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The impact of relative age on sampling and performance in Swedish age-group swimming system

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ABSTRACT

The phenomena of relative age effect (RAE) has been investigated thoroughly in the sport and school settings. However, different measures and research designs have been applied in the various settings. At the same time different constructs, such as sampling, participation, and performance have been investigated in separate studies. Most interpretations have been done in a de-contextualized manner. That is, results have not been interpreted based on the functioning of the age-grouping system over time, but rather on a general level of grouping individuals based on chronological age. The purpose of this study was to investigate the occurrence of RAE in sampling, competitive participation, and selection for national competition in the Swedish age-group swimming system based on a thorough understanding of the specific impacts of age and gender of this system over time.

Results show that there is inconclusive evidence suggesting that RAE occurs due to the age-grouping system in Swedish swimming. The system does not create a bias based on either relative age difference or gender. Based on this study and future suggestions the continued research on RAE should be expanded to include longitudinal studies following specific age by gender groups over time. In addition, measures of performance and criteria of selection should be investigated in order to draw conclusions if systematic discrimination is embedded within a specific country and sport age-grouping system in favor of athletes that could be attributed to a relative age.

Keywords: relative age, sampling, research design, swimming and performance

INTRODUCTION

Difference in relative age occurs when grouping children in sports or education based on year of birth, or a yearly cut-off date during a specific year, i.e. 1st of August 2000 to 31st of July 2001[8]. These cut-off dates vary between countries in the school setting (e.g. UK has 1st of September as cut-off date [2], whereas Sweden has 1st of January). In sport it also varies between countries and within a sport [24]. In youth and junior international swimming, each national federation is allowed by the international federation (FINA) to adopt their own age-grouping system. Out of 10 countries examined [24] the number of age-groups at the national level varies between four and 10. A lower number of age-groups implies either a larger age-span or/and a later competitive start at the national level. A higher number of age-groups implies the opposite. In addition, to number of age-groupings within a country, some countries chose to apply a staggered system, having girls start competing at the national level earlier than boys [24]. Regardless of school, sport, or country, the decision on how to apply different grouping principles is done for the purpose to maintain general developmental similarities within the group [2]. The grouping is thought to create a narrow performance gap between individuals and allow for better socio-emotional development within the group. In the sporting context in layman´s term it can be expressed as "leveling the playing field" [2].

Research investigating on how grouping by chronological age impacts the academic or athletic development of children is associated with the construct relative age effect (RAE) [3, 5, 9, 13, 14, 20, 23, 26, 27, 28, 31]. In school settings, a longitudinal design has been applied, measuring differences in performance results. Although conflicting results have been presented, the RAE effect seems to diminish over time [5, 20, 23] when focusing on academic performance between children categorized in quartiles based on a yearly cut-off date.

In sport, most research is done cross-sectionally, mainly on team sports [3, 9, 27, 28]. Measures of performance is seldom used. Rather a skewedness in distribution of numbers of subjects born in different quartiles is interpreted as RAE [26]. The sample distribution is often compared in three ways: 1) to an assumed distribution of 25% in each quartile [9]; 2) in relation to the national population distribution of age group within the specific country [13, 14]; or 3) between skill levels when using a meta-analysis [9]. The general interpretation by Cobley et al. [9] was that the factor of age increases the RAE from age 10 to the ages 15 through 18. Thus, there are conflicting interpretations of RAE based on what setting it is investigated in. When a significant skewedness in the distribution of subjects is the outcome in a sport setting, the notion of selection for talent identification [13] and discrimination [27] is used, based on differences in biological maturity due to relative differences in age within the age-group, thus explaining the RAE [26]. In sport research the reason suggested for differences in outcomes between the two settings is thought to be a difference between "compulsory school attendance" and "voluntary sport participation" [27]. In addition, sport implies a more direct competitive nature between individuals, for team selection and for individual honors, as compared to the school setting.

