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Original Article

Effect of relative age in men's ice hockey: the analysis of playing positions, hand dominance, and the level of basic anthropometric characteristics at the Ice Hockey World Championships 2017

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Abstract
The issue of Relative Age Effect (RAE), i.e. the influence of birthdate on performance, has been studied in sports over the last decades. Benefits in terms of morphological, psychological andphysiological characteristics resulting from earlier birthdates for athletes in the same age category often cause that, especially in junior categories, these relatively older individuals are perceived as sportingly talented. The influence of RAE in ice hockey has been proven in different categories, but only a few studies have been devoted to the RAE influence in national teams. The aim of this research was to analyse the RAE in players (n=402; Age M ±SD=27.0±4.16 SD) at the 2017 Ice Hockey World Championships (IHWC) in the context of playing positions, hand dominance and the level of basic anthropometric characteristics. Research data were obtained from the publicly available sources and analysed with the methods of descriptive and inferential statistics (relative and absolute frequency, chi-square test, odds ratio test, Cohen's w and Hedge's g). The results showed that from the point of view of effect size (ES), the influence of RAE can be considered small for both the entire researched group of2017 IHWC players and for the individual playing positions. From the point of view of statistical significance, the influence of RAE cannot be dismissed for the entire group of players and also for the group of right-handed forwards. Also the effect size (ES)of RAE in the context of hand dominance is small, with virtually small differences in body height and weight found between Q_1 and Q_4 players in almost all players. Summarily, it can be stated that only a small, resp. partial degree of RAE in national teams at the 2017 IHWC was demonstrated, also in the context of playing positions, hand dominance and the level of basic anthropometric characteristics.
Key Words: birthdate; talent development; athletic talent; national team; chronological age

Introduction

The issue of Relative Age Effect (RAE), i.e. the impact of birthdate on sports performance, has been a frequent research subject in sports during the last decades. Both in educational and sports systems, athletes are grouped according to their chronological age (Baker, Schorer,& Cobley, 2010). This brings the benefit of early birth in a number of sports: these individuals often have a developmental lead in morphological, psychological and physiological condition, which means that their better performance is not due to more talent, but frequently due to the RAE. In sports, the birthdate issue was first researched in ice hockey approximately in mid-1980s (Grondin, Deshaies, & Nault, 1984). Studies focused on various age levels and leagues: Barnsley, Thompsonand Barnsley (1985) found that a significantly higher frequency was found in junior playersin Western Hockey League and Ontario Hockey League provinces as well as in NHLprofessional players in the first three months of the year (Q_1) than in the fourth quarter. The follow-up study (Barnsley & Thompson, 1988) investigated the RAE influence on sporting success and it was found that the advantage of earlier birthdate could help players to be included in the elite selection. Fumarco et al. (2017) later reached the same conclusion.Barnsley and Thompson (1988)also found that the RAE had stronger influence in the top hockey league (NHL) than in the third league. The drop in the number of third league players born in the second half of the year was described by the authors as the so called drop-out effect. Alfermann (2014) characterizes this concept as ending a sports career before reaching the peak of athletic performance. When assessing the RAE influence on the length of sports careers, i.e. the so-called reverse RAE, Gibbs, Jarvis and Dufur (2012) found that the chronologically younger players had a longer athletic career than players born at the beginning of the year. Baker and Logan (2007) studied the RAE influence in the draft to the NHL and found that the date of birth (andthe size of native town) had a significant impact in later-born players, i.e. relatively younger players, on the probability of being selected to the NHL. However, Turnnidge, Hancock and Côté (2014) came to an opposite conclusion when they had looked at the RAE influence in ice hockey in theProvince of Ontario(2004–2010, n=146 424).

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In women's hockey, the RAE influence was demonstrated by Smith and Weir (2013) for large groups (n=36 555, U8–U21 and older). The Stenling and Holmström research (2014) on women players of the Swedish Hockey League (n=2 811) proved the RAE influence in all age categories (U6–U21). The authors also found that the RAE influence affected the playing position of forwards, resp. defence, but was not found in goaltenders.Similar conclusions came also from Weir, Smith, Paterson and Horton (2010).The results of study of RAE in large sets of players (males) from two age groups (7–8 years, n=17 613; 15–17 years, n=28 246; Ontario Hockey Federation) were presented by Hancock, Ste-Marie and Young (2013). The authors demonstrated a significant RAE influence in the age category of 7–8 years, stronger in the regular hockey players (χ^2=306.24; p<0.01) in contrast to substitute players (χ^2=64.75; p<0.01). A significant RAE influence was also proven in the age category of 15–17 years, again the impact was stronger in regular hockey players (χ^2=319.06; p<0.01) than in substitutes (χ^2=31.13; p<0.01). This problem is often referred to as the 'opening of the scissors' in the economic sciences, i.e. the problem is growing deeper instead of being eliminated.

