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THE NEED TO CONSIDER RELATIVE AGE EFFECTS IN WOMEN'S TALENT DEVELOPMENT PROCESS[1]

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Summary.—Relative age effects (RAEs) refer to age differences among athletes in the same selection year. This study analyzed birth date distributions of 301,428 female athletes (aged 10–20 yr.) in Swiss Youth sports and the subgroup ($n = 1,177$) of the National Talent Development Program (TDP) in individual sports. Comparisons showed significant RAEs in the distribution of athletes' birth dates in alpine skiing, tennis, athletics, fencing, and snowboarding. Significant "reverse" RAEs with an overrepresentation of athletes at the end of the year were found in table tennis. In the TDP, significant RAEs were found in alpine skiing and tennis. No RAEs were detected in athletics. In table tennis, fencing, and snowboarding, "reverse" RAEs were found. Clearly, RAEs are complex and vary across individual sports for females.

Age is a very important criterion for inclusion in many organizations and institutions within our society. The practice of age grouping is widely used in education and youth sports. Sports policy makers and sports federations typically group children by annual age categories to reduce the effects of developmental discrepancies. Although this strategy is well-intended, it leads to significant age differences of almost 12 mo. between children in the same annual age group. Being 'relatively older' compared to a 'relatively younger' peer leads to consistent participation inequalities and selection biases in youth and developmental ages and stages of sport. A high relative age in combination with higher physical (e.g., greater height, more strength) and psychological attributes provides performance advantages in the majority of sports. This advantage and the resulting skewed birth date distributions among participants in youth sport and professional sport has been termed the relative age effect (RAE) (Cobley, Baker, Wattie, & McKenna, 2009). In some technical sports where low weight and height is an advantage, an overrepresentation of athletes born at the end of the competition year has been observed. This special phenomenon of RAEs has been termed "reverse" or "inverse" RAE in the current literature, to emphasize the reversed trend compared to the traditional RAE (Baxter-Jones, Helms, Maffulli, Baines-Preece, & Preece, 1995; Delorme & Raspaud, 2009; Romann & Fuchslocher, 2011, 2013a; Gibbs,

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Jarvis, & Dufur, 2012; Coutts, Kempton, & Vaeyens, 2014; Wattie, Tietjens, Cobley, Schorer, Baker, & Kurz, 2014).

Until now, RAEs have been identified within a variety of youth sports and have been consistently noted in male youth team sports like basketball, baseball, ice hockey, rugby, soccer, and volleyball (Cobley, *et al*., 2009). In addition, most studies concerning RAEs in sports have been focused on male athletes and Cobley, *et al*. (2009) showed that existing literature about RAEs in female athletes only comprises 2% of the all participants investigated. Therefore, the existence of RAEs in female athletes is still a matter of debate. Furthermore, the majority of participants have been analyzed from team sports, while there are few studies examining RAEs in individual sports (Cobley, *et al*., 2009; Baker, Janning, Wong, Cobley, & Schorer, 2014).

In the few rare cases where female athletes in individual sports were investigated, significant RAEs have been shown in tennis (Baxter-Jones & Helms, 1996; Edgar & O'Donoghue, 2005), cross-country skiing, and alpine skiing (Baker, *et al*., 2014). However, no RAEs were found in several female individual sports like swimming, gymnastics (Baxter-Jones & Helms, 1995), tennis (Edgar & O'Donoghue, 2005), taekwondo (Albuquerque, Lage, da Costa, Ferreira, Penna, de Albuquerque Moraes, *et al*. 2012), figure skating, ski jumping (Baker, *et al*., 2014), badminton, and athletics (Nakata & Sakamoto, 2012). Interestingly, in shooting, jockeys in horse racing, and female snowboarding, significant "reverse" RAEs, with an overrepresentation of athletes born in the end of the year, have been observed (Delorme & Raspaud, 2009; Nakata & Sakamoto, 2011; Baker, *et al*., 2014). Hence, there has been much less research on individual female sports, and the results have been inconsistent and even contrary, especially for female athletes.