Delorme et al. [13, 14] has pointed out a methodological dilemma in RAE research in sport. That is if a biased distribution over the quartiles already exist among a specific age-group population within a sport, it is probable that this bias will exist at all levels within the specific

sport. Therefore, when examining if RAE is present in sports it was suggested [14] that the actual distribution of the sample should be identified first when investigating the presence of RAE within the sport specific sample studied. A recent study on Swedish swimming [6] examined RAE at the participation level in six different age by gender groups over a nine-year period from a methodological perspective. The conclusion was that using an assumed equal distribution or the national population distribution of the age by gender group increased the chances of significant outcome. In addition, when following the same age by gender group the occurrence of significant outcomes, diminished after the age when the highest number of participants was competing in the specific age by gender group. Recently Wattie et al. [33] proposed a developmental system model for explaining RAE. The model is based on three dimensions; individual, task, and environmental with separate constraints in each dimension that can both influence and be influenced by difference in relative age. Thus, a relationship of causality is not clearly defined. However, when applying such a model for interpretation of results similar patterns should occur in all age by gender groups.

The relevance of examining RAE at an early age either on the participation level or selected performance levels should be questioned. Especially prior to the age when the highest number of participants within an age by gender group has been reached, labeled as age of saturated sample (ASS). The authors suggest two reasons: 1) prior to ASS the rate of recruitment into a sport exceeds rate of elimination. Thus, skewedness in the distribution could also be due to sampling of different sport rather than specialization within a sport. Much research around positive youth development [12, 21] proposes sampling as an important possibility for youth in order to gain interest and maintain interest in a particular sport. 2) Throughout the athletic career of any athlete that wants to be challenged and reach her/his maximal potential the training load increases within a given sport. This training load varies between sports and seems to be of a greater volume in individual endurance sports than in team sports. Many national sport organizations and national sports federation are engaged in creating blueprints for long term athletic development [7]. Although some of the underpinnings in these documents can be criticized from a scientific perspective, it should be remembered that the intent is to create opportunities for individuals to engage in sport based on the individual´s choice and understanding of what the demands are on the next level of age and skill [12] in addition to creating a positive developmental climate [21].

Descriptive data [6, 14] have shown that the proportion of participating youth decreases in relation to the national population in French basketball decreases after ASS. Similar in Swedish swimming, the number of individuals that continue to compete decreases continuously year by year after the age of 12. This elimination of individuals away from competition was not identified as being due to RAE [6].

Previous research on the subject of RAE and swimming is scarce. Baxter-Jones [4] using, a sample of 54 individuals, identified RAE in the sport. Whereas Costa et al. [11] found conflicting results examining the top 50 performances nationally (a total of 7813 results). The distribution of swimmers had a significant outcome, visualized as a skewedness in distribution over the four quartiles each age by gender group. When examining the difference in performance times, based on Fédération Internationale de Natation points, no general trend of significant outcomes could be deciphered [11]. This implies that the

difference in number of swimmers appearing from all quartiles in the top 50 nationally does not affect the average performance times of the group of individuals between quartiles. Thus, the relation of appearing at this selected level and the average performance does not indicate an influence of differences in relative age within age by gender group in Portuguese swimming.

There are both methodological dilemmas and different approaches to examine RAE [5, 6, 9, 13, 14, 20, 23, 33]. Few studies related to RAE in swimming have been done [4, 11]. In addition, the sport of swimming is nationally governed and determine their own age-grouping system [24]. If RAE is built into the age-grouping system of a sport and country, similar patterns should be detected across age-groups and possibly between gender. A reversed pattern should be apparent when investigating the distribution of sampling the sport [12]. Therefore, the purpose of this study was twofold: First, to examine the skewedness of the distribution of swimmers categorized in quartiles based on the sample distribution participating in Swedish swimming and compare these distributions to the distributions of swimmers at a performance level (ages 13 through 16) and distribution of individuals sampling [12] the competitive aspect of sport for a period of less than one year. Second, to understand similarities and differences between age by gender in Swedish age-group swimming.

METHODS
The empirical data collected for this study was done in two parts. The second part was done post hoc the initial research design to gain more insight on the process of competitive development over time for the four cohorts.

