Scand J Med Sci Sports 2010: 20: 502–508
doi: 10.1111/j.1600-0838.2009.00961.x

SCANDINAVIAN JOURNAL OF
MEDICINE & SCIENCE
IN SPORTS

Relative age effect in youth soccer: analysis of the FIFA U17 World Cup competition

J. H. Williams

Department of Human Nutrition, Foods and Exercise, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, USA
Corresponding author: Jay H. Williams, PhD, HNFE Department, Virginia Tech, Blacksburg, Virginia 24060, USA. Tel: +1 540 231 8298, Fax: +1 540 231 3916, E-mail: jhwms@vt.edu

Accepted for publication 25 March 2009

This investigation sought to determine if a relative age effect exists in the FIFA U17 World Cup competition. Birthdates of players competing in the most recent six competitions, from 1997 to 2007 were examined. For all competitions, the distributions of birth months were significantly different than expected with more players born in the early months of the year compared with the later months. For the entire cohort of players, 40% were born in the first quarter of the year while only 16% were born in the last 3 months. A small portion of this effect seems to be due to physical stature of the players. This relative age effect held for all FIFA-designated geographical zones except for Africa. The African region displayed a reverse relative age effect with a relatively large portion of players born in the later part of the year, particularly in December of the age appropriate year. The results of this investigation show that at the highest level of youth soccer, there is a strong bias toward inclusion of players born early in the selection year.

Youth sports competitions are often constructed around specific age groups. Typically, an age group spans 1–2 year period. For international youth soccer competitions, the age group consists of players born between January 1 and December 31, inclusively. Under this grouping, players can differ in age by nearly 12 months. At the younger age groups, a year of growth and maturation can be an important factor determining performance on the field.

Athletes who are most successful in a given competition are often the oldest participants within the age group. That is, those athletes born closest to the cut-off date for the competition tend to excel. This relative age effect is common to a number of sports and activities. Research shows that it exists in youth basketball, tennis, ice hockey as well as other sports (Lariviere & Lafond, 1986; Barnsley & Thompson, 1988; Baxter-Jones & Helms, 1994; Dudink, 1994; Delorme & Raspaud, 2008). A number of studies have focused on the relative age effect in youth soccer (Helsen et al., 1998, 2005; Glamser & Vincent, 2004; Vincent & Glamser, 2006; Jimenez & Pain, 2008). These studies clearly indicate that at many levels of play, the identification and selection of players to participate in advanced training or competitions has a clear age bias.

The birthdates of players participating in the Under-17 (U17) FIFA World Cup were examined to determine if a relative age effect exists at this level of competition. This event was chosen as it is the highest level of youth soccer competition. By age 17, most players are near their physical and psychological maturity differences between older and younger players are expected be minimized. These players are more likely to have been identified in earlier selection processes and received advanced training and competition opportunities. Further, this large cohort of the players allows for comparison of historical trends and possible geographical differences. The results of this study suggest that at the highest level of youth soccer competition the relative age effect is strong.

Methods

The past six U17 FIFA World Cup competitions, spanning 10 years, were analyzed. This investigation focused only on males since women have not participated in this competition. Rosters with player birthdates were obtained from FIFA (http://www.fifa.com). The birth month and year for each player was recorded. For analysis purposes, birth months were designated numerically where 1 represents January and 12 represents December. The birth rates were then calculated per month. For the 2007 competition, player heights were also recorded. This was the only competition where these data were available.

Chi-square analyses were used to determine if the birth month distributions were statistically different from the expected distributions. This test was also used to compare the distributions of various groupings of teams and of the entire cohort. Teams were sub-grouped by competition year, FIFA designated geographical zone and the team's final placement in the competition. For all analyses, an equal distribution of births across all months was assumed (8.33% per month). Because of the various sub-group analyses performed, it was not possible to take into account potential variations in monthly birth rates that might occur between various countries and geographical regions. The level of significance was set at $P<0.05$.

Results

A total of 53 nations participated in the six tournaments were examined. For 2007, 24 countries participated whereas 16 participated in other years. A total of 1985 players were rostered for six competitions. For 2003, 2005, and 2007 the roster limit was 20 players. For all other years, the roster limit was set at 18 players. Not all countries submitted full rosters.

