Survival and Success of the Relatively Oldest in Swiss Youth Skiing Competition

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Survival and Success of the Relatively Oldest in Swiss Youth Skiing Competition

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ABSTRACT

Relative age refers to age differences between children in the same selection year. The present study investigated the prevalence of relative age effects (RAEs) at the Grand Prix Migros (GPM), which is the most popular alpine skiing race for children aged 7 to 14 years in Europe. In total, 17,992 Swiss junior alpine skiers, separated into female skiers (n = 7,227) and male skiers (n = 10,765), were evaluated in the 2010, 2011, and 2012 races. Chi-square analyses revealed no RAEs ($p > 0.05$) for the entire group of finishers in the qualification race for females in the Under U-8 to U-13 categories (n = 7,010) and all males (n = 10,410). Significant inverse RAEs were detected in the qualification race among female skiers in the U-14 and U-15 age categories ($p < 0.01$; odds ratio OR = 0.79; 95% confidence interval (CI) [0.64-0.98], and among disqualified male skiers ($p < 0.01$; OR = 0.54; [CI, 0.40-0.74]. However, significant RAEs were found for the entire group of both female and male skiers who qualified for the final race ($p < 0.01$; OR = 1.49; [CI, 1.28-1.73] of females, respectively OR = 2.18; [CI, 1.87-2.53] of males). RAEs were additionally apparent in all age categories of female and male finalists. The GPM is apparently influenced by RAEs, which may be an initial step towards RAEs in youth sports and may lead to an unequal participation in Swiss skiing.

Key words: Alpine Skiing, Gender, Relative Age Effect, Youth Sport

INTRODUCTION

Age is a very important criterion for inclusion in many organisations and institutions within our society. The practice of age grouping is involved in education and youth sports. Sport administrators typically categorise participants of youth competitions by annual age groups to reduce the developmental differences between athletes during childhood and adolescence

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[1]. Although this strategy is well-intended, it leads to significant age differences of almost 12 months between individuals in the same annual age group [2]. The advantage of being born early within a single age category has been termed relative age effect (RAE) [3]. In sports, RAEs have gained increasing awareness among sports scientists and coaches over the last three decades. Early research from 1984 until today has identified RAEs in a variety of sports at the junior level, with significant overrepresentations of athletes born in the first quartile (i.e., the first three month after the official cut-off date) [1]. It is apparent that within a specific birth year, there is considerable variation in the growth and biological maturity of individuals. This may lead to a biological mismatch between children within the same chronological age categories [4, 5]. Often these relatively older athletes are erroneously identified as having superior sporting prowess. Athletes who may be potentially skilled but lack the physical characteristics needed for performance at this developmental stage are often excluded [4, 6, 7]. The primary causes of RAEs appear to be maturational differences and physical attributes (e.g., greater aerobic power, muscular strength, and height) [1, 8]. Additional explanations for relatively older children's superior performance involve psychological development, practice experience, and mechanisms related to selection processes [1]. Once selected, the relatively older children generally experience much higher quality sport environments including better coaching, more positive feedback, and more intense levels of training and competition, all of which enhance performance [4]. On the other hand, children with a relative age disadvantage participate at a comparatively lower level of competition and have less support and training. As a consequence, these children are less likely to reach the highest levels in elite sports and are more likely to drop out of a particular sport [9].

To date, the majority of participants have been analysed in team sport contexts [1], such as soccer [9] and ice hockey [2]. Fewer studies have considered RAEs in individual sports and the influence of RAEs on children's and youth competitions. In sports like gymnastics, however, where late maturation is a performance advantage, no RAEs [10] or inverse RAEs - with an overrepresentation of female gymnasts born at the end of the selection year - have been described [11]. These results were explained with the emphasis of creativity and aesthetics in gymnastics and figure skating. Moreover, previous work suggested that sports that depend mainly on technical or motor skills show no RAEs [10]. In contrast Baxter-Jones and Helms [12] examined RAEs in tennis and swimming. They showed that almost 50% of elite female swimmers and tennis players aged 8 to 16 years were born in the first quartile of the selection year. Edgar and O'Donoghue [13] found significant RAEs among both the women's and men's elite junior tennis players participating at the junior competition circuit or a Grand Slam tournament of the International Tennis Federation. To our knowledge there is only one systematic study about RAEs in skiing [11], despite this sport attracting large amounts of children and adolescents [14]. Recently Baker et al. [11] analysed RAEs in alpine skiers, ski jumpers, cross-country skiers, snowboarders, and Nordic combined athletes. They found significant RAEs in cross-country skiing, snowboarding and alpine skiing of both genders. The existence of RAEs in alpine skiing were explained by physical variables, anthropometry and learned skills which are important predictors of performance [11, 15]. The researchers concluded that sport-specific contextual factors are important elements in understanding RAEs in individual sports and that further work, particularly in the under-researched female contexts, is necessary to validate the described findings.