Part I
A database connected to an online registration has been used in Swedish swimming competitions since early 2000. The database is maintained by the Swedish Swimming Federation and was accessed with their permission. Results in the databased are retrieved from competitions at the local, regional, and national level. The database contains information relating to date of birth, event swum, performance time, date of performance, and location of performance. The information on date of birth was used to categorize swimmers in quartiles. The authors retrieved data from the age cohorts by birth year, 1997, 1998, 1999, and 2000. Some of the license numbers in the database were not identified with numbers but with XX-XX-XX. These could not be labelled to a specific quartile. Thus, a number of individuals had to be excluded from the population database. For each age by gender group sample between 106,262 (boys born 1998) and 173,384 (girls born 1999) competitive results were coded. Deleted results, as represented by an unidentifiable birth data ranged between 18.0% and 25.3% for the different age by gender groups. The number of participants in the total population was elusive, because no differentiation could be made between the individuals labeled XX-XX-XX. Since a proportion of exclusion of results occurred, the analysis is based on an assumed random sample of the population. This made it possible to use inferential statistics on each sample [17].

The database made it possible to retrieve competitive results from the first competitive result recorded by an individual in the 1997 cohort until December of 2016. Thus, making a retrospective longitudinal design possible for each age by gender group. The age of ASS was identified for each age by gender group [6]. Three variables were computed from the

database and used as empirical data: 1) License number was used to determinate yearly distribution in quartiles for each age by gender group at the participation level. This distribution was labeled current year distribution (CYD). 2) Location of performance was used to identify performances at the National Age-Group Indoor Championships (NAGIC). Each age by gender group was followed for the four-year period that constituted NAGIC. The distribution in quartiles at NAIGIC was labeled performance level distribution (PLD). 3) Using each individual´s collective results and corresponding dates the time frame between the first appearance and last appearance in the database was used to compute individual competitive longevity (ICompL in years).

Part 2

Additional empirical data was collected from an open-access database [22] containing all results from NAGIC, identifying swimmers by name. This data was used to track all individuals for each age by gender group that competed for the 4-year period. This was done to gain a better understanding how the Swedish age-grouping principles affected participation at the high-performance level. NAGIC is limited to a certain number of possible competitors in each age-group depending upon number of events. It is organized the same way for both girls and boys in the following age brackets: 13 years and younger (13U), 14 years only (14O), and 15 and 16 years old (15&16). The latter age bracket was separated and analyzed as separate age groups. Qualifying competitions take place on a regional level and the top qualifiers are invited to NAGIC. For 13U and 14O the top sixteen qualifiers are invited in 6 and 7 events respectively. Thus, the total number of competitive places are for 13U (n=96) and 14 (n=112). For 15&16 the number of qualifiers is increased to 24 in 9 out of 12 events (n=264). The events that only allow 16 competitors are, so called distance events.

Statistical analysis

The following age by gender group sample abbreviations were used; girls born 1997 (G97), born 1998 (G98), born 1999 (G99), born 2000 (G00), boys born 1997 (B97), boys born 1998 (B98), born 1999 (B99), and born 2000 (B00). To test if RAE occurred at the participation level the following steps where completed: first ASS identified and checked if it occurred prior to or at the age of 13. The distribution at ASS was compared to the distribution at age 13. For the following years previous year distribution was used to test CYD at the competitive participation level. To test if RAE occurred at the performance level CYD was compared to PLD for that specific year. When examining the impact of RAE on sampling, the distribution of ASS was used to compare to distribution of sampling individuals. The authors assumed that a sampling is a "less than one-year process". These tests were done using a chi-squared "goodness of fit" test ($p<0.05$) set a priori. If a significant outcome occurred, odds ratio was used to determine when a quartile had a large enough difference in numbers in relation to another quartile. That is the effect size using odds ratio [18], confidence interval at 95% >1, was used in order to draw conclusions about a systematic RAE.