The fundamental issue creating the RAE problem is that the selection of athletic talents often occurs during the pubescence period when the performances of players of the same age group are affected by different levels of biological development. In majority of fitness-intensive sports, the so called 'athletic talents' are usually chosen according to the current level of morphological, psychological, and above all physiologicalconditionand they often end their athletic career after a few years. One of the possible reasons may be the fact that the advantage of their earlier date of birth and the associated number of benefits cease to affect them later (Abbott & Collins, 2004; Figueiredo et al., 2009). This is also suggested by Helsen et al. (2000): Many young athletes, who are referred to as athletic talents by their coaches, only benefit from their early physical maturity linked with the RAE. In spite of a large number of publications and knowledge from the field of RAE influence, this issue is still not given enough attention in practice. Coaches, clubs and sports federations are often unwilling to change the established system of identification, choice and talent selection. They also often argue that there is no evidence that changing the existing system will lead to a better selection (Romann & Fuchslocher, 2009). If talent identification is to be successful, it is important to choose a suitable method of its selection, which is often problematic as the potential of pubescents develops and changes during adolescence. According to Simonton (1999),a talent for 'something' can change in the course of ontogenesis into a talent for 'something completely different' or its potential may be not fulfilled at all unless it is properly developed.

Only very few studies focus on the relationship of RAE andthe lateralityof upper limbs (preferred hand);Loffing, Schorer and Cobley (2010) found that the influence of RAE on professional tennis players was statistically proven in players with dominant right hand, but not in players with dominant left hand. Berrenetxea et al. (2018) in their studies of elite water polo players did not find any RAE influence in the group sample (men: n=622; women: n=623). Therefore, it is not a ‚typical' RAE; nevertheless, lateralitycould be a possible moderator of the RAE particularly in left handed players, which should be taken into account in future studies.Cobley et al. (2009) as well as Jimenez and Pain (2008) point out that an earlier birthdate also brings the advantage of bigger body height (and, to some extent, weight) and the related higher level of strength, endurance and speed (Söğüt & Altunsoy, 2019, Vodička et al., 2018).The issue of RAE influence on body height was also examined by Hirose (2009) in football (soccer) players(male, n=332, 9.1–15 years) who found that players in U11, U13 and U14 categories born in the last quarter (Q_4) were significantly smaller than players from Q_1. These results confirmed the previous findings about the advantage of older athletes in the area of physiological characteristics.

The above given data make it clear that the issue of RAE influence in ice hockey is a frequent research topic especially in junior categories and in NHL players. Only a few studies are interested in RAE in national teams. For this reason, our study focuses on analysing the RAE influence on participants of the 2017 Ice Hockey World Championships.The aim of the research was to analyse the RAE influence on all players at the 2017 Championships in the context of playing positions, hand dominance and the level of basic anthropometric characteristics (body height and weight).

Material &methods

Participants

The Ice Hockey World Championships was held by Germany and France from 5 to 21 May 2017.The matches were played in Cologne and Paris. The total number of players was 402 (male),aged18.8 to 41.7 years (M±SD=27.0±4.16); research data were obtained from publicly available sources (http://www.hokej.cz/reprezentace/roster/15).

Data analysis

The following variables were analysed: birthdate, body height, body weight, playing position, hand dominance. The distribution of players into individual quarters was carried out according to their birthdate as follows: Q_1 (January through March), Q_2 (April through June), Q_3 (July through September), Q_4 (October through December).Data were analysed with the methods of descriptive and inferential statistics. With regard to the large size of the group, we used the Chi-Square (χ^2) test in its Goodness of Fit variant to assess the theoretical (expected) and empirical (observed) frequency distribution match. Data were analysed using the online calculator available at https://www.socscistatistics.com/tests/Default.aspx. The empirical distribution of frequencies was found from the official published data; information on the theoretical distribution of data frequencies was obtained from the data.un.orgdatabase. We used the data on the number of children born in the year which was the median of the birth year of all the participants of 2017 IHWC (median=1990). Frequencies expected: Q_1=24.73%; Q_2=24.09%; Q_3=26.27%; Q_4=24.9%(source:www.data.un.org). To compare the occurrence of the observed phenomenon (forQ_1:Q_4), we used the odds ratio statistical method (Odds Ratio; OR) and the confidence interval (CI) 95%.To assess the effect size (ES)of the χ^2test values, we used the effect size index*w* value, which can be - in accordance with the author (Cohen, 1988) - interpreted as small (*w*=0.10); medium (*w*=0.30) orlarge effect (*w*=0.50).To assess ES differences between the players born in the Q_1 and Q_4 quarters in the body height and weight variables, we used (because of the very different ranges of sizes of examined groups)the Hedge's g coefficient (interpretation: smallg<0.50;medium g<0.80, large effectg≥0.80).