In Switzerland skiing is the most popular individual sport [16]. Every year more than 7,600 children and adolescents, of both genders and aged between 7 and 14 years, register for one of 13 Grand Prix Migros (GPM) events, making it the most popular alpine skiing race in Europe. Through these popular sports events, children and adolescents can subsequently qualify for the nationwide final race. Given the relevance of RAEs and their potential for introducing a bias to participation and the selection process, an examination of RAEs in children and youth competitions in the individual sport of alpine skiing seems warranted.

Therefore, the aim of this study was to examine the prevalence and size of RAEs among the participants of the GPM, subdivided by gender and age groups. We hypothesised that RAEs would be absent in the qualification event which is open to all nominees, but would be prevalent within the finalists, especially the males.

METHODS

PARTICIPANTS

Every year around 7,600 children and adolescents register for the GPM skiing race. We analysed all 17,992 participants (from 22,484 registered) who started at the ski race in the 2010, 2011, and 2012 competitions. All persons who did not start were excluded from the analysis. In total n = 7,227 female skiers and n = 10,765 male skiers in the U-8 to U-15 age categories were evaluated. All races are performed separately for females and males and in each of the eight age categories (U-8 to U-15). The type of race is a giant slalom event which requires the participant to negotiate perfectly, alternating red and blue gates as fast as possible. This is typically completed in around one to two minutes depending on athlete age, gender and specific course. The qualification races take place in 13 different regions of Switzerland. Every participant who lives in Switzerland can start and qualify in one single qualification race (independent of place of residence) for the separate nationwide final race. The participants can only start in one single qualification race, and qualify for the final race if they are one of the five fastest skiers in their age group [14].

PROCEDURE

All participating skiers of the GPM were grouped according to gender, age, relative age, finishers and disqualified skiers (did not finish or missed a gate). All data were obtained from the website of the GPM which is provided by the Swiss Ski Federation (Swiss-Ski) [14]. As the cut-off date for all skiing categories in Switzerland is the 1st of January, the year was divided into four quartiles (Q1 represents January, February, and March; Q2 represents April, May, and June; Q3 represents July, August, and September; and Q4 represents October, November, and December). The observed relative age distributions of all skiers were calculated for each quartile. The expected distributions for the qualification races were recorded from representative birthdates of the corresponding Swiss population using weighted mean scores (Helsen, et al., 1998). The corresponding Swiss population (aged 7 to 14) was defined as the number of official residents (n = 722,881) registered with the Swiss Federal Statistical Office [17].

Beforehand, the respective age categories of the Swiss population were analysed to verify the equal distribution of relative age quartiles. All relative age quartiles of both genders were equally distributed (female: Q1 = 24.6%; Q2 = 25.2%; Q3 = 26.0%; Q4= 24.2%; male: Q1 = 24.7%; Q2 = 25.2%; Q3 = 26.0%; Q4 = 24.1%). The expected distributions of the final race were recorded from birthdates of the all participants who started at the qualification race. From these original data, chi-square tests were used to assess differences between the observed and expected relative age distributions, and post-hoc tests were used to determine the differences in frequency counts between significant quartiles. Odds ratios (OR) and matching 95% confidence intervals (CI) were calculated between Q1 and Q4. When comparing quartiles in all OR analyses, the corresponding Swiss population (for the qualification race) and all participants of the GPM (for the final race) were assigned as the reference group. In addition, effect sizes were computed to qualify the chi-square test results. For the chi-square analyses, the magnitude of the effect size was measured using Cramer's V [18]. According to Cramer [18], for $df = 3$ (which is the case for all comparisons of relative age quartiles), 0.06 < V (0.17 indicates a small effect, 0.17 < V < 0.29 a medium effect, and V (0.29 a large effect. All statistical analyses were carried out using SPSS 16.0. An alpha level of $p < 0.05$ was set as the criterion for statistical significance.

