group of female handball players [15].

The presented analysis of previous scientific achievements indicates a substantive need to undertake research focusing on the registration of anthropometric characteristics in a group of handball players at the highest levels of international competition. This approach is confirmed by the results obtained in the women's group at the games at the Olympic Games [15]. Undertaking this type of analysis is intended to identify the latest trends occurring in handball. The presented review of studies also indicates the need to look for factors that differentiate body height, BMI, body mass and age among high-sport level players.

The aim of this study was to identify and assess the determinants of the anthropometric profiles of male handball players participating in the Tokyo 2020 Olympic Games, taking into account playing position, quarters of birth, semesters of birth, continents and geographical regions.

2. Materials and methods

Participants

The study included high-level handball players (n = 180) participating in the Tokyo 2020 Olympic Games. The mean age of the players was 29.14 ± 4.78 years, body height was 190.16 ± 7.24, body weight – 94.14 ± 9.99 and BMI 25.99 ± 1.85.

Procedures

The data was collected from the official website of the International Handball Federations – IHF (www.ihf.info). The study material consisted of data on athletes' body height [cm], athletes' body weight [kg], athletes' age [years] and BMI, which were calculated by the authors according to the formula: BMI $= \dfrac{\text{body mass [kg]}}{\text{body height [m]}^2}$.

The collected study material was analyzed in relation to the four independent variables:
1. Position of the game: left wing [LW] (n = 21), left back [LB] (n = 30), center back [CB] (n = 26), right back [RB] (n = 24), right wing [RW] (n = 21), pivot [P] (n = 34), goalkeeper [GK] (n = 24);
2. Date of birth of the players, which was included in the four quarters (Q1: January 1 – March 31 (n = 51), Q2: April 1 – June 30 (n = 46), Q3: July 1 – September 30 (n = 52), Q4: October 1 – December 31 (n = 31)) and two semesters (S1: January 1 – June 30 (n = 96), S2: July 1– December 31 (n = 84));
3. Continental location of the represented country: Africa [AF] (n = 15), Asia [AS] (n = 30), Europe [E] (n = 105), South America [SA] (n = 30);
4. Geographical region of the world: Europe [E] (n = 105), Others [O] (n = 75).

Statistical analysis

The study material was subjected to statistical analysis. Normality of distribution was determined by the Shapiro–Wilk test, and homogeneity of variance was determined by the Levene's test. Intergroup differences for normal distributions were tested with the Student's *t*-test for two independent groups. For larger independent groups the ANOVA test was used, and intergroup differences were determined with the Tuckey's *b* post-hoc test. In non-parametric distributions, the Mann–Whitney *U*-test was used to determine differences between two independent variables, and the Kruskal–Wallis test was used for larger numbers of independent groups. Statistical significance was set at $p < 0.05$. The eta-square (η^2) was used to determine the effect size [ES] (<0.01 – no effect, 0.01–0.059 – small effect, 0.06–0.139 – intermediate effect, >0.14 – large effect) [4]. All statistical analyses were performed using TIBC Statistica 13.3 and Microsoft Office Excel software.

3. Results

The results presented in Table 1 indicate that the differentiating factor of the players' body height is the position in the game, and the effect size is large. It should be pointed out that P and LB have higher body height values than CB and WP (wing positions left and right). GK shows higher body height parameters than WP (left and right). It should also be pointed out that there are no differences in relation to RB. In terms of the overall aspect, WP players (left and right) have the lowest average body height, while players playing on P, LB, and GK manifest the highest body height values. Statistical analysis indicates that the country's geographic location is a differentiating factor in players' body heights. Players from AS have a significantly lower body height than players from other continents, and the effect size is large. Differences were shown in body height, which is statistically higher in the group of players with E than with O, and the effect size is large. In addition, the analyses conducted indicate that birth quarter and birth semester are not differentiating factors in the body height of handball players.

The results on body weight show statistical differences concerning on playing position, and the effect size is large. P was shown to have significantly higher body weight than other players. Players performing in the GK and backcourt position (left and right) have statistically higher body mass values than WP (left and right). Statistical analyses indicate that players from AS have significantly lower body weights than players from E and SA, and the effect size is intermediate. The results presented show that the body weight of players from E is significantly higher than that of players from O. It has been shown that the quarter and semester of birth are not factors that differentiate the body weight of athletes.

The results of statistical analyses relating to BMI indicate significant differences in the context of game position, and the effect size is large. P was shown to have a significantly higher BMI relative to the other players. It was shown, no significant differences in the other cases of variables for BMI.