The variable of ICompL was used both at the competitive participation level and at the performance level (NAIGIC). To make it comparable between age-groups a finite point at the year when swimmers turned 16 years. For G97 and B97 this was at the end of 2013, for G98 and B98 it was 2014, for G99 and B99 it was 2015 and for G00 and B00 it was

2016. At the participation level ICompL used to detect the occurrence of sampling and at the performance level it was used to detect if age grouping system had an impact on competitive longevity based on quartiles. Analysis of variance (ANOVA) for each age by gender group and Tukey´s honest significant difference (HSD), post hoc procedure was used when a significance occurred at the main level. Cohen´s d was then calculated to understand the effect size of categorizing the data into the four quartiles. Each age by gender group was treated as an independent sample.

Analysis of part II material was done based on descriptive statistics, since this material includes the whole population of competitors for each age by gender group at NAGIC, the use of inferential statistics is not applicable [17]. General trends of similarities and differences within and between age by gender groups were looked upon as patterns that could be related to environmental constraints [33].

RESULTS

Descriptive data revealed the following: The ASS generally occurred at age 12. The relative proportion of youth and adolescents that had competed in swimming were 72.77% (+ 9.74) more than the number competing at ASS. The elimination away from swimming after ASS was similar between gender and within age groups at the age of 13 (8.62% + 4.20) and at age 16 (52.40% + 7.87). Thus, indicating both sampling of the sport [12] and an (self) elimination away from the sport due to either a RAE [9, 26] or other mechanisms [19].

When comparing to PYD to CYD, and CYD to PLD in order to examine the existence of RAE at both the participation and the performance level no general pattern was found. At the participation level no significant skewedness in distribution occurred that would indicate RAE [9]. At the performance level (NAGIC) conflicting results appeared as measured when the distribution was divided into quartiles (Q). For G97 and G00 odds-ratio revealed a skewedness in the distribution for Q1 in favor of Q4. The same results appeared for B00. For B98 there was a significant outcome for all ages from 13 through 16, however odds-ratio revealed that Q1 & Q3>Q2 & Q4. These results could be attributed to research design that was applied, using the distribution of the actual age by gender group when testing for significant outcomes using the chi-squared test [6, 13, 14] (see Table 1).

Table 1: Comparison of distributions at the competitive participation- and performance level for each age by gender group in Swedish Swimming

	13 years		14 years		15 years		16 years		
Age by gender group	n at ParL	n at PerL	n at ParL	n at PerL	n at ParL	n at PerL	n at ParL	n at PerL	Odds ratio#
G 97	412	38*	349	41	279	40	207	37	Q1>Q4, at age 13
B 97	274	37	239	45	220	35	162	52	
G 98	384	35	288	42	221	34	157	45	
B 98	268	33*	264	42*	211	37*	164	55*	Q1 & Q3>Q2 & Q4, at all ages
G 99	504	35	390	43	312	58	236	59	
B 99	329	33	299	42	239	43	187	52	
G 00	553	39*	443	42	343	47	247	58	Q1>Q4, at age 13
B 00	337	35*	308	48	242	36	189	57	Q1>Q4, at age 13

* = significant different distribution at the performance level when comparing CYD to PLD
\# = odds ratio is interpreted as >1 for 95% confidence interval

The results for competitive longevity analyzed at the competitive participation level are shown in Table 2. ICompL was truncated at the age of 16. Thus, the systematic impact of being born earlier during a given year would give the participants a longer competitive career, based on either the notion of "head start" in comparison to participants born being later during the year [2, 3, 9, 27], or parental/coach´s choice of when the children are seen as ready for competition [15]. Results showed no systematic impact in general, but two "age by gender" groups showed a consistent pattern. For B99, when ICompL was tested over the four year span, no significant outcomes could be detected. Thus, the intent of age-grouping "to level the playing field" seems to have worked in this particular age by gender group. On the other hand, G00 showed a consistent pattern of Q1>Q3 & Q4. The effect, according to interpretations of Cohen´s d-values, was that the categorization into quartiles had a small effect initially at the age of 13, 14, and 15, but increased to a medium effect at the age of 16.