RESULTS

RAES OF FEMALE AND MALE PARTICIPANTS AT THE GRAND PRIX MIGROS

As indicated in Table 1, no RAEs were found for female and male finishers of the qualification race, or the disqualified female skiers ($p > 0.05$). However, female and male finishers of the final race were significantly overrepresented in Q1, and significantly underrepresented in Q4 (p < 0.01; OR = 1.49 [CI, 1.28-1.73] of females; respectively OR = 2.18 [CI, 1.87-2.53] of males). RAEs and effects were small for both females and males. Male skiers who were disqualified in the qualification race were more likely to be relatively younger. Those born at the end of the year (Q4) were overrepresented ($p < 0.01$; OR = 0.54 [CI = 0.40-0.74]; small effect). The groups of skiers disqualified from the final race were too small to consider.

RAES IN DIFFERENT AGE GROUPS AT THE GRAND PRIX MIGROS

In the subgroups of female U-8 to U-13 age categories and all male skiers we found no RAEs in the qualification race (Table 2). However in the U-14 and U-15 age category, more female skiers who were relatively younger, showed significant inverse RAEs (p < 0.05; OR = 0.79 [CI, 0.64-0.98] respectively OR = 0.85 [CI, 0.68-1.07]). In the final race, skiers of all age categories and both genders showed significant RAEs (p < 0.01). The strongest RAEs of female skiers appeared in the U-11 age group (p < 0.01; OR 2.01 [CI, 1.32-3.07]), while the strongest RAEs of male skiers were detected in the U-14 age category (p < 0.01; OR = 2.90 [CI, 1.87-4.51]). For females in the U-9, U-12, and U-13 age categories, the analysis revealed an atypical distribution, with the highest percentage of athletes born in the second quartile (Table 2). All remaining chi-square and post-hoc tests of the final competition highlighted an overrepresentation of participants born at the beginning of the year, and a decreasing number of participants born in subsequent quartiles.

DISCUSSION

RAEs have traditionally been observed in team sports and among male athletes at the elite level. Given the prevalence of RAEs in high-performance sport and the need to understand the mechanisms of RAEs researchers have emphasised the importance of broadening the scope of investigations to specifically consider the individual sports and female contexts [1]. To date very little is known about RAEs in individual sports, such as alpine skiing, or in children's and youth competitions that include both genders. Our data show that significant RAEs occur in the most popular alpine skiing race for children and young adolescents aged 7 to 14 years in Europe in all age categories, and for both male and female participants.

RAES OF FEMALE AND MALE PARTICIPANTS AT THE GRAND PRIX MIGROS

We found no RAEs in the GPM qualification race of all male starters and U-8 to U-13 female

Table 1. RAEs of Female and Male Participants at the Migros Ski Grand Prix

race type	status	Q1	Q2	Q3	Q4	Total	χ^2	V	Effect	OR Q1/Q4	95% CI
quali-	finisher	1763	1754	1731	1762	7010	8.9	0.02	no	0.98	(0.92, 1.05)
fication	(%)	25.1%	25.0%	24.7%	25.1%						
female	disqualified	61	49	58	49	217	1.9	0.05	no	1.22	(0.84, 1.78)
	(%)	28.1%	22.6%	26.7%	22.6%						
final	finisher	549	531	388	363	1831	58.3**	0.10	small	1.49*	(1.28, 1.73)
female	(%)	30.0%	29.0%	21.2%	19.8%						
quali-	finisher	2666	2688	2598	2458	10410	11.8	0.02	no	1.07*	(1.01, 1.13)
fication	(%)	25.6%	25.8%	25.0%	23.6%						
male	disqualified	61	80	103	111	355	16.6**†	0.12	small	0.54*	(0.40, 0.74)
	(%)	17.2%	22.5%	29.0%	31.3%						
final	finisher	639	463	448	289	1839	109.1**	0.14	small	2.18*	(1.87, 2.53)
male	(%)	34.7%	25.2%	24.4%	15.7%						

*Note: Q1 to Q4 = quartile 1 to 4; $\chi 2$ = Chi2-value; V = Cramer's V; *$P<0.05$; **$P<0.01$. † inverse RAEs; OR = Odds ratio; 95% CI= 95%-Confidence Interval. Quartiles of Swiss population: Q1=24.6%; Q2=25.2%; Q3=26.0%; Q4=24.2% (female); Q1=24.7%; Q2=25.2%; Q3= 26.0%; Q4=24.1% (male).*