Statistical analysis of the data indicates that none of the assumed independent variables differentiate the age of the players.

The results of the statistical analyses on the interactions between the study variables are presented in Table 2. Due to the large size of the data, only statistically significant results are presented.

One interaction was shown within body mass for players born in S2. E players have a higher body mass than O players, and the effect size is large.

There are three main significant interactions for the BMI variable. The results of statistical analyses indicate, a higher BMI of players born in Q2 occurs in the group of players with E with respect to players with O. The effect size of these differences is intermediate.

The data presented in Table 2 show an interaction between the term of birth and continent. In the group of players from E, higher BMIs occur for players born in S2, while the effect size is small. For players from SA, higher BMI values occur for those born in S1, and the effect size is large. Differences are shown among players born in S1, where the BMI of players from AS and SA is higher than that of those hailing from E. Effect size of the differences shown is intermediate.

The results of the statistical analyses indicate interactions within BMI relating to the players' term of birth and the geographic location of the country represented. Significant differences are shown among players from E, where the BMI of players born in S2 is higher, while the effect size is small. Among players from O, the BMI is higher among players born in S1, and the effect size is intermediate. There are significant differences among players born in S1, for which a lower BMI is found among players from E than from O, and the effect size is intermediate.

Table 1. Factors differentiating height, weight, BMI and age of male handball players

Variables	Body height [cm]	Body weight [kg]	BMI [kg/height [m]^2]	Age [years]
	M ± SD	M ± SD	M ± SD	M ± SD
Position				
LW	184.71 ± 7.60	84.95 ± 7.47	24.89 ± 1.40	29.52 ± 4.33
LB	193.37 ± 5.65	96.73 ± 6.72	25.70 ± 1.25	27.63 ± 4.33
CB	187.73 ± 5.54	91.38 ± 7.00	25.92 ± 1.52	28.73 ± 5.65
RB	189.67 ± 6.64	92.67 ± 7.70	25.75 ± 1.36	28.00 ± 4.38
RW	184.38 ± 6.92	84.62 ± 7.13	24.86 ± 1.07	29.14 ± 3.79
P	194.21 ± 5.90	104.94 ± 8.35	27.84 ± 2.15	30.06 ± 4.74
GK	192.63 ± 5.89	96.46 ± 7.56	26.00 ± 1.87	30.96 ± 5.44
Test	ANOVA $F(6.173) = 11.164$, $p = 0.00$, $\eta^2 = 0.28$	ANOVA $F(6.173) = 24.577$, $p = 0.00$, $\eta^2 = 0.46$	KW-H(6.180) = 45.899, $p = 0.000$, $\eta^2 = 0.23$	KW-H(6.180) = 9.255, $p = 0.16$, $\eta^2 = 0.019$
Differences	$P > CB**, LW***, RW***;$ $GK > LW***, RW***;$ $LB > CB**, LW***, RW***$	$P > CB***, LW***, GK***,$ $LB***, RB***, RW***;$ $GK > LW***, RW***;$ $LB > LW***, RW***;$ $RB > LW*, RW**$	$P > CB*, LW***, GK*,$ $LB**, RB**, RW***$	
Birth quarter				
Q1	189.43 ± 7.65	93.37 ± 10.56	25.97 ± 2.00	30.02 ± 4.92
Q2	190.17 ± 7.57	94.35 ± 10.18	26.04 ± 1.74	28.13 ± 4.79
Q3	190.62 ± 7.07	94.37 ± 9.94	25.93 ± 1.88	28.90 ± 4.67
Q4	190.58 ± 6.55	94.74 ± 9.21	26.06 ± 1.79	29.58 ± 4.60
Test	ANOVA $F(3.176) = 0.27217$, $p = 0.845$, $\eta^2 = 0.005$	ANOVA $F(3.176) = 0.1510$, $p = 0.9289$, $\eta^2 = 0.003$	KW-H(3.180) = 0.285, $p = 0.963$, $\eta^2 = 0.015$	KW-H(3.180) = 3.628, $p = 0.304$, $\eta^2 = 0.004$
Birth semester				
S1	189.76 ± 7.62	93.88 ± 10.39	26.02 ± 1.88	29.09 ± 4.94
S2	190.62 ± 6.80	94.45 ± 9.57	25.96 ± 1.83	29.19 ± 4.61
Test	T-Test $t(1,178) = -0.793$, $p = 0.429$, $\eta^2 = 0.003$	T-Test $t(1,178) = -0.386$, $p = 0.7$, $\eta^2 = 0.001$	U M-W Z = 0.2652, $p = 0.791$, $\eta^2 = 0$	U M-W Z = 0.033, $p = 0.974$, $\eta^2 = 0$
Continent				
Africa [AF]	189.53 ± 6.73	91.80 ± 8.44	25.55 ± 2.00	28.13 ± 5.04
Asia [AS]	181.90 ± 7.20	87.87 ± 10.56	26.49 ± 2.11	28.03 ± 4.51
Europe [E]	192.71 ± 5.98	96.17 ± 9.37	25.85 ± 1.73	29.50 ± 4.93
South America [SA]	189.90 ± 5.24	94.50 ± 9.85	26.19 ± 1.91	29.47 ± 4.34
Test	ANOVA $F(3.176) = 24.199$, $p = 0.00$, $\eta^2 = 0.292$	ANOVA $F(3.176) = 6.1676$, $p = 0.00052$, $\eta^2 = 0.095$	KW-H(3.180) = 3.888, $p = 0.274$, $\eta^2 = 0.005$	KW-H(3.180) = 1.805, $p = 0.614$, $\eta^2 = 0.007$
Differences	AS < AF**, E***, SA***	AS < E**, SA*		
Region				
Europe [E]	192.71 ± 5.98	96.17 ± 9.37	25.85 ± 1.73	29.50 ± 4.93
Others [O]	186.59 ± 7.38	91.31 ± 10.21	26.18 ± 2.01	28.63 ± 5.54
Test	T-Test $t(1.178) = 6.144$, $p = 0.00$, $\eta^2 = 0.177$	T-Test $t(1.178) = 3.309$, $p = 0.001$, $\eta^2 = 0.059$	U M-W Z = −0.947, $p = 0.343$, $\eta^2 = 0.005$	U M-W Z = −0.805, $p = 0.421$, $\eta^2 = 0.004$
Differences	E > O	E > O		

