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## Relative age effect of female and male handball players participating in Olympics Games Tokyo 2020

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## Abstract

**Introduction:** The aim of this study was to determine whether the relative age effect (RAE) was present among handball players participating in the Tokyo 2020 Olympics. **Materials and Methods.** The study involved a group of handball players participating in the Tokyo 2020 Olympics. All data was collected from the website of the IHF. The research material consisted of data on the players' dates of birth, which were broken down by four quarters (Q1: January 1–March 31, Q2: April 1–June 30, Q3: July 1–September 30, Q4: October 1–December 31) and two semesters (S1: January 1–June 30, S2: July 1–December 31). The following independent variables were used: game position, continent and world region. Differences between the dates of birth were determined using the chi-square test. To determine the strength of correlations, Cramér's V was used. **Results.** In general terms, the main factor differentiating the RAE among handball players participating in the Tokyo 2020 Olympics was the geographical location of the country they represented (continent). There was no RAE among female handball players. Among male handball players, the RAE was differentiated by the region of the world (Europe, others). **Conclusions.** In order to thoroughly investigate and describe the RAE, further research and the search for factors that differentiate it should be carried out.

## Keywords

RAE, handball, olympic, female, male

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## Article

## Relative age effect of female and male handball players participating in the Olympics Games Tokyo 2020

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**Abstract:** Introduction: The aim of this study was to determine whether the relative age effect (RAE) was present among handball players participating in the Tokyo 2020 Olympics. Materials and Methods. The study involved a group of handball players participating in the Tokyo 2020 Olympics. All data was collected from the website of the IHF. The research material consisted of data on the players' dates of birth, which were broken down by four quarters (Q1: January 1–March 31, Q2: April 1–June 30, Q3: July 1–September 30, Q4: October 1–December 31) and two semesters (S1: January 1–June 30, S2: July 1–December 31). The following independent variables were used: game position, continent and world region. Differences between the dates of birth were determined using the chi-square test. To determine the strength of correlations, Cramér's V was used. Results. In general terms, the main factor differentiating the RAE among handball players participating in the Tokyo 2020 Olympics was the geographical location of the country they represented (continent). There was no RAE among female handball players. Among male handball players, the RAE was differentiated by the region of the world (Europe, others). Conclusions. In order to thoroughly investigate and describe the RAE, further research and the search for factors that differentiate it should be carried out.

**Keywords:** RAE, handball, Olympics, female, male.

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### 1. Introduction

Sports success in team games depends on many factors. One of them is a properly prepared and controlled process of recruiting and selecting players who are predisposed to achieve the highest sports performance. A literature review shows that the occurrence of the relative age effect (RAE) is associated with a recruitment and selection process in sports.

The literature review indicates that research on the RAE in team games includes both youth and senior players. As regards youth teams, research shows that the RAE is present among football players [1–8] basketball players [9, 10] volleyball players [11, 12] and baseball players [8].

Previous studies on the RAE indicate that it also occurs among senior players with high sports performance in team games. This applies to football players [5, 8, 13–17], basketball players [13] volleyball players [13], ice hockey players [18] and baseball players [8]. The literature on the subject also indicates that the RAE determines the start of senior careers in football, basketball, rugby, volleyball and water polo [19]. A study of the participants of the World Cup has not confirmed that the RAE is present among futsal players [20].

The analysis of the literature also shows that adolescents have different motor skills depending on the RAE and that this applies to football players [1,2], basketball players [10] and volleyball players [12]. The RAE is also a factor that differentiates the height and weight of football players [2] and basketball players [10]. Studies conducted so far indicate that the RAE among football players depends on the level of games [4, 7]. Differences in the RAE also occur depending on the final position in football [6], basketball [10] and volleyball [11] competitions. The literature on the subject also includes reports pointing out that differences in the RAE depend on the nominal position in football [5] and basketball [9] competitions. In addition, differences in the quality of sports performance among basketball players have been shown [9]. A review study indicates that the RAE occurs primarily among male senior players and is associated with the players' quantitative and qualitative characteristics [21]. A study of female volleyball players participating in youth world championships show differences in the RAE depending on the continent from which the players come [11].

As is the case with youth players, seniors also show differences in the RAE depending on the level of football games [14, 16, 17] and the nominal position in football [5, 15, 16] and ice hockey [18].