Table 2. RAEs of Participants at the Migros Ski Grand Prix by Age Category

race type	age cat.	n	% Q1	% Q2	% Q3	% Q4	χ^2	V	Effect	OR Q1/Q4	95% CI
qualification female	U-8	747	25.3	28.1	24.9	21.7	5.3	0.05	no	1.14	(0.92, 1.41)
	U-9	897	25.6	26.0	24.1	24.3	2.2	0.03	no	1.03	(0.86, 1.25)
	U-10	1097	24.6	24.8	24.7	25.9	2.2	0.03	no	0.93	(0.79, 1.10)
	U-11	1065	26.5	25.2	24.6	23.8	2.7	0.03	no	1.09	(0.92, 1.30)
	U-12	1021	25.0	25.1	24.4	25.6	2.0	0.03	no	0.96	(0.80, 1.14)
	U-13	917	24.2	23.9	24.8	27.2	4.5	0.04	no	0.87	(0.73, 1.05)
	U-14	688	23.4	22.2	25.4	28.9	9.0*†	0.07	small	0.79	(0.64, 0.98)
	U-15	574	24.9	22.6	24.4	28.1	6.6*†	0.07	small	0.85	(0.68, 1.07)
final female	U-8	225	31.6	26.7	21.3	20.4	5.5*	0.09	small	1.32	(0.86, 2.03)
	U-9	257	31.1	33.1	18.7	17.1	16.8**	0.15	small	1.72*	(1.14, 2.60)
	U-10	245	28.5	27.3	23.7	24.4	4.0*	0.07	small	1.23	(0.84, 1.80)
	U-11	242	34.3	31.0	19.4	15.3	20.9**	0.17	medium	2.01*	(1.32, 3.07)
	U-12	237	26.7	29.1	17.7	26.4	6.3*	0.09	small	1.04	(0.70, 1.53)
	U-13	218	28.4	30.3	21.6	19.7	10.7*	0.13	small	1.62*	(1.05, 2.48)
	U-14	206	30.7	25.2	25.2	18.8	12.5**	0.14	small	2.01*	(1.28, 3.16)
	U-15	201	31.8	28.4	22.9	16.2	16.2**	0.16	small	2.22*	(1.38, 3.59)
qualification male	U-8	1214	26.2	26.9	24.5	22.3	5.9	0.04	no	1.15	(0.98, 1.36)
	U-9	1540	27.6	25.3	24.4	22.7	9.2	0.04	no	1.19*	(1.03, 1.38)
	U-10	1657	26.6	25.7	25.4	22.3	6.1	0.04	no	1.18*	(1.02, 1.35)
	U-11	1620	25.5	24.8	26.7	23.0	1.8	0.02	no	1.09	(0.94, 1.26)
	U-12	1481	24.4	26.8	24.6	24.2	2.9	0.03	no	0.99	(0.85, 1.15)
	U-13	1242	24.6	26.9	23.4	25.1	5.4	0.04	no	0.96	(0.82, 1.13)
	U-14	927	25.4	23.2	25.6	25.9	2.8	0.03	no	0.96	(0.80, 1.16)
	U-15	729	23.0	27.0	24.6	25.4	2.8	0.04	no	0.89	(0.72, 1.10)
final male	U-8	265	34.0	30.9	19.2	15.8	15.7**	0.14	small	1.83*	(1.22, 2.73)
	U-9	224	35.3	23.2	26.3	15.2	11.2**	0.13	small	1.91*	(1.25, 2.93)
	U-10	238	38.2	21.8	26.1	13.9	21.1**	0.17	medium	2.31*	(1.51, 3.52)
	U-11	237	37.6	24.9	22.4	15.2	21.5**	0.17	medium	2.23*	(1.48, 3.37)
	U-12	230	33.5	21.7	29.6	15.2	14.2**	0.14	small	2.18*	(1.43, 3.34)
	U-13	227	28.6	28.6	28.2	14.5	11.8**	0.13	small	2.01*	(1.29, 3.15)
	U-14	215	42.3	20.9	21.9	14.9	36.2**	0.24	medium	2.90*	(1.87, 4.51)
	U-15	203	29.5	28.5	21.6	20.4	7.1*	0.11	small	1.59*	(1.02, 2.49)