Different explanations have been proposed for the RAE in sports. The effects are seen primarily in youth, and certainly among equally mature adult athletes. One would not consider a few months' difference in age to yield large differences in physical attributes (e.g., greater height and muscular strength). As RAEs are based on chronological age, relatively older children consistently have the advantage of advanced age, which favors advanced maturation (Schorer, Cobley, Busch, Brautigam, & Baker, 2009). As a consequence, adolescents born at the end of the selection year are less likely to reach the highest levels in elite sports and are more likely to drop out (Helsen, Starkes, & Van Winckel, 2000). Delorme, Boiché, and Raspaud (2010a) illustrated that dropout rates result from two major processes. First, adolescents born late in the selection year may be less likely to join a sport in which weight, height, or strength are important for performance. Second, those who are involved in a sport are more likely to drop out and have fewer chances to be selected because they tend to be smaller, less strong, and less physically mature. Additional explanations for relatively older children's superior performance involve the amount of practice experience and also psychological development (Musch & Grondin, 2001). They described factors related to the sports setting that may increase RAEs, such as the level of competition, the sport's popularity, early specialization, and the expectations of coaches who are involved in the selection process. In the majority of male sports, the level of competition and the popularity of the sport are higher compared to female sports. This is due to higher participation rates, more media attendance, and more funding in male sports, which affects the prevalence of RAEs (Swiss Federal Office of Statistics, 2013).

To date in Switzerland, significant RAEs have been detected in soccer for both sexes (Romann & Fuchslocher, 2011, 2013b). No data is available in other Swiss team sports or in any Swiss individual sport. The Swiss Federal Office of Sport (FOSPO) and Swiss Olympic (SO) invest approximately 20 million Swiss Francs (22 million US$) in individual youth sports, and there is a major concern about funding reaching athletes with the most potential and effective investment. Given the presence of these well-funded and well-organized programs and the potential for introducing bias into talent selection of sports, it is worth examining female individual sports that have high participation and receive the most governmental funding. In Switzerland, these sports are alpine skiing, tennis, athletics, table tennis, fencing, and snowboarding. Therefore, the purposes of this study were twofold: first, to examine the prevalence and size of RAEs in these female individual sports; and second, to identify whether the selection level modifies the prevalence and size of the RAEs.

Method

Participants

The Swiss youth sport system is based on two levels of performance. The first level is a nationwide extracurricular program called Youth and Sport (J+S), which is offered for all children and adolescents ages 10 to 20 yr. interested in a specific sport. The second level is the National Talent Detection and Development Program (TDP) for athletes from 10 to 20 yr. old. All female athletes who participated in the seasons from 2009 to 2011 were included in the analysis. For this period of time, J+S contained 186,468 females actively registered in alpine skiing, 58,155 in tennis, 47,580 in athletics, 3,675 in table tennis, 3,372 in fencing, and 2,178 in snowboarding. Participants can only register once per year for a J+S program in a specific sport, but it is possible to participate in more than one sport.

The minimum duration for a J+S course is at least 30 wk. per yr. with one training session per wk. Every training session has to last at least

60 min. Athletes of TDP are assisted by licensed coaches and are expected to train more than 400 hr. per yr. (Swiss Federal Office of Statistics, 2013). The FOSPO and SO jointly established the cut-off criterion for adoption into the program as 400 hr. In total, 301,428 datasets of three different sports were examined to calculate RAEs in Swiss individual sports. Comparisons were carried out between the datasets of all registered J+S athletes and athletes in the TDP.

Procedure

All athletes were grouped according to the birth month of the selection period, sport, and selection level. The cut-off date for all analyzed sports was January 1st. As in prior RAE studies, the year was divided into four quarters (Q) to analyze RAEs. Q1 represented January, February, and March; Q2 represented April, May, and June; Q3 represented July, August, and September; and Q4 represented October, November, and December. The observed birth date distributions were calculated for each quarter. The expected birth date distributions of J+S were the distributions of all corresponding birthdates of the Swiss population (ages 10–20 yr.), obtained from the Swiss Federal Office of Statistics (2013). Beforehand, the respective age categories of the Swiss population were analyzed to verify the equal distribution of relative age quartiles. All relative age quartiles of Swiss resident females were similarly distributed (Q1=24.6%; Q2=25.2%; Q3=26.0%; Q4=24.2%). According to Delorme, Boiché, and Raspaud (2010b), instead of the entire Swiss population the distribution of J+S (all registered athletes) was used as a basis (expected distribution) to evaluate RAEs of TDP. The expected birth date distributions of the TDP were the distributions of all athletes who were participating in the specific sport program of J+S. If a biased distribution already existed among the entire basic population of registered athletes of J+S, the same pattern would arise among the TDP as well, and influence the conclusions drawn about RAEs.