LW – left wing, LB – left back, CB – center back, RB – right back, RW – right wing, P – pivot, GK – goalkeeper, Q1–Q4 – birth quarter, S1–S2 – birth semester, KW – Kruskal–Wallis test, U M–W – Mann–Whitney U-test, p – level of significance, η^2 – effect size, $* - p < 0.05$, $** - p < 0.01$, $*** - p < 0.001$.

Table 2. Interactions between body weight, BMI and age of male handball players for independent variables

Variables	Interactions	Differences	Result
Body weight	Region* birth semester	S2: E (94.91 ± 10.16) > O (88.35 ± 8.85)**	ANOVA $F(1,176) = 5.12$, $p = 0.025$, $\eta^2 = 0.283$
BMI	Birth quarter* region	Q2: O (22.44 ± 1.56) < E (25.55 ± 1.86)	U M-W $Z = -2.161$, $p = 0.031$, $\eta^2 = 0.103$
	Birth semester* continent	E: S1 (25.49 ± 1.65) < S2 (26.15 ± 1.74)	U M-W $Z = -1.962$, $p = 0.05$, $\eta^2 = 0.037$
		SA: S1 (26.70 ± 1.89) > S2 (25.16 ± 1.56)	U M-W $Z = 2.068$, $p = 0.039$, $\eta^2 = 0.146$
		S1: E (25.49 ± 1.65) < AS (26.73 ± 2.00)*, SA (26.70 ± 1.89)*	KW-H(3,96) = 12.182, $p = 0.007$, $\eta^2 = 0.1$
	Birth semester* region	E: S1 (25.49 ± 1.65) < S2 (26.15 ± 1.74)	U M-W $Z = -1.962$, $p = 0.05$, $\eta^2 = 0.037$
		O: S1 (26.52 ± 1.95) > S2 (25.53 ± 2.00)	U M-W $Z = 2.488$, $p = 0.013$, $\eta^2 = 0.083$
		S1: E (25.49 ± 1.65) < O (26.52 ± 1.95)	U M-W $Z = -2.913$, $p = 0.004$, $\eta^2 = 0.089$

Q1–Q4 – birth quarter, S1–S2 – birth semester, KW – Kruskal–Wallis test, *U* M–W – Mann–Whitney *U*-test, *p* – level of significance, η^2 = effect size, * – $p < 0.05$; ** – $p < 0.01$, *** – $p < 0.001$.