The percentage of players born each month for each competition is shown in Fig. 1. As can be seen, there appears to be a clear relative age effect each year with greater percentage of participants born in the early months rather than later. For the entire cohort of players, nearly 40% of the players were born in the first quarter of the year. Conversely only 16% of the players were born in October, November, or December. The median birth month was 5 (May). For the entire cohort, the distribution of birth months was significantly different than expected and there was a strong negative correlation between birth month and the number of players (Table 1).

Table 1 shows the median birth months for each year, the χ^2 and the correlation coefficient between birth month and number of players born each month. In all years, the median birth month is in the first half of the year and the distribution of birth months are significantly different than that expected. There are also significant negative relationships between the birth month and the number of participants.

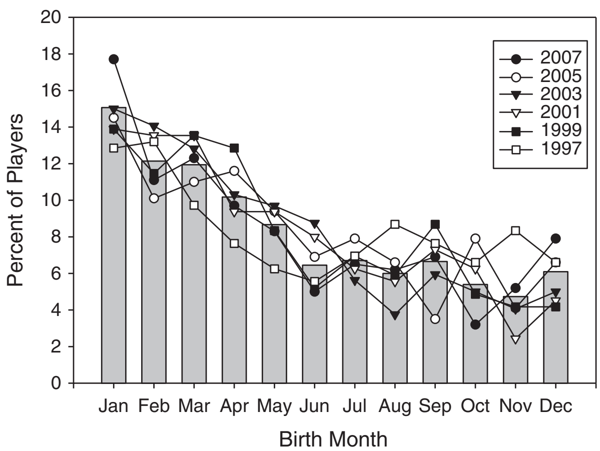

Fig. 1. The percent of players born each month for all competitions (lines). The bar graph represents the entire cohort of players from all six competitions.

Table 1. Relative age effect across years

Year	Median	χ^2	r
2007	4	103.1	– 0.779
2005	5	42.0	– 0.840
2003	4	68.3	– 0.933
2001	4	53.3	– 0.935
1999	4	52.8	– 0.879
1997	5	23.2	– 0.642
Entire cohort	5	279.7	– 0.913

All χ^2 are significant ($P<0.05$). The r values represent the regression coefficient between birth month and number of participants. All r values are significant, $P<0.05$).

Table 2. Relative age effect across FIFA designated regions

Region	Median	χ^2	r
Africa	8	56.2	0.479
Asia and Oceania	5	62.5	– 0.934
Europe	4	140.6	– 0.916
North and Central America	4	90.5	– 0.952
South America	4	110.7	– 0.960

All χ^2 and r values are significant ($P<0.05$).

Many of the team rosters had underage players. That is, players who were born after the oldest birth year of participation. For example, in the 2007 competition the age-appropriate players were born in 1990. However, several of the participants were born later, in 1991. Overall, there were 314 underage players representing 16% of the entire cohort. When analyzed as a separate cohort, the underage players also demonstrated a relative age effect. The mean and median birth month was 5 with 36% of the players born in January, February or March vs only 19% born in the last quarter of the year. The distribution of birth months was significantly different than expected ($\chi^2 = 35.5$, $P<0.05$). The correlation coefficient between birth month and number of participants for the underage group is -0.700 ($P<0.05$).

Table 2 and Fig. 2 show the distribution of birth months across FIFA designated geographical regions. All demonstrated significant age effect distributions. All regions except Africa showed median reported birth months of April and May as well as negative correlation coefficients between birth month and number of players born each month. The Africa region showed a "reverse" relative age effect with a positive r-value and a median reported birth month of August. Some individual African nations also showed a reverse relative age effect. For example, in the 2007 competition, Ghana, Nigeria, and Togo showed birth month distributions that favored younger players. Of the 19 African teams entered in the six competitions, 14 had median reported birth months later in the reported calendar year (July–

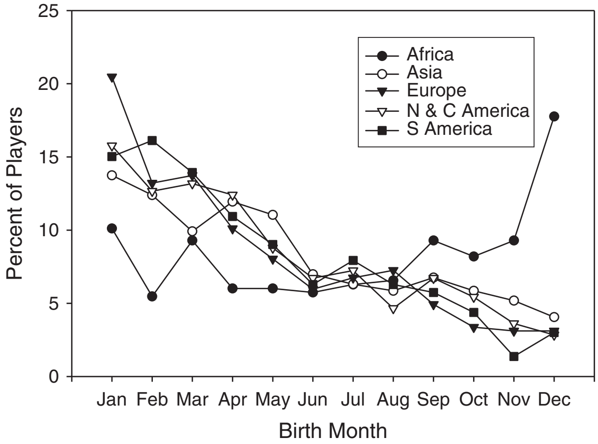

Fig. 2. Percent of players born each month for the FIFA designated regions.