Studies on the RAE in handball indicate that it occurs in female youth teams [22–25] and male youth teams [22, 23, 25–28] as well as in female senior teams [22, 24, 25, 28] and male senior teams [22, 25, 27, 28]. As in other team games, differences in the RAE are also present in both female and male youth handball teams depending on the level of games [23].

The literature on the subject indicates that differences in the RAE depend on the place held by female [24] and male teams [26] in international youth competitions. A report points out that there are no differences in the RAE among female senior players depending on the final place in the Women's World Cup [22]. Research results so far indicate that the RAE is differentiated by the nominal position in handball games. It should be noted that these differences occur among female youth players [24, 28]. Different results have been obtained by de la Rubia et al. [24], who have indicated no differences in the RAE among female youth players depending on the position in games. There are also differences among male adolescent players [22, 26, 28].

As regards differences in the RAE in senior teams depending on the nominal position in games, it should be noted that the literature contains reports indicating that it both occurs and is absent. Differences are observed among female wingers and male quarterbacks [22]. As regards the birth semester, differences in the RAE occur among female side quarterbacks [24]. The RAE has not been found in the remaining positions. A study by de la Rubia et al. [28] indicates that differences in the RAE occur in all positions, in both female and male teams, on a quarterly and semester basis.

A study on the RAE based on performance analysis indicates that there is a difference in the effectiveness of throws among male youth players [22], while there is no difference in other parameters among both female and male players. There is also a correlation between the RAE and the time spent on the court during a match (minutes), technical fouls-turnovers and the number of penalties in male youth teams [28]. In female youth teams, there is a correlation between the RAE, playing time (minutes) and the number of assists. In the U-19 category (age category: under 19 years old), there is a correlation between the RAE, technical fouls-turnovers and the number of penalties [28]. When it comes to senior players, it should be noted that differences in the RAE occur in the number of turnovers (men), steals (women and men) and penalties (women and men) [22]. Additionally, among female senior players, there are differences in the overall playing time and the playing time in a single match (minutes) [22]. Research on the RAE based on performance analysis shows that in the category of male seniors, there are correlations between the RAE and playing time (minutes), the effectiveness of throws and the number of steals, while there are no significant correlations among female players [28].

Research on the RAE shows that the continent from which players come is a factor that differentiates it. In youth teams (U-19 and U-21), the RAE occurs among players on

all continents. As regards senior teams, the RAE is noticeable in single tournaments among players from Africa and Europe [28].

This review of research on team games, including handball, indicates a substantively justified need to determine whether the RAE occurs among handball players participating in the Olympic Games, which are considered to be top competitions by many theoreticians and practitioners of sports. It is also justified to look for factors that differentiate the RAE in top handball competitions.

The aim of this study was to determine whether the RAE was present among handball players participating in the Tokyo 2020 Olympics.

## 2. Materials and Methods

### 2.1. Participants

The study involved a group of handball players (women  $n = 179$ , men  $n = 180$ ) participating in the Tokyo 2020 Olympics. The respondents' mean age was: women  $28.18 \pm 4.47$  years and men  $29.14 \pm 4.78$  years. The average height was: women  $175.17 \pm 6.62$  cm and men  $190.16 \pm 7.24$  cm, body weight: women  $70.40 \pm 8.79$  kg and men  $94.14 \pm 9.99$  kg, BMI: women  $22.90 \pm 2.07$  and men  $25.99 \pm 1.85$ .

### 2.2. Procedures

All data used was collected from the official website of the International Handball Federation (IHF) (women: <https://www.ihf.info/competitions/women/307/olympic-games-tokyo-2020---womens-tournament/20353/groups-rankings>, men: <https://www.ihf.info/competitions/men/308/olympic-games-tokyo-2020---mens-tournament/20351/groups-rankings>). The research material consisted of data on the players' dates of birth, which were summarized in four quarters (Q1: January 1 – March 31, Q2: April 1 – June 30, Q3: July 1 – September 30, Q4: October 1 – December 31) and two semesters (S1: January 1 – June 30, S2: July 1 – December 31).

The collected material was analyzed in relation to the nominal positions held by the studied handball players in games (goalkeeper [GK], left wing [LW], pivot [P], left back [LB], center back [CB], right back [RB], right wing [RW]). The analysis also took account of players depending on the geographical location of the country they represented (Africa, Asia, Europe, South America); analyses relating to the continent among female and male handball players were not included in relation to the respondents' gender due to the low number of players from a single continent (Africa). The collected material was also analyzed in relation to the geographical region from which the players came (Europe vs. others).