Analysis

From these original data, odds ratios (ORs) and 95% confidence intervals (*CI*) were calculated for Q1 vs Q4. All statistical analyses were carried out using SPSS 18.0. Chi-square tests were used to assess differences between the observed and expected birth date distributions. If the differences were significant, then *post hoc* tests were used to calculate the mean differences between the quarters. In addition, effect sizes were computed to qualify the results of the chi-squared tests. The appropriate index of effect size is Cramer's V (V) if the *df* is above 1 (Aron & Aron, 2003). According to Cramer (1999), for *df*=3 (which is the case for all comparisons of birth quarters), V=0.06 to 0.17 described a small effect, V=0.18 to 0.29

described a medium effect, and $V \geq 0.30$ described a large effect. An alpha level of $p < .05$ was applied as the criterion for statistical significance.

Results

Compared to the respective Swiss female population, significant RAEs were found in all registered J+S athletes of alpine skiing, tennis, athletics, snowboarding, and fencing. An exception was table tennis where significant "reverse" RAEs were detected with an overrepresentation of athletes born in the end of the year (Table 1). However, calculations of effect sizes showed that the RAEs have no practical relevance for the participation of all analyzed sports.

Compared to the distribution of all registered J+S athletes, the athletes of the TDP showed significant RAEs in alpine skiing and tennis. In athletics, no RAEs were detected. In contrast, female snowboarders, table tennis players, and fencers showed significant inverse RAEs (Table 2). RAEs were small in alpine skiing and medium in tennis. Inverse RAEs were small in female table tennis and medium in female snowboarding and fencing.

Discussion

RAEs in Individual Sports

RAEs have traditionally been observed among male athletes of the elite level in team sports where physical attributes such as weight, height, and strength represent key factors for success. As shown, the self-selected J+S athletes of alpine skiing, tennis, athletics, fencing, and snowboarding showed statistically significant RAEs. In other words, female adolescents born in the beginning of the selection year are more likely to participate in these individual sports compared with their younger counterparts. Those born in Q3 and Q4, possibly because of their less advantageous physical and/or psychological attributes, showed a kind of self-selection process and apparently did not participate in these sports. It is important to note that coaches of the TDPs have to select from the pool of athletes participating in J+S. This distribution of athletes of J+S influences the prevalence of RAEs in the TDP in these individual sports.

Table tennis seems to be an exception, showing "reverse" RAEs in the basic population of all J+S participants. However, van Rossum (2006) showed that if motor skills are a fundamental asset for success and the relevance of physical factors is low, no RAEs can be expected in certain sports. Compared to the study of van Rossum (2006) which compared only 56 athletes, the sample size is much bigger ($n = 3{,}675$). There are Swiss sports like soccer where RAEs have been found in the basic population of active female soccer players (Romann & Fuchslocher, 2011). If there is no

TABLE 1
RAEs in the Female J+S Population

Sport	*n*	Q1	Q2	Q3	Q4	χ^2	V	OR Q1/Q4	95% *CI*
Swiss population	319,480	78,592	80,509	83,065	77,314				
%		24.6	25.2	26.0	24.2				
Alpine skiing	186,468	46,521	46,809	48,360	44,778	31.0†^{R}	0.01	1.02	(1.00, 1.04)
%		24.9	25.1	25.9	24.0				
Tennis	58,155	15,033	14,787	14,604	13,731	84.4†^{R}	0.02	1.07	(1.04, 1.10)
%		25.8	25.4	25.1	23.6				
Track and field	47,580	12,870	12,375	11,709	10,626	237.6†^{R}	0.04	1.19	(1.14, 1.23)
%		27.0	26.0	24.6	22.3				
Table tennis	3,675	795	975	990	915	17.7†^{R}	0.04	0.85	(0.77, 0.94)
%		21.6	26.5	26.9	24.9				
Fencing	3,372	921	792	933	726	27.6†^{R}	0.05	1.24	(1.10, 1.41)
%		27.3	23.5	27.7	21.5				
Snowboard	2,178	564	609	522	483	16.2†^{R}	0.05	1.14	(0.99, 1.32)
%		25.9	28.0	24.0	22.2				

Note.—For the analysis of all J+S participants, this study normalized according to the basic population (national distribution). For the analysis of TDP participants this study normalized according to the respective J+S distribution (according to Delorme, 2010). The reason for this approach is that only active participants of J+S (first level) can enter in the TDP (second level). Q1 to Q4 = quarter 1 to 4; V = Cramer's V; *$p < .05$. †$p < .01$. ^{R} = reverse RAEs; OR = Odds ratio; 95% *CI* = 95% Confidence Interval.

