

Relative age effect presence among swimmers within Youth Olympic Games

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Purpose: Swimming is one of the oldest activities known to man. In the context of sports performance, swimmers became a subject of admiration due to their superior technique and untouchable records. However, such a tendency toward the absolute results increases the danger of Relative Age effect (RAE) occurrence within swimming.

Methods: Therefore, the authors of this research aimed to enlighten the possible existence of RAE in swimming during the Youth Olympic Games (YOG) in 2018. Data were retrieved through the web source, and afterward analyzed through the Chi-square test.

Results: Results revealed there is an unequal distribution of four generations within the same competition age (youth) category. The great value of the Chi-square test ($\chi^2 = 289.869$; $P = .000$) indicates the (enormous) magnitude of the effect occurring within the analyzed competition. The youngest 2003 generation was present at less than 10% (7.15%) while the oldest one (2000) represents almost half (42.55%) of the overall sample.

Conclusions: Managers of competitive sports events should pay attention to this issue because there is up to four years of difference between some competitors, and that system may include both pre-pubertal and post-pubertal competitors in the same age category. Youth categories, especially cadets in early pubertal stages are being affected. The authors suggest that the separation of this youth category into more than one would be of much help for athletes and sports organizations to ensure more fair competition system.

Keywords: talent identification, youth Olympics, RAE, swimming, YOG.

Introduction

Relative Age Effect (hereinafter referred to as RAE), is an chronological indicator of the birthdate (month) within a one (or more calendar years). Major sports organizations, aiming to ensure fair opportunities for the development of the sporting potential of as many young athletes as possible¹, organize competitions in younger categories based on age groups categorized into time spans of one to two or more calendar years². In this way, athletes born in month at the beginning of age category are 12/24 or more months older than those born at the end of the age competition range. RAE, a phenomenon occurring among the youth age categories, and its influence commonly play a significant part in the selection and consequently success of young athletes, especially in sports where body morphology directly influences performance. Swimming is a sports discipline in which muscle strength and body size have an important role in competition performance³, and therefore there may be a greater probability of RAE appearance within swimming. Indeed, swimmers who reach the elite level usually present some physical characteristics, such as greater development in body height and ecto-mesomorphic development⁴. As swimming competitions do not use weight categories, disciplines are absolute, and athletes with relatively higher ecto-mesomorphic values (according to the Heath-Carter somatotype method)

seem to be favored by coaches. Secondly, body mass index has been associated with swimming performance and fitness level in young athletes⁵. In a recent review⁶ regarding RAE in swimming, authors suggest that RAE impact on competition performance occurs in 89.78% of the overall sample. The greatest extent of RAE was found in U12-U14 age range, while the impact on competitive performance was greatest in U15-U18 range. Regarding swimming disciplines, RAE was especially reported for the butterfly and 400m medley. The addressed issue has been much more researched in the last decade than before, and there are certain national-level analyses concerning swimming reported. The RAE was found consistently among Portugal swimmers⁷, German swimmers⁸ until 13 to 15 for females and 16 to 18 years for males, and among Australian swimmers⁹ in periods of 13-15 years for males and 12-14 for females. Contrary, there was a lack of evidence for RAE among Hungarian swimmers¹⁰. There is unfortunately only one existing article¹¹ regarding international-level swimming, based on the Olympics 2012 results which revealed RAE existence limited to female and Asian samples, with no significant impact on success/medal winning. Such results agree with the results of the review concerning RAE¹², where RAE was absent at the Olympic level regardless of sex due to earlier (regional & national) selection processes where RAE do occur. RAE analyses within the Youth Olympic Games (YOG) were conducted on taekwondo athletes

only¹³ and reported the significant existence of RAE across the overall sample. But, why is a determination of RAE existence so important? Because such existence negatively affects the careers of youth athletes, diminishes their effort, lowers their self-esteem, produce errors in talent development process and demotivates relatively younger ones to compete and even quit sports. Beside review article⁶ which indicate the prevalence of the RAE in swimming in more than half (58.65%) of the participants analyzed, unfortunately, there is still a lack of empirical research based evidence regarding the presence of RAE among international-level youth swimmers, especially within specific technical discipline. The aim of this research is to determine and enlighten the possible existence of RAE within swimming at the YOG as highest youth international-level swimming competition using nonparametric Chi-square analysis,