4. Discussion

The collected material and its statistical analysis indicate that the main factors differentiating the height and body weight of handball players are the position in the game, continental location and the region of the country represented. BMI varies only according to position in the game.

Discussing the obtained results of body height in the context of playing positions, it should be pointed out that the highest parameters were registered for P, LB, and RB, while the lowest were for wing position (left and right). It should be pointed out that the differences shown are consistent with the results presented by other authors [2], [7], [8], [18], [20], [22], [25]. The literature contains items in which backcourt players are subjected to body height registration without distinguishing between LB, CB and RB [2], [20], [22]. The results presented in this study indicate that CB players should be analyzed as an independent group during future studies. The proposed approach can be translated into the process of recruiting and selecting players for the LB, RB and CB positions to identify players who can achieve the highest sporting performance in a specific position in the future, which is the case in other team games. It should be pointed out, however, that in addition to body height, many other variables should be taken into account in the selection process to holistically evaluate the player, which is the case in other team games [27].

When considering the differences between body heights in the context of playing positions, it should be pointed out that they may be due to the characteristics of conducting sports combat. The body height of P, LB and GK players is significantly higher than that of LW and RW. Playing in the P position is characterized by conducting sports combat in physical contact with the opponent, so it can be presumed that body height can translate into gaining an advantage in physical conditions. This provides more opportunities for players to pass and seek solutions that are more difficult for the opponent to defend, which can increase the effectiveness of the offensive play. In many teams, P players are found in the position of central defender, where body height can translate into greater opportunities to block shots and play zone defense. The body height in GK, with which the range of stance is associated, allows the player to cover a much larger part of the goal, which significantly reduces the space in the goal, and at the same time forces players to make technically advanced throws into certain sectors of the goal, which can lead to defense by the goalkeeper, or a missed throw. One of the characteristic actions of players performing in the LB position is to make a throw from the second line (>9 meters). Higher parameters within the body height allow the player to make a throw over the defensive block, which can result in fewer blocked throws and gaining a physical advantage over the defender. This can be confirmed by the fact that the percentage of throws over the block made by backcourt players from the second line is 20.95%, while 31.74% are throws made in contact with the defender [14]. It is also important to point out the correlation between body height and the speed given to the ball during the throw [7], [34], which can also translate into the effectiveness of the game. The lack of differences in body height between RB and LW and RW indicates that, in addition to the ability to play in the indicated position, the left-handedness of players is one of many determining factors in the recruitment and selection process for the sport. This fact may be

caused by the much lower percentage of left-handers in the general population, which is about 10% [5], as well as in the male population [12].

The results obtained for players' body mass in relation to playing position correspond with previous results presented by other authors. They confirm the trends that the highest body weight is found in players in the P position, while the lowest for LW and RW [2], [7], [8], [18], [20], [22]. However, it should be pointed out that some of the listed items did not record weight in the context of the exact position (LB, CB, RB), but overall for all backcourt players, which does not allow for a full comparison [2], [20], [22].

The results within body mass and BMI indicate that P players have significantly the highest values in relation to the other items. The occurrence of the same differences in body mass and BMI may be due to the fact that they are correlated in the group of handball players [38]. The reasons for the differences shown should also be attributed to the characteristics of the P position game, in which the course of sports combat occurs mainly in physical contact with the opponent. Thus, high body mass enables the player to gain a physical advantage over the opponent and minimize the effectiveness of the defensive actions of the defensive player. Analyses of throws from the P position indicate that they make about 40% of their throws in physical contact with the defender [13]. Developing a throwing position and cooperating with players in other positions (for example, executing a proper cover) also requires P players to gain an advantage of physical conditions over the opponent, which ultimately translates into the effectiveness of the game of an individual player as well as the whole team. The demonstrated differences in body mass between GK, LB, LW, and RW similar to body height may be caused by the correlation between height and body mass in a group of handball players at the senior level [38]. The results also indicate higher body mass of RB players in relation to LW and RW in the absence of differences in body height. Such a condition may indicate greater muscle mass in RB players, but further studies including body composition and other anthropometric tests should be conducted to know the exact reasons for the indicated differences. A difference in body height was shown between LB and CB players, while within body mass there is no such difference, which may indicate that further research should be conducted to holistically understand and describe the differences shown.