Note: Q1 to Q4 = quarter 1 to 4; χ2 = Chi2-value; V = Cramer's V; *P<0.05; **P<0.01. †inverse RAEs; OR = Odds ratio; 95% CI=95%-Confidence Interval. Quartiles of Swiss population: Q1=24.6%; Q2=25.2%; Q3=26.0%; Q4=24.2% (female); Q1=24.7%; Q2=25.2%; Q3= 26.0%; Q4=24.1% (male).

age categories. This means that the participants did not differ significantly from the Swiss population and there is no self-selection bias in the GPM ski race. This result was expected given that the qualification event is open to all nominees and there is no form of selection to be fulfilled. In the final race, where the fastest skiers of the thirteen qualification races were selected, significant RAEs occurred. Q1 skiers were significantly overrepresented, and Q4 skiers were significantly underrepresented, compared to the distribution of participants in the qualification races. Hence, relatively older skiers are more likely to qualify for the final race, compared to their younger counterparts. Similar to most team sports, relatively older alpine skiers of the GPM race seem to have an advantage in anthropometric and physical variables which support their performance [15]. Those born in Q3 and Q4 are significantly disadvantaged, probably because of their less advantageous physical attributes. Underlining this fact, we found a significant inverse RAE among the disqualified male skiers in the qualification race, showing an overrepresentation of disqualified participants born at the end of the year (Q4) compared to the distribution of starters in the GPM. Being relatively younger may provide disadvantages in skiing such as being physically and cognitively less mature and having less experience in decision-making than relatively older peers in the age category [11]. These factors may alter the possibility of missing a gate or to finish the race and the relatively younger may perceive that they need to push themselves more forcefully in order to post a qualifying time.

RAES IN DIFFERENT AGE CATEGORIES AT THE GRAND PRIX MIGROS

In the qualification race, all male participants of the U-8 to U-15 year age categories did not differ significantly from the Swiss population. This is in line with findings in soccer, where no RAEs have been detected in the basic population of all registered male Swiss soccer players in the 10-15 year age group [20]. In the final race, skiers of all age categories and both genders showed significant RAEs. Baker et al. [11] found significant RAEs among all elite female and male alpine skiers registered in the database of the International Ski Federation. In the same study no RAE was detected for female gymnasts in the U-12 to U-15 year age group. These differences between alpine skiing and gymnastics were explained by sport-specific contextual factors. In alpine skiing where RAEs occur, physical and anthropometric variables are important predictors of performance, on the contrary in gymnastics the emphasis on technical and motor skills may be the reason for the lack of RAEs [11, 15]. Additionally, RAEs in the final race were stronger in all male age categories compared to females. This finding is in line with previous studies, where RAEs were weaker and more variable for female athletes compared to males [1].

RAES IN FEMALE PARTICIPANTS

As suggested by Vincent and Glamser [21], there may be additional factors determining RAEs in female sports. Firstly, in some sports, young females born in Q1 and Q2 are more likely to participate compared with their younger counterparts. Those born in Q3 and Q4 show a kind of self-selection process before even trying the activity, potentially because of their less advantageous physical attributes [22]. In the female U-14 and U-15 age categories of the MGP, significant inverse RAEs occurred in the qualification race, which means that there was greater participation by girls born in Q4 than those born in Q1. A possible explanation might be that female anaerobic and aerobic characteristics, speed, and physical fitness plateau shortly after menarche [23]. Therefore, some of the physiological benefits of being born early in the competition year might disappear in the U-14 and U-15 age categories. Accordingly late maturing females frequently catch up with their peers who matured early, and can even produce superior athletic performances [7]. This may influence their participation in ski racing. During and after puberty, physical characteristics needed for athletic performance are sometimes inconsistent with the stereotyped idea of an ideal female body, which is expected to be thin and petite in western countries [24]. Accordingly, social pressures may prevent females from achieving excellence in competitive sports and could lead elite female skiers to drop out of sports like alpine skiing [22, 25]. In brief, during and after puberty, Q1 female skiers could be more likely to drop out from ski racing than Q4 female skiers. In line with this finding, in the final race of the GMP, female skiers of Q2 were overrepresented in the 8-year, 11-year and 12-year age categories. Similar distributions have been reported in female handball, soccer, and ice hockey [22, 26-28]. In these studies, several possible explanations for this trend are described. These include the cultural importance of different sports, the transfer of relatively older athletes to other sports, and socially constructed gender roles which may provoke a dropout of Q1 athletes [21, 24, 25].