Table 3. Relative age effect vs final placement

Place	Median	χ^2	r
Champion	4	38.1	– 0.663
Runner-up	5	26.2	– 0.568
Third	5	27.6	– 0.696
Fourth	4	40.4	– 0.708
Bottom four	5	55.2	– 0.824

All χ^2 and r values are significant ($P<0.05$).

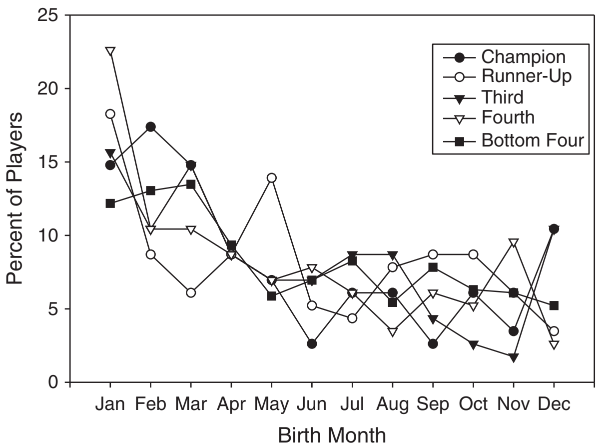

Fig. 3. Percent of players born each month based on final placement.

December). In addition, of the 314 underage players, 41% were included on one of the African team rosters. This indicates that for the African region, the trend is for more players to be born later in the calendar year rather than earlier.

The most and least successful teams also showed a relative age effect. Table 3 and Fig. 3 show the results for the tournament champions, runners-up third and fourth place finishers as well as the four last place teams. The nature of the tournaments do not allow for direct determination of a true "last place" team thus, the data for the bottom four finishers (based on points earned) were pooled. For all placements, the χ^2 values were statistically significant and there were negative relationship between birth month and number of players. Median birth months were in April and May.

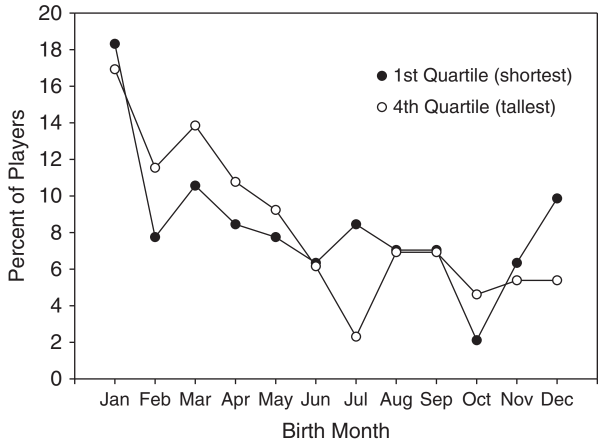

Fig. 4. The birth month distribution for the shortest (1st quartile) and tallest (4th quartile) players.

Mean height for the entire cohort was 176.8 ± 0.3 cm. This value falls between the 50th and 75th percentile for adolescents of the same age (WHO Multicenter Growth Reference Study Group, 2006). To understand the potential influence of stature in the relative age effect, the birth month distributions of the shortest (1st quartile) and tallest (4th quartile) were examined (Fig. 4). For the 1st quartile, the relative age effect approached but did not achieve statistical significance ($\chi^2 = 18.9$, $P = 0.06$) whereas the tallest players showed a significant effect ($\chi^2 = 23.7$, $P<0.05$). Mean height for the age appropriate group (176.9 ± 0.3 cm) and the under age group (175.7 ± 0.8 cm) did not differ significantly. Figure 5 shows the mean heights for the age appropriate and underage players as a function of birth month. Because some birth months were represented by only a few under age players (2–3), birth months were collapsed into quarter of the year. Except for the October-December period, underage players tended to be shorter but not significantly so.