Table 2: Comparison of competitive longevity at the competitive participation level at NAGIC in Sweden

Age by gender group	13	14	15	16
G97	ns	Q1>Q4[a]	Q1>Q2[a] & Q3[a]	Q1>Q2[b] & Q4[c]
B97	Q1>Q4[a]	ns	ns	Q2>Q4[b]
G98	ns	Q1>Q2[a] & Q4[b]	ns	ns
B98	ns	Q1>Q4[a]	Q1>Q2[a] & Q4[a]	ns
G99	Q1>Q4[a]	ns	ns	ns
B99	ns	ns	ns	ns
G00	Q1>Q3[a] & Q4[a]	Q1>Q3[a] & Q4[a]	Q1>Q3[a] & Q4[a]	Q1>Q3[b] & Q4[b]
B00	Q1>Q3[a] & Q4[a]	Q1>Q3[a] & Q4[b]	ns	Q1>Q4[b]

ns = no significant outcome based on ANOVA
Qx>Qy = significant difference between quartiles, using Tukey's HSD post hoc
a = small effect as interpreted using Cohen's d
b = medium effect as interpreted using Cohen's d
c = large effect as interpreted using Cohen's d

The average ICompL at the age of 16 for G00 for Q1 was 6.83 years (+1.79) compared to Q4 5.27 years (+ 1.91). The results for G00 could be explained as a constant year effect [28, 29]. However, the temporal aspect of a "head start", i.e. an increased competitive longevity has been shown to be reversed at the elite level in hockey [16] which supports the intention of age-grouping system to "level the playing field" in order to stimulate performance development. Research from the school setting also implies the chronological age-group system creates a narrowing of the academic performance gap over time [5, 20, 23]. The sporadic occurrence of significant outcomes, the high occurrence of a small effect size, in conjunction shift to increased effect size at the older years (B00, G97 & G00) is not conclusive evidence that RAE occurs, since it does not occur systematically. Thus, there was not enough evidence to indicate discrimination [27] or inevitable consequence of elite

sport [2] in favor of relatively older competitors influenced by environmental factors attributed to the age-grouping system [24] as proposed by Wattie et al [33] at the participation level in Swedish age-group swimming.

ICompL was also used to investigate the sampling of swimming as a sport for these age groups. Two measures where used to indicate sampling; 1) one competition only and 2) one competitive year. Descriptive statistics showed a homogeneous sampling. Regardless of sample size in the age by gender group, the average percentage for one competition only was 16.18% (+ 1.88), and for one year of competition it was 33.10% (+ 2.57). The distribution of sampling individuals was only significant in three out of the eight "age by gender" groups. All these significant outcomes occurred in the boys age-groups (B97, B99, and B00). However, no odds ratio´s showed an effect size, and the distribution for B99 was reversed, that is more individuals in Q1 sampled swimming, rather than the other quartiles.

When tracking all the individuals competing at NAGIC some general trends were found both in relation to gender and to age-group. For gender there were four general trends, two showing differences and two showing similarities. The first trend was a difference in proportion of "at least" a year-younger competitors in an age bracket between gender (13U, and 15&16). More girls (20.22% + 6.02) competed in 13U at the age of 12 as compared to boys (12.29% + 3.73). This trend continued up to the age of 15 in the 15&16 age bracket, although less pronounced, where girls at age 15 accounted for more of the places (42.14% + 7.10) as compared to boys (38.07 % + 4.04) in 15&16 age bracket. The notion that younger girls are more prevalent to be able to compete with older girls could be attributed to the earlier biological maturation that occur in girls as compared to boys [30] and variation of biological maturation between individuals [25]. The second trend of differences was the proportion of competitors competing during all four years of NAGIC. Here, the proportion of boys (34.13 % + 2.90) exceeded the proportion of girls (30.64 % + 5.40). Musch and Grodin [26] proposed that RAE is dependent on the depth of competition, which has been supported in later research [10, 32]. The range for the absolute number of participants striving to compete at NAGIC was lower for boys (n= 512-681) as compared to girls (n=760-981). Suggesting that it was easier for boys once they achieved NAGIC status at 13U to maintain this status due to a smaller within sport population as compared to girls.