POSSIBLE SOLUTIONS

Several ways to avoid RAEs in selections have been suggested [1], including creating categories based on biological age rather than chronological age, using chronological age categories that are based on intervals of less than a year [1, 29] and implementing quotas where specified relative age distributions must be met [2]. All these suggestions could be used in popular youth competitions as well. However, these changes require cooperation and coordination among sport administrators, federations and coaches. A special challenge in individual sports is that usually athletes are not selected by coaches as in team sports. In individual sports selections are mostly based on competition results. Therefore suitable measures to counteract RAEs in youth skiing competitions have to change the current competition system and rules.

Theoretically, categories based on height or weight could reduce RAEs in youth skiing competitions [5]. This type of solution may be costly, time consuming, and would need the complete support of the federation and coaches. In addition it is unproven in their value for resolving RAEs [1]. Another suggestion could be to change the starting order in the qualification races. Usually the racing conditions are better at the beginning of the race, because the track is perfectly prepared and conditions become worse as more athletes ski down the track [30]. According to this fact a starting order beginning with the relative youngest participant and ending with the relative oldest participant may help mitigate against RAEs influencing race time performance in alpine ski races.

The likelihood of RAEs in youth competitions may be reduced by emphasising technical skills as criteria of performance and reducing the influence of race time [31]. This could be carried out by implementing competitions which includes these elements and/or a correction factor. These correction factors could be calculated by correlating race time with relative age within each age and gender category in order to reduce RAEs and propagate fairer competition within ski races. However, the feasibility of such an approach would require additional research and discussion with relevant stakeholders.

CONCLUSION

While there are many other potential solutions or variations to deal with RAEs, it is strongly encouraged that coaches and sporting federations generate their own unique approaches to improve the fairness of age category competitions. The ultimate challenge is to keep those athletes who are physically or psychologically disadvantaged due to RAEs involved in the sport, until they have fully matured [5]. From our point of view, athlete selections that favour more technical skills, or competitions which may consider correction factors in the final results or other modified competition rules levelling the playing field should be seriously considered.

REFERENCES

1. Cobley, S., Baker, J., Wattie, N. and McKenna, J., Annual Age-Grouping and Athlete Development: A Meta-Analytical Review of Relative Age Effects in Sport, *Sports Medicine*, 2009, 39(3), 235-256.
2. Barnsley, R. H. and Thompson, A. H., Birthdate and Success in Minor Hockey: The Key to the NHL, *Canadian Journal of Behavioral Science*, 1988, 20(2), 167-176.
3. Barnsley, R. H., Thompson, A. H. and Barnsley, P. E., Hockey Success and Birthdate: The Relative Age Effect, *Canadian Association for Health, Physical Education, and Recreation*, 1985, (51), 23-28.
4. Sherar, L. B., Baxter-Jones, A. D. G., Faulkner, R. A. and Russell, K. W., Do Physical Maturity and Birth Date Predict Talent in Male Youth Ice Hockey Players?, *Journal of Sports Sciences*, 2007, 25(8), 879-886.
5. Baxter-Jones, A. D., Growth and Development of Young Athletes: Should Competition Levels Be Age Related?, *Sports Medicine*, 1995, 20(2), 59-64.
6. Till, K., Cobley, S., Wattie, N. et al. The Prevalence, Influential Factors and Mechanisms of Relative Age Effects in UK Rugby League, *Scandinavian Journal of Medicine & Science in Sports*, 2010, 20(2), 320-329.
7. Malina, R. M., Eisenmann, J. C., Cumming, S. P., Ribeiro, B. and Aroso, J., Maturity-Associated Variation in the Growth and Functional Capacities of Youth Football (Soccer) Players 13-15 Years, *European Journal of Applied Physiology*, 2004, 91(5), 555-562.
8. Carling, C., le Gall, F., Reilly, T. and Williams, A. M., Do Anthropometric and Fitness Characteristics Vary According to Birth Date Distribution in Elite Youth Academy Soccer Players?, *Scandinavian Journal of Medicine & Science in Sports*, 2009, 19(1), 3-9.
9. Helsen, W., Starkes, J. and Van Winckel, J., The Influence of Relative Age on Success and Dropout in Male Soccer Players, *American Journal of Human Biology*, 1998, 10(6), 791-798.
10. van Rossum, J. H., Relative Age Effect Revisited: Findings from the Dance Domain, *Perceptual and Motor Skills*, 2006, 102(2), 302-308.
11. Baker, J., Janning, C., Wong, H., Cobley, S. and Schorer, J., Variations in Relative Age Effects in Individual Sports: Skiing, Figure Skating and Gymnastics, *European Journal of Sport Science*, 2012, iFirst Article, 1-8.
12. Baxter-Jones, A. and Helms, P., Effects of Training at a Young Age: A Review of the Training of Young Athletes (Toya) Study. *Pediatric Exercise Science*, 1996, 8, 310-327.
13. Edgar, S. and O'Donoghue, P., Season of Birth Distribution of Elite Tennis Players, *Journal of Sports Sciences*, 2005, 23(10), 1013-1020.
14. Swiss-Ski, Grand Prix Migros, 2012, Retrieved from *http://www.gp-migros.ch/home.html*
15. Neumayr, G., Hoertnagl, H., Pfister, R., et al. Physical and Physiological Factors Associated with Success in Professional Alpine Skiing, *International Journal of Sports Medicine*, 2003, 24(8), 571-575.
16. Swiss Federal Office of Sport, Statistics of Youth and Sport, 2012, Retrieved from *http://www.jugendundsport.ch*
17. Swiss Federal Office of Statistics, Permanant Residential Population, 2012, Retrieved from *http://www.bfs.admin.ch/bfs/portal/de/index/themen/01.html*
18. Cramer, H., *Mathematical Methods of Statistics*, Princeton University Press, Princeton, NJ, 1999.
19. Feltz, D. and Petlichkoff, L., Perceived Competence among Interscholastic Sport Participants and Dropouts, *Canadian Journal of Applied Sport Sciences*, 1983, 8(4), 231-235.
20. Romann, M. and Fuchslocher, J., Relative Age Effects in Swiss Junior Soccer and Their Relationship with Playing Position, *European Journal of Sport Science*, 2013, 13(4), 356-63.
21. Vincent, J. and Glamser, F. D., Gender Differences in the Relative Age Effect among US Olympic Development Program Youth Soccer Players, *Journal of Sports Sciences,* 2006, 24(4), 405-413.