Because the Africa region showed a significant reverse age effect and because these nations rostered the most under age players, a closer examination of this group of players was performed. Figure 6 shows the birth month distribution for both age appropriate and under age players in Africa as well as the other regions. For this analysis, players that were two years underage were not included. For regions other than Africa, there is a steady decline in the percentage of players born each month from the earliest to the latest month. For the Africa region, the distribution of players across birth months was relatively even,

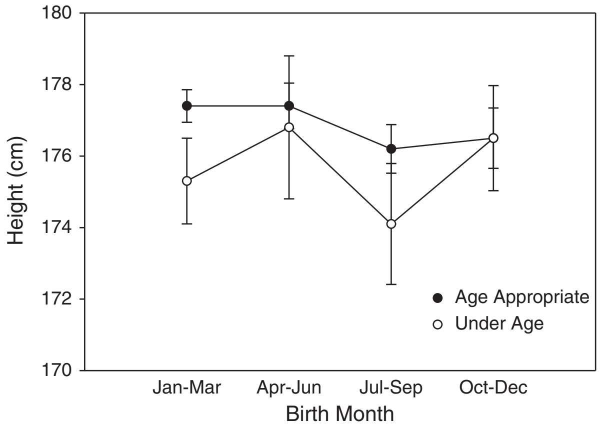

Fig. 5. Mean heights of the age appropriate and underage players. Values are means ± SEM.

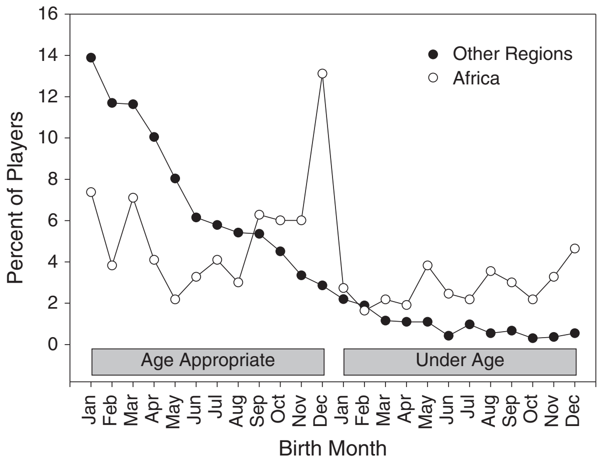

Fig. 6. Birth month distributions of the age appropriate and underage players from Africa and the other regions.

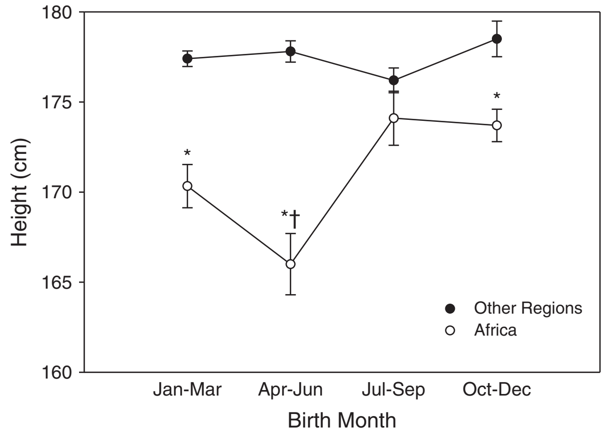

Fig. 7. Mean heights of the players from Africa and the other regions. Values are means ± SEM, $*P<0.05$ between groups, $\dagger P<0.05$ within Africa vs Jul–Sep and Oct–Dec.

except for the month of December of the age appropriate year (13.1%). The percent of players born this month was nearly twice as great as any other month. In addition, 33.6% of the African players were under age vs 11.1% of the players from the other regions. The mean height of the Africa players was significantly less than the mean of the other regions (171.0 ± 1.2 vs 177.6 ± 0.3 cm, $P<0.05$). Players born in the first half of the year and the last quarter of the year were significantly shorter than players from the other regions (Fig. 7). The African players born in the second quarter of the year were significantly shorter than those born in the last two quarters. Only four African players were the 4th quartile (tallest) of the entire cohort of player heights.

Discussion

The results of this investigation show that at the highest level of youth soccer competition, a considerable relative age effect exists. That is, players participating in the men's FIFA U17 World Cup are far more likely to have been reported to be born in the early part of the reported calendar year than in the latter. This trend has held for the most recent six competitions, spanning 10 years. A relative age effect was apparent for most individual geographical zones and for the most and least successful teams. The only exception was that many of the African nations, and the African zone as a whole, showed a reverse age effect with their rosters populated by a large number of under age players. Lastly, the relative age effect in the U17 World Cup seems to be somewhat dependent on the stature of the players.