Results

RAE influence in all players and in individual playing positions

Table 1 gives an overview of frequency distribution in the group of all players according to the birthdate in theQ_1–Q_4quarters as well as frequency distribution in the groups according to the playing position (goaltender, defence, forwards).

Table1–RAE influence on playing positions and entire investigated group

Position	Q_1	Q_2	Q_3	Q_4	χ^2	*p*	OR (CI)	*w*	ES
Goaltender (*n*=48)	13 27.1%	13 27.1%	12 25.0%	10 20.8%	0.63	0.89	1.33 (0.42–4.23)	0.11	Small
Forward (*n*=226)	78 34.6%	54 23.9%	54 23.9%	40 17.7%	13.94	0.00	2.00 (1.17–3.41)	0.25	Small
Defence (*n*=128)	43 33.6%	22 17.2%	35 27.3%	28 21.9%	7.12	0.07	1.57 (0.79–3.13)	0.24	Small
Total (*n*=402)	134 33.3%	89 22.1%	101 25.1%	78 19.4%	17.75	0.00	1.76 (1.16–2.68)	0.21	Small

Note: Q_i=square,χ^2=chi-square test, *p*=p-value, OR=Odds Ratio, CI=Confidence Interval, *w*=Cohen's w, ES=effect size interpretation

Table 1 clearly shows that 1/3 of the players (33.3%) is born in Q_1, and more than 1/2in the first half of the year (55.4%). In terms of assessing the effect size (ES), it is possible to consider the influence of RAE both for the entire research group and for individual playing positions as small (*w*=0.11–0.25). The assessment of the statistical significance of RAE with the help of χ^2test showed that the RAE influence cannot be dismissed for the entire group (χ^2=17.75; p<0.01) and for the group of forwards (χ^2=13.94; p<0.01). On the other hand, the RAE influence is dismissed in the group of goaltenders (χ^2=0.63; *p*=0.89) as well as the defence (χ^2=7.12; *p*=0.07).The use of the odds ratio test (OR) has allowed us to assess how much chance of getting to the 2017 IHWC the players born in Q_1have, compared to the players born in Q_4. It was found that forwards had in all cases the greatest chance(OR=2.00; CI=1.17–3.41), goaltenders the smallest chance(OR=1.33; CI=0.42–4.23). Forwards born in Q_1thus had a two times greater chance of participating in 2017 IHWC than forwards born in Q_4.

RAE influenceand handdominance

In Table 2, the groups of all players and the groups of playing positions are divided by hand dominance into subgroups of right-handed (R) and left-handed (L), for which the RAE influence was subsequently researched.

Table2–RAE in connection with hand dominance and playing positions

Position	Q_1	Q_2	Q_3	Q_4	χ^2	*p*	OR (CI)	*w*	ES
Goalies-R (*n*=44)	12 27.3%	11 25.0%	12 27.3%	9 20.5%	0.5	0.92	1.37 (0.4–4.6)	0.11	Small
Goalies-L (*n*=4)	1 25.0%	2 50.0%	0 0.0%	1 25.0%	-*	-*	-*	-*	-*
Forwards-R (*n*=177)	63 35.6%	40 22.6%	44 24.9%	30 16.9%	13.24	0.00	2.15 (1.2–4.0)	0.27	Small
Forwards-L (*n*=49)	15 30.6%	14 28.6%	10 20.4%	10 20.4%	2.13	0.55	1.54 (0.5–4.8)	0.21	Small
Defence-R (*n*=95)	34 35.8%	17 17.9%	23 24.2%	21 22.1%	6.66	0.08	1.66 (0.8–3.7)	0.26	Small
Defence-L (*n*=33)	9 27.3%	5 15.2%	12 36.4%	7 21.2%	2.64	0.45	1.32 (0.3–5.3)	0.28	Small
Total-R (*n*=316)	109 34.5%	68 21.5%	79 25.0%	60 19.0%	17.68	0.00	1.86 (1.2–2.9)	0.24	Small
Total-L (*n*=86)	25 29.1%	21 24.4%	22 25.6%	18 20.9%	1.22	0.75	1.42 (0.6–3.4)	0.12	Small

Note: L=left-handed players; R=right-handed players; *=insufficient group size

In terms of effect size (ES), it is necessary to consider RAE influence as small in the group of all players, in individual playing positions, right-handed as well as left-handed players (left-handed goaltenders were not assessed because of their small number, n=4). The statistical assessment of RAE (χ^2test) showed that it cannot be dismissed for the group of all players (R, χ^2=17.68; p<0.01) and forwards (R, χ^2=13.24; p<0.01). The odds ratio (OR) test results and confidence interval (CI 95%) in players from Q_1 and Q_4 showed that the right-handed forwards (R) born in Q_1 had the greatest chance to get to the 2017 IHWC tournament (OR=2.15; CI 1.2–4.0), i.e. with 2.15 times greater probability.