### 2.3. Statistical Analysis

The collected material was subjected to statistical analysis. Differences between the observed and expected distributions of the dates of birth were determined using the chi-square test ( $\chi^2$ ). In order to determine the strength of correlations between the studied variables, Cramér's  $V$  was determined (0.10–0.20 – a weak correlation, 0.20–0.40 – a moderate correlation, 0.40–0.60 – a relatively strong correlation, 0.60–0.80 – a strong correlation, >0.80 – a very strong correlation) [29]. The level of statistical significance was set at  $p < 0.05$ . All calculations were performed using IBM SPSS Statistics 27 and Microsoft Office Excel Software.

## 3. Results

### 3.1. RAE in All Players

Table 1 contains the results of the analyses of the quarterly and semester distributions of the dates of birth of all participants (women and men) in the Tokyo 2020 Olympic Games.

**Table 1.** Distribution (n and %) of birth dates in quarters and semesters of all handball players by the game position, continent and region.

Variables	Q1	Q2	Q3	Q4	$\chi^2$	Vc	S1	S2	$\chi^2$	Vc
n	94	91	97	77	2.616		184	175	0.226	
%	26.2	25.3	27	21.4	$df=3$ $p=0.455$	-	51.3	48.7	$df=1$ $p=0.635$	-
<b>Positions</b>										
<b>GK</b>	n	14	15	11	10		28	22		
	%	28	30	22	20		44.5	55.4		
<b>LW</b>	n	11	10	11	11		21	22		
	%	25.6	23.3	25.6	25.6		48.8	51.2		
<b>P</b>	n	12	15	16	18		27	34		
	%	19.7	24.6	26.2	29.5		44.3	55.7		
<b>LB</b>	n	19	19	13	9	12.218		38	22	6.788
	%	31.7	31.7	21.7	15	$df=18$ $p=0.836$	0.107	63.3	36.7	$df=6$ $p=0.341$
<b>CB</b>	n	13	12	19	12		25	31		
	%	23.2	21.4	33.9	21.4		44.6	55.4		
<b>RB</b>	n	13	13	15	7		26	22		
	%	27.1	27.1	31.3	14.6		54.2	45.8		
<b>RW</b>	n	12	7	12	10		19	22		
	%	29.3	17.1	29.3	24.4		46.3	53.7		
<b>Continent</b>										
<b>Africa</b>	n	5	13	4	7		18	11		
	%	17.2	44.8	13.8	24.1		62.1	37.9		
<b>Asia</b>	n	23	13	14	10	19.335		36	24	6.241
	%	38.3	21.7	23.3	16.7	$df=9$ $p=0.022$	0.134	60	40	$df=3$ $p=0.1$
<b>Europe</b>	n	50	54	72	49		104	121		
	%	22.2	24	32	21.8		46.2	53.8		
<b>South</b>	n	16	11	7	11		26	19		
<b>America</b>	%	35.6	24.4	15.6	24.4		57.8	42.2		
<b>Region</b>										
<b>Europe</b>	n	50	54	72	49	9.61		104	121	6.107
	%	22.2	24	32	21.8	$df=3$ $p=0.022$	0.164	46.2	53.8	$df=1$ $p=0.013$
<b>Others</b>	n	44	37	25	28		80	54		
	%	32.8	27.6	18.7	20.9		59.7	40.3		

Q1–Q4 = birth quarter; S1–S2 = birth semester; n = number of cases; % = relative frequency;  $\chi^2$  = chi-square;  $df$  = degrees of freedom;  $p$  = level of significance; GK = goalkeeper; LW = left wing; P = pivot; LB = left back; CB = center back; RB = right back; RW = right wing

The results show that the quarterly distribution of the dates of birth statistically differs from the one expected in the context of the continent from which the players came ( $\chi^2=19.335$ ,  $df=9$ ,  $p=0.022$ ); however, the effect size is weak ( $Vc=0.134$ ).

Similarly, the results show that the quarterly distribution of the dates of birth is statistically different compared to the one expected in the context of the region of the world

from which the players came (Europe – others) ( $\chi^2 = 9.61, df = 3, p = 0.022$ ); however, its effect size is weak ( $V_c = 0.164$ ).