A unique finding of the present study is that the African zone, as a whole, showed a reverse relative age effect. This appears to be the first report of such a phenomenon. For these nations, players were more likely to have been born in the latter part of the age appropriate year with nearly 14% born in December 1990. Also, African nations rostered relatively more supposedly under age players than other regions (approximately one-third). No other study showing such a skewed distribution in the percentage of participants born at the end of the competition year could be found. The reason for this phenomenon is not readily apparent. Physical stature may play a role given that the African players born in the later part of the year tend to be taller than those born earlier. However, average height of the African players was significantly less than the other regions. An important consideration is that an underlying assumption of this study is that that the birthdates obtained are accurate. It seems reasonable that with such a large percentage of players born in a single month there may be errors in the reporting of actual birth dates. A study of vital registries in Cameroon indicates that only 33% of births could be confirmed by a birth certificate since the documents are held by the father (Ndong et al., 1994). Further, only about half of the births for children under 1-year-old are registered. Thus the potential for error in reporting actual birth dates is large. Dvorak et al. (2007) suggested that the differences between reported birth age and skeletal age might reflect such errors. This idea is also supported by the unique distribution of player heights for the African region with players born in the latter part of the year being significantly taller than those born in the first part. One would expect, based on the WHO height statistics, an opposite distribution (WHO Multicenter Growth Reference Study Group, 2006). Their survey of the world population indicated that players born at the end of the playing year should be approximately 2 cm taller than those born at the beginning of the year. In any case, it is clear that more work is needed to explain why the African nations exhibit such an atypical birth month distribution. Future work should be directed toward a more detailed examination within Africa to determine if this phenomenon is unique to the western region of Africa (as the present data suggest) or consistent across the continent. Insight could also be gained by examining other international competitions such as athletics where African nations excel. Lastly, if this is a real trend and not reflective of erroneous reported birth dates, it should hold for other age group competitions.

The finding of a relative age effect in the U17 World Cup competition agrees with other studies of both elite and lower levels of youth soccer. Helsen and colleagues (Helsen et al., 2005) show a relative age effect for nearly all countries competing in U15 and U18 European competitions. They also show a similar pattern of birth month distribution at the U12 and U14 club team level. In the Unites States, two studies show that the selection of male Olympic Development Program (ODP) player pools is biased toward older players (Glamser & Vincent, 2004; Vincent & Glamser, 2006). This was the case for state, regional, and national pool selections. Interestingly, in these three studies, there was no significant relative age effect in women's competitions or ODP pool selections. Lastly, Spanish youth club team rosters as well as national U17 and U20 team rosters are skewed towards older players (Jimenez & Pain, 2008). However, professional and senior national team rosters show less relative age effect bias with more even distributions of birth months. Based on these studies and the present investigation, it is clear that the relative age effect exists for male participation at multiple age and playing levels.

There are several possible explanations why the relative age effect exists at the U17 World Cup level of play. First, the older players in a given age group are expected to be more physically mature than their younger counterparts. Studies from Portuguese and Mexican soccer as well as Canadian hockey show that skeletal maturity level plays an increasingly important role in the selection process as the players mature (Malina et al., 1982; Lariviere & Lafond, 1986; Pena Reyes et al., 1994; Malina et al., 2000). At the younger age groups (11–12 years), there is a more even distribution of players exhibiting late, average, and early stages of skeletal maturity. At the older age groups (15–16 years), teams are heavily dominated by players with early or average maturity levels. Using MRI examinations of the wrist, Dvorak et al. (2007) found that players from international U17 competitions possessed greater skeletal maturity than a normative population of the same age. In the present study, the tallest players showed a significant relative age effect whereas the shortest players did not. Also, the under age and age appropriate players did not differ significantly in height. If stature played no role in the distribution of birth months, the tallest and shortest players would both display significant relative age effects and a greater difference in height between the youngest and oldest players would be expected. Thus, the present data are consistent with the supposition that physical size plays a role, albeit small, in driving the relative age effect.

A second possible explanation is that relatively older players are identified at an early age as being "talented" and are likely to receive higher-level instructional and competitive opportunities. Cumming et al. (2006) suggested that more physically mature players receive more non-autonomy support from coaches. They suggest that this creates a sociopsychological environment that is more conducive to discontinuing participation. However, early maturing players may receive more instructional support that is perceived as non-autonomy. Coaches may focus more attention on those players with greater physical prowess. It is very likely that increased training for relatively older players at the younger ages perpetuates an early relative age effect. This training benefit becomes an increasing advantage for the older players as they reach the late adolescent ages.