Two trends that showed similarities between gender were: First, the proportion of competitors appearing only in 13U and 14O was similar (girls; 15.08 % + 5.50 versus boys; 15.52 % + 6.36). Secondly, the proportion of individuals competing at NAGIC for the first time in the 15&16 age bracket (girls; 32.53 % + 6.80 versus boys; 30.41 % + 4.20). This could be interpreted as the age-grouping system in Swedish swimming [24] provides a "level playing field" [2] for both early bloomers and late bloomers in relation to biological maturation [25, 30]. This is contrary to what most previous research in sport have suggested [3, 9, 14, 26, 27] but in concordance with some research in sport [16] and evidence from school setting [5, 20, 23].

When further examining the data the age-grouping system seems to accommodate two different groups. A larger group consisting of individuals competing in one or two events at NAGIC and a smaller group of individuals competing in three events or more. Even though the number of events and possible competitive places increased from age group to age group (13U; 6 events, 96 places, 14O; 7 events, 112 places, 15&16; 12 events, 264 places)

the size difference in number of competitors between the two subgroups was apparent, except for boys age 16 (15&16) were the two groups had similar number of competitors (see Table 3).

Table 3: Descriptive statistics showing differences between subgroups in each age by gender group competing at NAGIC

Age by gender	13 years in (13U)				14 years in (14O)				15 years in (15&16)				16 years in (15&16)			
	n*	mean*	n#	mean#	n*	mean*	n#	mean#	n*	mean*	n#	mean#	n*	mean*	n#	mean#
G 97	25	1.40	13	4.15	21	1.29	20	4.25	25	1.56	15	4.53	26	1.46	31	4.65
G 98	22	1.14	13	3.85	25	1.46	17	4.65	23	1.52	10	5.30	29	1.55	16	5.44
G 99	20	1.10	15	3.73	25	1.24	18	4.50	37	1.46	21	3.62	39	1.49	20	4.25
G 00	28	1.32	11	4.00	23	1.39	22	3.63	27	1.48	20	4.05	36	1.36	22	3.68
mean	24	1.24	13	3.93	24	1.35	19	4.26	28	1.51	17	4.38	33	1.47	22	4.51
SD	4	0.14	2	0.18	2	0.10	2	0.45	6	0.04	5	0.72	6	0.08	6	0.74
B 97	26	1.50	11	4.27	26	1.31	19	4.05	26	2.13	20	4.60	24	1.63	28	4.07
B 98	19	1.26	14	4.21	23	1.39	19	4.21	26	1.50	11	4.27	27	1.48	28	4.36
B 99	16	1.26	17	4.18	24	1.33	18	4.39	34	1.44	9	5.67	26	1.38	26	4.69
B 00	22	1.23	13	4.08	31	1.32	17	4.18	19	1.53	17	4.47	26	1.38	31	4.19
mean	21	1.31	14	4.19	26	1.34	18	4.21	26	1.65	14	4.75	26	1.47	28	4.33
SD	4	0.13	3	0.08	4	0.04	1	0.14	6	0.32	5	0.63	1	0.12	2	0.27
Total mean	22	1.28	13	4.06	25	1.34	19	4.23	27	1.58	15	4.56	29	1.47	25	4.42
Total SD	4	0.13	2	0.19	3	0.07	2	0.31	6	0.23	5	0.66	5	0.09	5	0.52

* = subgroup competing in one or two events

\# = subgroup competing in three or more events

DISCUSSION

The purpose of this study was twofold: First, to examine the presence of RAE in age-group swimming based on participation in competition at the levels of sampling, continued participation, and at the performance level. Second, to identify similarities and differences between gender in Swedish age-group swimming in order to understand the impact of the structure of the Swedish swimming age-grouping system. When comparing the present results to previous research [3, 4, 5, 9, 11, 13, 14, 16, 20, 23, 26-29] within sport, it is important to keep in mind the differences in the methodological design (longitudinal) and approach (type of data collected). In an effort to understand the possible impact that the age-grouping system have on creating RAE, it was important to separate the results attributed to constraints on an individual (IL), task (TL) or environmental level (EL) [33]. The authors have focused on four factors; age grouping principles (EL), popularity of the sport [EL], birth date (IL) and gender (IL). The research design made it possible both to understand the temporal aspect and to compare the results between individual "age by gender" groups, thus detecting systematic constraints in different dimensions.