Methods

This research is part of the Croatian Science Foundation project¹⁴ named: *Biological, Chronological and Relative Age in the Process of Establishment of Croatian National Sport Talent System [IP-2020-02-3366]*. The project investigates biological, chronological and relative age, on sample of youth Croatian national team members (Volleyball, Basketball, Swimming, Taekwondo) using classic methods and modern technologies such as Sonic Bone ultra sound device, BIA, Tensiomiography, Spirometry....) to analyse and measure „actual“ age and predict final adult height of athletes. Project objectives are: 1) To strengthen Croatian potential of sports talent development by connecting: national federations, local community, coaches and scientific institutions; 2) To investigate the correlation of biological and relative age with results; 3) To generate new knowledge on the usefulness of the instrument for assessing biological age and muscle contractile; 4) To strengthen awareness on the importance of biological age in the process of sports talent developments an interaction between biological and chronological age in sports, especially in youth categories. Due to the indirect nature of the RAE analysis, there were no individual measurements conducted and therefore this investigation does not need approval, but authors strongly adhere to the *Code of Ethics of the World Medical Association* (Declaration of Helsinki) and all investigations are approved by Ethical Committee (003-08/20-04/00121818-205-02-05-20-006.) The investigation focused on $n=980$ participants of both sexes born between 2000 and 2003, swimming competitors who competed at the YOG in 2018. To achieve this research objective, the participants were divided into sub-groups and mutually compared according to the birth date: a) year of birth= 2000, b) year of birth= 2001, c) year of birth= 2002, and d) year of birth= 2003. Secondly, the birth dates of all participants were analyzed to access precise RAE disposition. Sub-group division was conducted by the official competition rules prescribed birth years of youth participants at the (summer) YOG 2018. Data were collected from the official web page of the Olympic Word¹⁵. Library Non-parametric Chi-square (Pearson's χ^2 test) was used for statistical analysis as a standard scientific procedure to assess and identify possible RAE through interaction between observed and expected frequencies of (in this case) birth years within the overall sample. A statistical level of significance of 95% ($P<.05$) was applied.

Results

Expected frequencies of birth year would be approximately equal distribution of all four birth years, as spontaneous distribution is often seen in nature. Unfortunately, that is not the case. with this particular investigation.

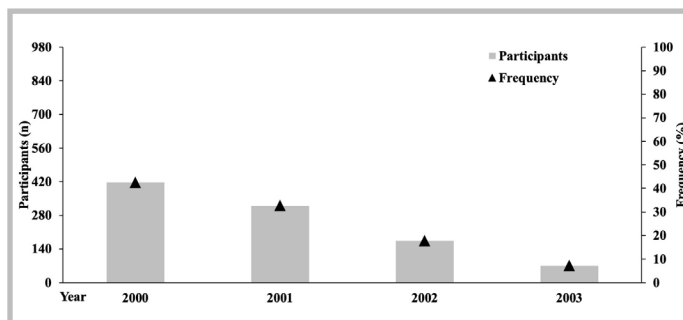


Figure 1. Distribution of competitors (Fo) according to their birth age (n=980)

Legend: Fo- observed frequencies/number of competitors, 2000-2003-birth years.

Results revealed unequable distribution regarding birth age. As equal distribution would be $Fe=245$ participants per sub-group, results presented in Figure 1 suggest that the oldest (2000) subgroup has almost six times more athletes ($n=417$) than the youngest one ($n=70$). Figure 1 brings visual insight into the evident proportional tendency in the relation between chronological age and the number of athletes from each generation. Furthermore, according to Jakobson et al.¹⁶ there is a relatively and naturally equal distribution of talents within every generation with theoretically equal mean, which implies there should not be talented generations. Hence, the number of missed talents within the youngest generation equals the number of athletes within the underrepresented generation subtracted from the mean value. On the other hand, the surplus generated by the difference between the number of athletes in the oldest generation compared to the mean represents the number of “non-talented” athletes who came in certain competition ranges due to their earlier maturation rather than talent.

As can be seen in Figure 1, the first two birth years seem to be overrepresented in swimming at YOG 2018. There is a meaningful difference between expected ($Fe=245$) and observed frequencies, along with the high Chi-square result ($\chi^2= 289.869$; $df=3$; $P=.000$). Almost three-quarters of belong to the 2000/2001 birth age, while the youngest one represents less than 10%.

Discussion

Swimming is an absolute sport with no weight (or height) boundaries which is „fertile ground“ for the genesis of RAE. Athletes with greater amounts of muscles will have greater power capacities within, and will generate a greater swimming speed than other athletes. When examining the findings from previous studies^{12 i 13} in conjunction with the results obtained from this research (Table 1), it becomes challenging to identify a clear link. This suggests that there may be a fundamental flaw in the national selection process for athletes. Ideally, talent should be evenly distributed across all age groups, which is clearly not the case here. Further, earlier investigations¹⁷ on competitive swimmers observed no lung growth during the period of one competitive season, so absolute lung capacity and volume largely depend on an individual's morphology too. Speaking of

swimming physics, maybe the most important aspect regarding swimming is skeletal longitudinally. As swimming techniques rely on extremities and their active movements throughout the water, the longitudinally of skeleton and consequently extremities are directly proportional to the pressure area and consequently increases force impact on overall speed. However, it should be appointed that the somatotype of swimmers depends on the swimming discipline within which they compete¹⁸, as the process of morphologic adaptation to the discipline requirements. The fact that coaches often use just their authority in the selection process, without scientific methods that include various measurements and assessment of biological age, is also one more time confirmed by the research¹⁹ conducted on a sample of youth basketball players which found that more players were born in the 1st quartile than in the other 3 quartiles. So generally, short-distance swimmers will tend to have a more muscular (mesomorphic component) constitution, in regards to long-distance swimmers who need greater body longitudinality (ectomorphic component). However, in younger age categories developmental periods are the main drivers (and limiters) of physical strength and functional abilities. Speaking of individuals, the dynamics of developmental periods will depend on many factors, such as genetics, diet, physical activity, social environment and many more. One of the recent researches²⁰ found significant evidence of RAE in Brazilian athletics among the U16 and U18 male categories. Interestingly, this effect was observed exclusively in the shorter distance trials within the U18 female category. This suggests that RAE tends to manifest when there is a higher level of participation and competition within the sport. A similar pattern can be applied in specific swimming categories marked by increased participation and intensified competition. However, to draw conclusions without doubt, further research is necessary.