RAE influence, level of anthropometric indicators and hand dominance

In Table 3, the whole group and individual playing positions are divided into the right-handed (R) and left-handed (L); the mean values (M) for body height and weight are shown inQ_1, Q_4 and $Q_{1–4}$.The first (Q_1) and the last quarters(Q_4) were chosen because of the expected significant differences caused by the RAE.The Hedges' g value (Hedges, 1981) was used to assess effect size(ES) between Q_1 and Q_4.

Table3–RAE in connection with height, weight, hand dominance and playing positions

Position	Height [cm]	Q_{1-4} [$\bar{M}$]	Q_1 [$\bar{M}$]	Q_4 [$\bar{M}$]	g [Q_1:Q_4]	ES	Weight [kg]	Q_{1-4} [$\bar{M}$]	Q_1 [$\bar{M}$]	Q_4 [$\bar{M}$]	g [Q_1:Q_4]	ES
	R+L	185.0	186.2	184.0	0.62	Medium	R+L	84.3	86.7	84.3	0.47	Small
Goalies(n=48)	R	184.9	186.2	183.2	0.91	Large	R	84.3	86.7	84.1	0.49	Small
	L	185.8	-*	-*	-*	-*	L	84.3	-*	-*	-*	-*
	R+L	183.9	183.5	184.6	0.22	Small	R+L	86.7	86.9	88.4	0.23	Small
Forwards(n=226)	R	184.3	183.9	185.2	0.26	Small	R	87.3	87.8	88.9	0.17	Small
	L	182.6	181.5	182.9	0.30	Small	L	84.4	83.3	86.8	0.62	Medium
	R+L	185.8	186.3	186.0	0.06	Small	R+L	89.8	89.7	90.2	0.08	Small
Defence (n=128)	R	186.0	186.4	185.6	0.15	Small	R	89.6	89.6	89.7	0.02	Small
	L	182.6	185.8	187.3	0.25	Small	L	90.1	90.2	91.7	0.23	Small
	R+L	184.7	184.6	185.0	0.08	Small	R+L	87.4	87.8	88.5	0.11	Small
Total (402)	R	184.9	184.9	185.0	0.02	Small	R	87.6	88.2	88.5	0.05	Small
	L	183.9	183.3	185.1	0.33	Small	L	86.6	86.0	88.7	0.40	Small

Note: *=insufficient group size; g=Hedge's g

Compared to the average (M) body height (184.7 cm) of all players (n=402), the goaltenders (diff=+0.3 cm) and the defence (diff=+1.1 cm) achieve slightly higher average values;lower values are then achieved by forwards (diff=-0.8 cm). Small substantively significant differences in body height between players from Q_1 and Q_4 were found in the groups of all players, forwards and defence players, both right-handed (R) and left-handed (L). Only in the whole group of goaltenders, amedium significance of differences (g=0.62) was found as well as alarge significance in the right-handed goaltenders (R).With regard to the fact that they are all adult players and that the goaltenders (Table 2) have shown only a very small RAE influence, this is difficult to explain logically. Due to the average weight of all players (87.4 kg), the biggest differences were found in the defence (diff=+2.4 kg), a lower weight was found in forwards (diff=-0.7 kg) andgoaltenders (diff=-3.1 kg). Small effect size differences in body weightbetween players born in Q_1 and Q_4 were found, with the exception of left-handed forwards (g=0.62), for all other players (goaltenders, forwards and the defence, right-handed as well as left-handed).