The results indicate that players from Asia have the lowest average body height in relation to players from other continents. The reasons for the differences shown may be due to differences in the body height of the general population in relation to the continents [9], [11]. Given the correlation in the group of handball players between height and body weight [38], the same argument could be the reason for differences in body weight depending on the geographic location of the country represented. It should be noted the lack of differences in body weight between AS and AF players that were present for height. BMI scores, despite the lack of significant differences, are higher in players with AS relative to AF. This indicates that in order to determine the reasons for the lack of differences, further research should be conducted focusing in particular on the measurement of body composition mainly muscle mass and body fat. Further scientific investigation should be carried out on a larger group of athletes at different levels of competition, taking into account the method adopted in this study, in order to accurately understand and generalize the results and confirm them.

Analysis of the collected research material showed higher values of height and weight in the group of players from E in relation to players from other continents. It should be pointed out that in the group of handball players, both variables are correlated with each other [38]. The reasons for this should be attributed, as with the continents, to differences in the average body height of the general population, which indicates higher values of E residents relative to the others for both adults [9], [11], [24] and adolescents [29]. The popularity of the sport and its sporting level on each continent may also be a variable that influences the differences shown. Handball in Europe is very popular, which creates conditions for children to start training at a young age and may translate into more people playing the sport at all stages of training. This creates opportunities to identify talents at the level of selection, taking into account many variables (including anthropometric), players who can achieve the highest sports results in the future. This approach is found in soccer and basketball [27].

The demonstrated interactions in body weight and BMI relate mainly to the semester of birth. It is noticeable that among players from E, lower values are found in S1, while higher values are found in S2. In teams from other continents, higher values are found in players born in S1. This condition translates into differences between players from E and O. However, it should be pointed out that overall (Table 1), continent and region is not a factor that differentiates players' BMI. Therefore, it can be presumed that the results shown are related to RAE (relative age effect). Previous studies indicate its occurrence in soccer [26], [28],

as well as in other sports [17], [39]. In handball, studies also indicate the occurrence of RAE in senior teams [16], [31]. The reasons for the interactions shown in this article related to RAE may be the popularity of the sport, which is high in E and thus the availability of handball training and the possibility of starting it at a very young age is more accessible. This, therefore, allows the acquisition of technical-tactical and motor skills at an earlier stage, which bridges the differences associated with sexual maturation. A later start of handball training (before and during puberty), due to the nature of the game, will predispose players born in the first months of the year, due to the faster rate of entry into puberty in which there is a jump in body height, body weight and motor skills such as strength and speed. This can be confirmed by correlational studies showing a relationship between BMI and the speed given to the ball during the throwing process in both junior and senior teams [38], while body mass is one of the predictors of jump height among young players [10]. In a way, this confirms the fact that RAE determines the start of senior careers in various team games [21]. To accurately describe, verify and generalize the results obtained, further research should be conducted at different levels of the game, taking into account height and weight in the context of RAE, continent and region of the globe in the method adopted in this study.

Limitations

The study included players with the highest level of sportsmanship during the Olympic Games. However, it should be noted that the number of teams performing at the indicated event is relatively low in relation to the number of national federations affiliated with the IHF, and the uneven number of teams from each continent, which is related to the organization of the Olympic tournament. To verify and generalize the results obtained, further research should be conducted by the method adopted in this article. The research should include players of the highest sports level in the country (national team). A larger number of national teams should also be included in the research in the context of both the continent and the geographic region of the country represented.

5. Conclusions

The factor most strongly differentiating body height, body weight and BMI is playing position. The highest values were recorded for pivot players, while the lowest values were recorded for wing players (left and right). The results indicate that future studies of backcourt players' body height should be recorded for the exact position (LB, CB, RB) in the game. Factors that differentiate height and weight are the continental location of the country represented, where the lowest results were shown for players from Asia. The variable that differentiates height and weight is the geographic region and higher scores are found among players from Europe relative to other players. The interactions shown indicate a substantive need for further research with other levels of play at both junior and senior levels in the context of RAE (relative age effect) to verify and generalize the results obtained.

In order to optimize the recruitment and selection process of athletes, body height, body weight and BMI should be recorded. The aforementioned variables should be one of the many factors (in addition to technical, tactical, and motor skills) taken into account in the selection of players to play in particular positions who can achieve the highest sports results in the future. The recruitment and selection process should also refer to biological age in addition to calendar age. In the training process, attention should also be paid to the prediction of body height, body weight and BMI using various assessment methods, such as centile grids, which can influence the appropriate selection of players for particular playing positions, thus optimizing the training process and identifying talents.

Disclosure statement

Authors declare no conflict of interest and availability to all research data.

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