Significant differences were also found in the semester distribution of the dates of birth compared to the one expected in the context of the world region (Europe – others) ( $\chi^2 = 6.107, df = 1, p = 0.013$ ); however, as in the previous cases, the effect size is weak ( $V_c = 0.13$ ). The conducted analyses do not indicate that the RAE occurs in the other analyzed parameters.

### 3.2. RAE in female handball players

**Table 1.** Distribution (n and %) of quarters and semesters of birth dates of female handball players by game position and region.

Variables	Q1	Q2	Q3	Q4	$\chi^2$	Vc	S1	S2	$\chi^2$	Vc
n	43	45	45	46	0.106		88	91	0.5	
%	24.02	25.14	25.14	25.70	$df = 3$ $p = 0.991$	-	49.16	50.84	$df = 1$ $p = 0.823$	-
<b>Positions</b>										
<b>GK</b>	n	8	6	6			14	12		
	%	30.8	23.1	23.1	23.1		53.8	46.2		
<b>LW</b>	n	3	7	5	7		10	12		
	%	13.6	31.8	22.7	31.8		45.5	54.5		
<b>P</b>	n	4	7	7	9		11	16		
	%	14.8	25.9	25.9	33.3		40.7	59.3		
<b>LB</b>	n	10	8	6	6	12.071		18	12	6.246
	%	33.3	26.7	20	20	$df = 18$ $p = 0.844$	0.15	60	40	$df = 6$ $p = 0.396$
<b>CB</b>	n	7	6	10	7		13	17		
	%	23.3	20	33.3	23.3		43.3	56.7		
<b>RB</b>	n	6	9	5	4		15	9		
	%	25	37.5	20.8	16.7		62.5	37.5		
<b>RW</b>	n	5	2	6	7		7	13		
	%	25	10	30	35		35	65		
<b>Region</b>										
<b>Europe</b>	n	24	33	34	29	5.068		57	63	0.402
	%	20	27.7	28.3	24.2	$df = 3$ $p = 0.167$	0.168	47.5	52.5	$df = 1$ $p = 0.526$
<b>Others</b>	n	19	19	11	17		31	28		
	%	32.2	20.34	18.6	28.8		52.5	47.5		

Q1–Q4 = birth quarter; S1–S2 = birth semester; n = number of cases; % = relative frequency;  $\chi^2$  = chi-square;  $df$  = degrees of freedom;  $p$  = level of significance; GK = goalkeeper; LW = left wing; P = pivot; LB = left back; CB = center back; RB = right back; RW = right wing

The results of statistical analyses presented in Table 2 show that, generally, the quarterly and semester distributions of females' dates of birth do not significantly differ depending on the nominal position in games and on the world region.

### 3.3. RAE in Male Handball Players

The research results presented in Table 3 concern the distribution of the dates of birth of male handball players participating in the Tokyo 2020 Olympics.

**Table 2.** Distribution (n and %) of quarters and semesters of birth dates of male handball players by game position and region.

Variables	Q1	Q2	Q3	Q4	$\chi^2$	Vc	S1	S2	$\chi^2$	Vc
n	51	46	52	31	6.267		96	84	0.8	
%	28.33	25.56	28.89	17.22	$df=3$ $p=0.099$	-	53.33	46.67	$df=1$ $p=0.371$	-
<b>Positions</b>										
<b>GK</b>	n	6	9	5	4		14	10		
	%	25	37.5	20.8	16.7		58.3	41.7		
<b>LW</b>	n	8	3	6	4		11	10		
	%	38.1	14.3	28.6	19		52.4	47.6		
<b>P</b>	n	8	8	9	9		16	18		
	%	23.5	23.5	26.5	26.5	11.969	47.1	52.9	4.133	
<b>LB</b>	n	9	11	7	3	$df=18$	20	10	$df=6$	0.152
	%	30	36.7	23.3	10	$p=0.849$	66.7	33.3	$p=0.659$	
<b>CB</b>	n	6	6	9	5		12	14		
	%	23.1	23.1	34.6	19.2		46.2	53.8		
<b>RB</b>	n	7	4	10	3		11	13		
	%	29.2	16.7	41.7	12.5		45.8	54.2		
<b>RW</b>	n	7	5	6	3		12	9		
	%	33.3	23.8	28.6	14.3		57.1	42.9		
<b>Region</b>										
<b>Europe</b>	n	26	21	38	20	9.316	47	58	7.439	
	%	24.8	20	36.2	19	$df=3$	44.8	55.2	$df=1$	0.203
<b>Others</b>	n	25	25	14	11	$p=0.025$	49	26	$p=0.006$	
	%	33.3	33.3	18.7	14.7		65.3	34.67		