22. Romann, M. and Fuchslocher, J., Influence of the Selection Level, Age and Playing Position on Relative Age Effects in Swiss Women's Soccer, *Talent Development & Excellence*, 2011, 3(2), 239-247.

23. Thomas, J., Nelson, J. and Church, G., A Developmental Analysis of Gender Differences in Health Related Physical Fitness, *Pediatric Exercise Science*, 1991, 3, 28-42.

24. Choi, P. Y. L., *Femininity and the Physically Active Woman*, Routledge, London, 2000.

25. Shakib, S., Female Basketball Participation: Negotiating the Conflation of Peer Status and Gender Status from Childhood through Puberty, *American Behavioral Scientist*, 2003, 46(10), 1405-1422.

26. Baker, J., Schorer, J., Cobley, S., Brautigam, H. and Busch, D., Gender, Depth of Competition and Relative Age Effects in Team Sports, *Asian Journal of Exercise and Sports Science*, 2009, 6(1), 7-13.

27. Weir, P., Smith, K. and Paterson, C., Canadian Women's Ice Hockey: Evidence of a Relative Age Effect. *Talent Development & Excellence*, 2010, 2(2), 209-217.

28. Romann, M. and Fuchslocher, J., Influences of Player Nationality, Playing Position, and Height on Relative Age Effects at Women's under-17 FIFA World Cup, *Journal of Sports Sciences*, 2013, 31(1), 32-40.

29. Boucher, J. and Halliwell, W., The Novem System: A Practical Solution to Age Grouping. Journal of the Canadian Association for Health, *Physical Education and Recreation*, 1991, 57, 16-20.

30. Hraski, Ž and Hraski, M., Influence of the Skier's Body Geometry on the Duration of Giant Slalom Turn, in: Müller E., Lindinger S., Stöggl T., Fastenbauer V. eds., *Science & Skiing IV*, Meyer & Meyer Sport Ltd., Oxford, 2009.

31. Vaeyens, R., Lenoir, M., Williams, A. M. and Philippaerts, R. M., Talent Identification and Development Programmes in Sport: Current Models and Future Directions, *Sports Medicine*, 2008, 38(9), 703-714.