TABLE 2

RAEs in the Female Talent Development Program ($N = 1,177$)

Sport	*n*	Q1	Q2	Q3	Q4	χ^2	V	OR Q1/Q4	95% *CI*
Alpine skiing	508	165	141	107	95	23.9†	0.13	1.67	1.19, 2.16
%		32.5	27.7	21.1	18.7				
Tennis	156	62	31	31	32	15.9†	0.18	1.77	1.15, 2.71
%		39.7	19.9	19.9	20.5				
Track and field	227	69	62	55	41	3.0†	0.07	1.39	0.94, 2.05
%		30.4	27.3	24.2	18.1				
Table tennis	111	22	19	40	29.97	7.0*[R]	0.15	0.84	0.49, 1.46
%		19.8	17.1	36.0	27.1				
Fencing	88	13	19	25	31	12.9†[R]	0.22	0.33	0.17, 0.63
%		14.8	21.6	28.4	35.2				
Snowboard	87	11	19	30	27	14.1†[R]	0.23	0.35	0.17, 0.70
%		12.7	21.8	34.5	31.0				

Note.—Q1 to Q4 = quarter 1 to 4; $\chi 2$ = Chi2-value; V = Cramer's V; [R] = reverse RAEs; OR = Odds ratio; 95% *CI* = 95% Confidence Interval; expected frequencies were taken from respective sports (shown in Table 1). $^*p < .05$. $^\dagger p < .01$.

RAE in the general participation in sports, there should be some sports where a "reverse" trend of the RAE exists; table tennis seems to be one of these sports. A possible reason for the existence of inverse RAEs in table tennis could be that this sport is a sport attracting those who drop out of tennis (Worek, 2013). Elite youth tennis requires high physical and cognitive demands. A high relative age is an advantage, and therefore high RAEs are found in tennis (Edgar & O'Donoghue, 2005). Players who are not selected in elite groups tend to be smaller, less strong, and less physically mature and might change to a racket sport with less physical demands. But this is speculative, and further research is needed to explain the mechanisms of "reverse" RAEs in table tennis.

RAEs in Talent Development Programs

In the subgroups of talent development programs, statistically significant RAEs were found in alpine skiing and tennis. No RAEs were detected in female athletics; in female table tennis, fencing, and snowboarding, "reverse" RAEs were found. In alpine skiing and tennis where strength, weight, or height are seen as relevant for performance, children born late in the competition year may be less likely to be selected. In contrast, in sports like table tennis, fencing, or snowboarding, which require high technical skill or aesthetics for performance, relatively younger, smaller, less strong, and less physically mature individuals may have an advantage and are more likely to be selected (Baker, *et al*., 2014).

The existence of RAEs in male sports where physical factors are fundamental for success are well documented in the literature (Cobley, *et al*., 2009). However, in female sports, RAEs are more variable when compared to males. In some sports like alpine skiing, volleyball, and soccer, RAEs were found, although they were always smaller than those observed in the male athletes of the same selection level (Nakata & Sakamoto, 2012; Baker, *et al*., 2014; Romann & Fuchslocher, 2014). In other sports like ski jumping, figure skating, and taekwondo, no RAEs were found (Albuquerque, *et al*., 2012; Baker, *et al*., 2014). In snowboarding and gymnastics, "atypical" distributions with the highest proportions in Q3 were reported (Schorer, *et al*., 2009; Baker, *et al*., 2014). The mechanisms explaining the inconsistency of RAEs in females are largely unknown. Previous research has suggested that lower participation in female sports may reduce the depth of competition for females and thereby moderate the size and strength of RAEs (Schorer, *et al*., 2009). The absence of RAEs in female and male taekwondo was explained by grouping youth participants into competitive or weight categories (Albuquerque, *et al*., 2012). A categorization by weight removes the effects of greater strength, size, and weight due to maturational differences. Therefore, according to recent literature, weight categories seem to eliminate RAEs (Albuquerque, *et al*., 2012; Albuquerque, Tavares, Lage, de

Paula, da Costa, & Malloy-Diniz, 2013; Delorme, 2013). Additionally, Albuquerque, *et al*. (2013) showed that only in extra-light to middle-weight judo athletes there are no RAEs because technical demands are important for performance. The existence of RAEs in half-heavy and heavy athletes was explained by the high physical demand in heavy categories.