Q1–Q4 = birth quarter; S1–S2 = birth semester; n = number of cases; % = relative frequency;  $\chi^2$  = chi-square; df=degrees of freedom; p = level of significance; GK = goalkeeper; LW = left wing; P = pivot; LB = left back; CB = center back; RB = right back; RW = right wing

Statistical analyses have shown that the quarterly distribution of the birth dates significantly differs from the expected one depending on the region of the world ( $\chi^2 = 9.316$ ,  $df = 3$ ,  $p = 0.025$ ), and the size effect is moderate ( $Vc = 0.227$ ).

The obtained results also show that the semester distribution of the dates of birth significantly differs from the expected one depending on the region of the world ( $\chi^2 = 7.439$ ,  $df = 1$ ,  $p = 0.006$ ), and the effect size is relatively moderate ( $Vc = 0.203$ ).

The quarterly distribution of the dates of birth generally does not significantly differ; however, the significance of  $p = 0.099$  indicates a certain statistical tendency in this aspect among handball players characterized by high sports performance. There are no statistically significant differences in the remaining analyzed variables.

#### 4. Discussion

The research results indicate that the RAE was present among handball players participating in the Tokyo Olympics, and the differentiating factors were the geographical location of the countries (continent and region) from which they came. The RAE was clearly visible among men and was differentiated by the region from which the team came.



The results indicating quarterly differences in the RAE, depending on the continent and the region of the world, correspond with the results obtained by de la Rubia et al. [28] and Campos et al. [11]. It can be presumed that the occurrence of these differences may be influenced by many factors. One of them could be the popularity of the discipline, which may translate into the time of starting training, and thus into the recruitment and selection process. In European countries where handball is very popular many young players start training before adolescence. The technical skills acquired during this period and the development of motor skills, in a way, compensate for the differences that appear between players during adolescence (depending on their biological age). Starting training in adolescence, without determining the biological age, predisposes players who mature earlier to achieve higher anthropological and motor parameters, and thus to obtain better sports performance at this stage, which results from the characteristics of handball. This has also been confirmed by the studies by de la Rubia et al. [22, 28], indicating that players born in the first quarters of the year spend more time on the court during the game, which may be related to the level of their motor skills. A study by Lupo et al. [19] also indicates that the RAE determines the beginning of senior careers, which also creates grounds for accepting the above hypothesis regarding the moment of starting training.

The results concerning the lack of the RAE in general correspond to the results obtained by Bjørndal et al. [25], de la Rubia et al., [28] and Wrang et al. [27], who indicate that this effect is absent among both female and male senior players. It should be noted that the studies by Bjørndal et al. [25] and de la Rubia et al. [28] included European players, which may indirectly explain the differences in the RAE shown in this study in the context of the continent and the region of the world from which the players came. When discussing the research results in general terms, it is necessary to point out that handball players differ from football players [5, 15–17] and ice hockey players [18] who exhibit the RAE, which may indicate differences between handball and the other disciplines in the recruitment and selection process. The observed differences provide grounds for further research on differences in the discussed scope, in the context of the practiced sport discipline.

The research results do not indicate that the RAE is present among handball players participating in the Tokyo 2020 Olympic Games in the context of the nominal position in games. In terms of both the total number of players and their gender, the results correspond to the results obtained by de la Rubia et al. [24], who indicate that there is no RAE among senior female players depending on the position in games. Different results are reported by de la Rubia et al. [22], who have shown differences in the RAE among female senior wingers and male senior quarterbacks. The results described by de la Rubia et al. [28] also indicate the quarterly and semester occurrence of the RAE among female and male players depending on the position in games. The observed differences can be explained by both the period in which the research was conducted and the discrepancy between the levels of the games.