Research conducted in 2022²¹ on a sample of track and field athletes concluded that young competitors should be met with patience and dedication from coaches. Additionally, the abandonment of the cut-off system which takes into the calculation a calendar year (1st January to 31th December) instead of an individual's (birthdate-based) chronological age would significantly help. Unfortunately, cut-off date-based age boundaries do not follow individual aspects which seems to be one of the key factors for success in competitive swimming as an individual sport. This research illuminates the problem of such stratification and its possible consequences on an individual's sports career.

Practical Applications

There are two established approaches and one innovative method that warrant further investigation for mitigating the impact of the Relative Age Effect (RAE) in swimming, as well as in other sports.

1. **Institutional Approach:** The first strategy is proactive and institutional in nature. Governing bodies and associations responsible for organizing championships and other competitive events should scrutinize age groupings. Ideally, all age categories, except for seniors, should encompass a one- to two-year age range. It is imperative that these associations incorporate these findings into their official regulations; otherwise, meaningful change and improvement will remain elusive.
2. **Chronological Adjustment:** The second approach is indirect and was elaborated upon by Cobley et al. in 2019²².

The authors proposed corrective adjustments to swimming times based on decimal coefficients related to chronological age. Swimmers were then categorized into top 10, 25, 50, and "all swimmers" groups. While these adjustments do mitigate the RAE among swimmers, they focus on individual swimming times rather than the relationships between competitors. This method serves as a valuable supplementary tool for coaches and teams, helping to clarify the distribution of talent within a group, team, or club. Such an application can reduce the RAE's impact on talent identification and selection processes, thereby decreasing talent attrition rates within generations. However, it's worth noting that this approach does not eliminate the RAE in competitive settings; it merely equalizes final outcomes due to its retrospective nature.

3. **„Actual“ - Biological Age use (or other approach):** Transitioning from a model that categorizes younger athletes based on their chronological age to one that classifies participants according to their actual, measured biological age or other methods like Height²³. Biological Age is objective of the previously mention Project Founded by Croatian Science Foundation. This innovative method aims to provide a more accurate representation of an athlete's developmental stage, thereby potentially reducing the influence of RAE.

Conclusions

According to the presented results, it can be concluded there is a significant difference between observed and expected frequencies ($\chi^2 = 289.869$; $P = .000$), or in other words, there is an unequal distribution of four generations within the same competition age (youth) category. The oldest generation (2000) seems to be overrepresented with 42.55% of all competitors included, followed by the second one with 32.65%. The youngest generation (2003) includes less than 10% (7.15%) of competitors. It means that the oldest generation has 35.40% greater representation compared to the youngest one, within the overall sample. There are up to four years of difference in chronological age between some competitors. Swimming coaches and professionals should pay attention to the addressed issues in order to reduce selection and success-related mistakes which lead to the dispersal and loss of talents from club/team perspective, and possible abandonment of club/swimming from the athletes' perspective. Short-term effects are mainly manifested in motivation dispersal, while long-term effects may include various psychological complexes, aversion towards physical activities, connected health issues that may arise in the future, etc. In conclusion, recommended strategies to reduce RAE should be conducted as carefully as possible, because changes in association rules affect the whole sports community, and the best way to conduct it is to firstly do a pilot period to check its real usefulness. Secondly, swimming adjustments should be used as precisely as described, otherwise it does not help, and incorrect coefficients may even lead to RAE increase. Further investigations may include other sports within the Youth Olympic Games, as well as swimming, separately by discipline, sex, and in other international competitions to illuminate the possible RAE existence, its magnitude and pace in different categories, sports and groups of sports, and relations between them. It is also useful to construct new methodological approach which will enable to compare and validate within competition formats in different sports.

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Informed Consent Statement

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Sport Science.

Conflicts of interest

The authors have no conflicts of interest to declare.

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Declaration if used ChatGPT

We don't used ChatGPT.

Author-s contribution

Conceptualization, M.B. and D.C.; methodology, C.D; software, M.B and I.G.; validation, M.B. and C.D.; formal analysis, M.B. and I.G.; investigation, D.C.; resources, D.C. and D.C.; data curation, DC and M.B.; writing—original draft preparation, M.B. and I.G.; writing—review and editing, D.C. and M.G. visualization, M.B. and I.G.; supervision, D.C.; project administration, M.B. All authors have read and agreed to the published version of the manuscript.

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