Discussion

Barnsley, Thompson and Barnsley (1985) found in NHL players already in 1982/83an uneven distribution of players' frequencies in individual quarters Q_1–Q_4(n=715, Q_1=32.0%, Q_2=29.8%, Q_3=21.9%, Q_4=16.2%). The results of our research (Q_1=33.3%, Q_2=22.1%, Q_3=25.1%, Q_4=19.4%) proved in all the 2017 IHWC players (n=402) a statistically significant (χ^2=17.75, p<0.01), but mostly small(*w*=0.21) RAE influence. Many authors (Ulbricht et al.,2015;Müller, Müller, Hildebrandt,& Raschner, 2016)state that RAE influence in junior categories grows with a higher performance level of the athletes. Müller et al. (2015) founda smaller RAEinfluence in provincial ski racers (χ^2=9.00; *p*<0.05; *w*=0.26) than in national ski racers (χ^2=11.29; p<0.01; *w*=0.41), while these values are comparable with the values we found in the national teams of hockey players (χ^2=17.75; *p*<0.01; *w*=0.21). Delorme,Boiché and Raspaud (2009) noted that the RAE influence in French elite athletes was not proven in football, basketball, volleyball, handball and rugby players;a significant influence was found only in ice hockey players (n=248; χ^2=13.13; p<0.01). Smith and Weir (2013)investigated the RAE influence in the Ontario Women's Hockey Association (2010/2011)and found that, of all the age categories studied (U8–U21 andSenior/Masters), RAE influence was most significant in the age category of U14 (χ^2=117.62; *p*<0.01; *w*=0.13) and weakest, but still statistically significant, in the age category of Senior/Masters (χ^2=15.8; *p*<0.01; *w*=0.15). The numerical characteristics in the Senior/Masters category are similar to those we have found in the group of all ice hockey players at the 2017 IHWC. When investigating RAE influence on playing positions through our research, we have found a small RAE influence in terms of effect size; based on statistical significance (χ^2test) the RAE influence cannot be dismissed in the entire group (χ^2=17.75; *p*<0.01) as well as in the group of forwards (χ^2=13.94; p<0.01). Lavoie, Laurencelle, Grondin and Trudeau (2015) found in the Quebec hockey league (U15) that the least influence of RAE was observed in the position of goaltender (n=50; χ^2=2.64; *p*>0.05;*w*=0.23). The weakest and statistically insignificant RAE influence on the goaltender position was also confirmed by Stenling and Holmström (2014) in the Swedish women players of the Elite category(n=90; χ^2=4.76; p>0.05; w=0.23)and Junior Elite category (n=45; χ^2=5.58; p>0.05; w=0.35).Our results show that 78.6% of players at the 2017 IHWChave dominant right hand, and only 21.4%left hand. Although in terms of effect size (ES) a small RAE influence on individual playing positions was shown, in terms of statistical significance this influence cannot be dismissed in the group of all players or in forwards (R). Loffing, Schorer and Cobley (2010)studied the influence of RAE in professional tennis players (ATP, Top 500, 2000–2006) and found that 86.6% tennis players play with the right hand and 13.4% with the left hand. The authors showed that the RAE influence in players with the dominant right hand (n=889) is small in terms of the ES (effect size), but statistically significant (χ^2=27.32; p<0.01; w=0.18). Again, a small RAE influence in terms of the ES, statistically insignificant (χ^2=3.28; p=0.35; w=0.15) was found in players with the dominant left hand.The odds ratio (OR)test results assessing the chance of Q_1 born players to qualify for 2017 IHWC tournament compared to Q_4born players proved that the forwards (R) born in Q_1 have the largest chance. The odds ratio test (OR) was also used by Müller, Hildebrandt and Raschner (2015), who were assessing the chances of skiers born Q_1against Q_4. They demonstrated bigger chances for the national ski racers(OR=4.67, age 7–11 years, OR=2.6, age 12–15 years), compared to the provincial ski racers (OR=1.82, age 7–11 years, OR=1.51, age 12–15 years).

Conclusion

Through assessing the influence of RAE on 2017 IHWCplayers, it was found that, in terms of effect size (ES), the RAE influence can be considered small both in the whole researched group and in individual playing positions. From the point of view of statistical significance, the RAE influence cannot be dismissed in the entire group of players as well as in the group of right-handed forwards (R).

In assessing RAE influence in relation to hand dominance, only a small influence was found both in the group of all players and in individual playing positions, resp. both right-handed and left-handed players, from the point of view of effect size (ES). The RAE influence cannot be dismissed in the group of all right-handed players and right-handed forwards in terms of statistical significance. In terms of effect size (ES) of differences between the Q_1 and Q_4 players, small differences in body height (except for goaltenders) and body weight (except for left-handed forwards) were found in all the players. Summarily it can be stated that only a small, resp. partial degree of the RAE influence has been demonstrated in national teams at the2017 IHWC. Due to the results of numerous researches demonstrating the RAE influence especially at junior level, it is important to recommendthe coaches and sport functionaries working with talented young people (as well as the parents) to learnabout the RAE influence and to take this into account when selecting athletic talents.

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