When referring the results to the literature on the studied phenomenon in team games, it should be noted that they do not correspond to the data on football players [5, 15]. Differences should be seen in the characteristics of the games, the training process, as well as recruitment and selection in football and handball. The literature also contains results indicating that in football and ice hockey, the RAE occurs in relation to selected positions depending on the period in which the games (the research) took place and the level of the games [16, 18]. Therefore, it should be pointed out that the occurrence of the RAE depending on the nominal position in games tends to be non-homogenous, which indicates the need for further research in order to empirically understand the phenomenon.

When discussing the results obtained among women, it should be stated that, in general, the RAE does not appear depending on the nominal position in games and the region of the world from which the representatives come. The lack of this effect should be explained by the ontogenetic development of women, who often start training during or after the end of puberty, which eliminates differences between players who mature earlier

and later in terms of both anthropological features and the level of motor skills. These results are not unequivocal and, in some respects, they are or are not identical with those obtained by other authors. The results presented by de la Rubia et al. [24] indicate that the RAE does not occur on a quarterly basis, yet it is observed on a semester basis. Also, in terms of the nominal position in games, the mentioned authors indicate differences in the RAE among female quarterbacks [22, 24]. The observed discrepancies may result from different time periods in which the research was conducted and the level of the games. The lack of the RAE in senior female teams is also indicated by Bjørndal et al. [25] and de la Rubia et al. [28], whose research results correspond to those described in this study, creating grounds for a hypothesis that in general the RAE does not occur among female handball players. As regards the results concerning the RAE in relation to the nominal position in handball games, it should be noted that de la Rubia et al. [28] indicate that the RAE occurs on a quarterly and semester basis in all positions. Therefore, it should be noted that these results differ from those presented in this study, indicating the need for further research in this area in order to describe the general trends and generalize the results for the entire population of female handball players. The results obtained indirectly confirm the general tendency in sports indicating that the RAE primarily occurs among men [21].

The results obtained among men indicate that the RAE does not occur among male handball players in general terms. It should be noted, however, that on a quarterly basis, the statistical significance ( $p = 0.099$ ) indicates a statistical tendency in the group under discussion. The presented results indirectly correspond to the position of de la Rubia et al. [21], who indicate that the RAE occurs primarily among male senior players.

When referring to the results of men in terms of the RAE in the context of the nominal position in games, it should be noted that other authors have obtained different results. They indicate that the RAE occurs among handball players depending on the nominal position in games [22, 28]. These discrepancies indicate a substantively justified need to conduct further research on the issue discussed in order to understand and describe it, and to indicate the factors that differentiate it. Also the results obtained in other team games are the prerequisites for further research. Among football players, the RAE occurs depending on the nominal positions [15]; however, the literature also indicates that the RAE only exists in the case of certain nominal positions in football [5] and ice hockey [18], and only in selected football leagues [16].

When discussing the presented research results in the context of the region of the world from which the players came, it should be noted that significant differences in the RAE have been shown in terms of both quarterly and semester distributions. This can be explained by the popularity of handball in Europe and other countries participating in the Tokyo 2020 Olympics, which may translate into the number of players at the earlier stages of training, as well as the appropriate recruitment, selection and training process in handball. It can also be presumed that due to the great popularity of handball in Europe, the training process begins before adolescence, which reduces individual differences between players at the initial stage and allows for a holistic approach to each player. Starting handball training in adolescence predestines early-maturing players to achieve higher sports results due to a higher level of motor skills and anthropological features. The research results presented in this article indirectly correspond to those presented by other authors indicating that the RAE occurs among players from Africa and Europe [28].

The research results presented in this article and their discussion in relation to the results obtained by other authors indicate that there is a substantively justified need to continue research on the RAE. Future research should focus on showing major trends among players participating in top and less-advanced competitions in order to generalize research conclusions. The obtained results also indicate the need for research on the RAE in the context of the regions of the world from which players come, analyzing the recruitment and selection process in handball. From scientific and practical points of view, longitudinal studies of players from the beginning of handball training until their achievement of the highest sports performance in the context of the RAE may prove to be valuable.

In addition to the levels of motor skills, anthropological features and technical and tactical skills, handball players' biological development should be taken into account in the recruitment and selection process.

## 5. Conclusions

The main factor differentiating the RAE among handball players participating in the Tokyo 2020 Olympics in general terms was the geographical location of the country they represented. There was no RAE among female handball players. Among male handball players, the RAE was differentiated by the region of the world from which they came. In order to thoroughly investigate and describe the RAE, further research and the search for factors that differentiate it should be carried out.

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