Additionally, the varying cultural importance of different sports might affect the number of participating athletes, with the most capable athletes competing in sports with the highest cultural relevance (Weir, Smith, & Paterson, 2010). This can be confirmed in the current data, given that alpine skiing and tennis were the individual sports with the highest popularity, the largest amounts of sponsoring money, highest media attendance, and largest numbers of participants in Switzerland (Swiss Federal Office of Sport, 2013). The existence of "reverse" RAEs in female table tennis, fencing, and snowboarding might show a contrary phenomenon. Female athletes who are not successful or drop out of culturally important sports might transfer to less competitive and more technical sports like snowboarding, fencing, and table tennis. A second possible explanation might be that the physical characteristics needed for athletic performance are sometimes inconsistent with the stereotyped ideal representation of the female body, which is expected to be thin and petite (Choi, 2000). Researchers have argued that social pressures, such as stereotyped ideas of femininity, could pressure early-maturing girls to drop out of sports where physical attributes are important (Vincent & Glamser, 2006). This might favor a transfer to a sport that integrates aesthetics and high technical skill into performance (e.g., from tennis to table tennis or from alpine skiing to snowboarding). Moreover, previous studies have suggested that sports that depend heavily on the technical skills or motor skills of the participant will produce no RAE (van Rossum, 2006; Schorer, *et al*., 2009) or even "reverse" RAEs as shown in the current data. In sports where aesthetics and technical skill determine performance, "reverse" RAEs seem to be more prevalent.

Possible Solutions

To further optimize the talent development system in Switzerland and retain youth in sport, the challenge seems twofold. On one hand, it seems important to include athletes disadvantaged due to RAEs in individual sports at an early age. On the other hand, it is crucial to keep athletes involved in talent development programs after puberty ends. Barnsley and Thompson (1988) have suggested creating categories by weight, height, or age categories with a smaller bandwidth (e.g., 6 mo. instead of one yr.). This change would result in smaller RAEs and fewer physical differences between athletes within any specific age category. As shown by Albuquerque, *et al*. (2012) and Delorme (2013), the implementation of weight categories may counteract RAEs in sports. Grondin, Deschaies, and Nault (1984) recommended an alteration of the activity year's cut-off dates. A yearly rotation for the cut-off date might work since all athletes would then experience the advantage of a higher relative age at some point in their careers (Hurley, Lior, & Tracze, 2001). Albuquerque, *et al*. (2012) showed that the absence of RAEs in taekwondo can be explained by grouping youth participants into competitive and weight categories. Therefore, weight categories instead of age categories might be an approach to reduce RAEs.

An additional potential solution could be to change the attitudes of youth team coaches (Helsen, *et al*., 2000). In selections of long-term talent development programs, assessments of future potential should be emphasized in contrast to aspects of performance (Vaeyens, Lenoir, Williams, & Philippaerts, 2008). An additional goal for coaches might be introduced, which is that they should pay more attention to technical aspects when selecting athletes for talent development programs and should not overrate physical characteristics such as height and strength. This procedure would lead to two performance groups: one "potential" group which is likely to succeed in the future and one "competition-winning" group for immediate success. The likelihood of RAEs in talent development programs may be reduced by emphasising technical skills as criteria of performance and reducing the influence of rankings in competitions (Wattie, *et al*., 2014).

An additional approach could be the implementation of correction factors. First, a normalization of the performance by weight could reduce RAEs (Albuquerque, *et al*., 2012; Delorme, 2013). Second, in sports assessed in centimeters, grams, and seconds (like alpine skiing, swimming, or track and field), correction factors could be calculated. For example, in athletics a correlation between race time and relative age within each age category could show and eliminate the influence of RAEs on performance. However, on the one hand, this type of solution may be costly (each sport and age category needs specific correction factors), time consuming, and would need the complete support of the federation and coaches (Romann & Fuchslocher, 2014). The feasibility of such an approach would require additional research and discussion with all relevant stakeholders.

In the current Swiss system, a decrease in RAEs may substantially enhance retention and performance at the elite senior level in the future. Athletes with high potential for future success would not be excluded early and could fulfill their potential in senior categories. According to the data, the consequences and implications of RAEs should be taught at all levels of coaching education, particularly for coaches of TDPs. Therefore, from the authors' point of view, furthering the education of all coaches may counteract future RAEs in Swiss female individual sports. Moreover, in Switzerland, talent identification and athlete development should be viewed as a long-term process. In contrast to aspects of performance, assessments of future potential should be emphasized (Vaeyens, *et al*., 2008). In any case, it would be a significant step forward for the sporting system, federations, and coaches to select athletes with the highest potential for the future instead of the athletes with the highest chance of winning in the present.

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