When RAE was analyzed using the variables of gender and birth date in relation to the distribution of individuals in quartiles within the sample and competitive longevity the evidence was inconclusive whether RAE occurred or not. The distribution at the sampling level was compared to ASS distributions, at the competitive participation level it was compared to the PYD, and at the performance level it was compared to CYD. The number of skewed distributions with significant outcome was 3 out 8 at the sampling level. At the participation level there were no significant outcomes in all 32 cases. However, conflicting results occurred when using competitive longevity as a measure of indicating RAE rather than using the number of participants at the level. Then RAE (Q1>Q) occurred in 13U

(G97, G00, B98 & B00). In B98 a different pattern showed significant outcome in all age-groups (13U, 14O, 15 in 15&16, and 16 in 15&16). Here the pattern was Q1 & Q3>Q2 & Q4, which does not support previously theoretical suggestions of greater physical advantages due to a higher relative age [26]. The explanation of the occurrence of RAE in sport as compared to school is that sport contains a talent identification processes [31].

In addition to this the authors followed the suggestions by Delorme et al. [13, 14] that the appropriate population distribution should be used when using chi-squared "goodness of fit" test to determine if significant outcomes were present. As previously pointed out, using theoretical distributions could seriously impact the sensitivity in the statistical test, thus producing a sampling error. The collective interpretation is that, when RAE was analyzed using the variables of gender and birth date in relation to the distribution of individuals in quartiles within the sample and competitive longevity measured over quartiles within a birth year, the evidence was inconclusive whether RAE occurred or not. Thus, no constraints on the individual level is embedded within the Swedish swimming age-grouping system.

When examining the Swedish age-grouping systems and its´ principles, the birth date was not tracked, because of the open access data used. However, it indicates a couple of things that the authors interpret as environmental constraints that minimizes RAE. The relative reduction in number of participants from 13 years of age to the age of 16, seems as natural occurrence in sport [14] or an inevitable consequence of elite sports [2] due to either a process of self-elimination [13], other processes [19], an increased work load in order to enhance performance [7], or a combination of these factors. At the same time the occurrence of sampling, as interpreted by less than one year competitive participation, was similar an did not show conclusive evidence of RAE. The Swedish swimming age-grouping system (EL) allows for both sampling, continued competitive participation and competitive development. Long-term athlete development takes time in sports and should take time [7]. The peak performance age for female swimmers is 22.5 years versus male swimmers 24.2 years [1]. However, the age of peak performance varies depending upon the individual´s choice of competitive event. In addition, the improvement in performance needed to compete at the Olympic level is 9.6% versus 9.4 % for female versus male swimmers for an eight-year period, prior to Olympic competition [1]. Thus, the Swedish age-grouping system at the national level provides a "level playing field" [2] that allows for both sampling [12], continued performance improvement, and the possibility of talent identification [9, 33]

CONCLUSION
When RAE was analyzed on using the variables of gender and birth date
in relation to the distribution of individuals in quartiles within the sample and competitive longevity the evidence was inconclusive whether RAE occurred or not. The age-grouping system in place in Sweden seems to diminish rather than enhance RAE on all levels of participation. Thus, the interaction of factors at the environmental level and individual level interact to allow for both samplings, continued participation and performance to take place.

APPLICATIONS IN SPORT
The research design used in the study, the different levels of participation and the variables measured suggests that identifying the occurrence of the construct of relative age effect is a complicated matter. For future research within the field of how to improve positive youth development in combination with long-term athlete development over time in a specific

sport within a specific country the following needs to be considered. First, contextualizing the occurrence of relative age effect should be done within a specific country in the specific sport based on an understanding of the sport´s age-grouping principles. Second, a longitudinal design following more than one age by gender group should be applied. Otherwise similarities and/or differences between age groups or age by gender groups cannot be detected. Third, the measure often used to detect RAE in voluntary sport participation needs to be improved. The use of a significant skewedness in the birth date distribution of a sample is not enough to infer that selection procedures or talent identification systems based on performance are the cause of RAE. The criteria for talent identification/selection should be scrutinized in order to detect if they contribute to RAE.

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