Third, it is possible that the pool of young players available for selection into national teams is reduced as cohort ages. Helsen et al. (1998) found that as youth league players mature in age, the number of participants born in the later part of the birth year decreases. Relatively younger players appear to drop out and are no longer available for selection. Thus, it is possible that the distribution of birth months for the U17 World Cup teams better reflects the distribution of the entire pool of available players. With fewer younger players, the likelihood of a skewed birth month distribution increases.

Regardless of specific contributing factors, there are a number of important consequences for the relative age effect for youth soccer. Many younger players who possess the potential for developing into exceptional adult players may drop out before their potential is realized. These players may see an inherent bias in the selection process that they cannot over come (i.e. birth month) and opt to participate in other activities where physical maturity and subjective evaluation may be less important. Such seems to be the case in youth soccer (Helsen et al., 1998) as well as in youth hockey (Barnsley & Thompson, 1988). Also, while older players may receive advanced opportunities for development, it is not clear if this is an advantage. The older players and their coaches may place less emphasis on skill development and more reliance on physical advantages. Advanced physical maturity at the younger ages and during adolescence are often transient and are diminished in young adulthood (Lefevre et al., 1990). Thus, older players who rely heavily on physical abilities may not develop the technical abilities needed to progress beyond the youth level. This is supported by the finding that in senior national teams, the relative age effect is much less apparent and those rosters tend to be populated by a more even distribution of birth months (Jimenez & Pain, 2008). At the senior and professional level, where physical maturity is less varied, performance often depends on other aspects such as technical and tactical abilities as well as fitness (Kalapotharakos et al., 2006; Rampinini et al., 2007, 2009). In either case, the effects of a persistent relative age effect are negative in that potential high-level players may be lost and/or relatively older players may not develop to their full potential.

Jimenez & Pain (2008) argue that the current identification and development process, which allows for age bias, results in "wasted potential." Technically gifted but less mature players drop out or fail to receive advanced training while older, more mature players fail to develop the technical aspects for their game. Combined, these two factors may diminish the talent pool for senior national teams. Coaches should also be encouraged to evaluate players on potential as well as talent. Also, training should focus on developing the skills needed to play at the highest level rather than capitalizing on the player's physical attributes.

Perspectives

In conclusion, a study of the U17 FIFA World Cup participants reveals that over the past six competitions, there is a strong relative age effect. The rosters of the teams participating in these competitions show a clear bias in favor of players born in the early part of the year. This holds true for all of the FIFA designated regions except for the Africa region where a reverse relative age effect was found. Physical maturity seems to play some role, albeit small, in explaining the relative age effect. It may also result from the selection process and/or the training environment provided. In either case, there are several negative outcomes for a persistent relative age effect.

Key words: soccer, youth, age effect, development.

References

Barnsley RH, Thompson AH. Birthdate and success in minor hockey: the key to the NHL. Can J Behav Sci 1988: 20: 167–176.

Baxter-Jones A, Helms P. Born too late to win? Nature 1994: 370: 186.

Cumming SP, Battista RA, Martyn S, Ewing ME, Malina RM. Estimated maturity status and perceptions of adult autonomy support in youth soccer players. J Sports Sci 2006: 24: 1039–1046.

Delorme N, Raspaud M. The relative age effect in young French basketball players: a study on the whole population. Scand J Med Sci Sports 2008: 19: 235–242.

Dudink A. Birth date and sporting success. Nature 1994: 368: 592.

Dvorak J, George J, Junge A, Hodler J. Application of MRI of the wrist for age determination in international U-17 soccer competitions. Br J Sports Med 2007: 41: 497–500.

Glamser FD, Vincent J. The relative age effect among elite American youth soccer players. J Sport Behav 2004: 27: 31–38.

Helsen WF, Starkes JL, van Winckel J. The influence of relative age on success and dropout in male soccer players. Am J Human Biol 1998: 10: 791–798.

Helsen WF, van Winckel J, Williams AM. The relative age effect in youth soccer across Europe. J Sports Sci 2005: 23: 629–636.

Jimenez IP, Pain MT. Relative age effect in Spanish association football: its extent and implications for wasted potential. J Sports Sci 2008: 26: 995–1003.

Kalapotharakos VI, Strimpakos N, Vithoulka I, Karvounidis C, Diamantopoulos K, Kapreli E. Physiological characteristics of elite professional soccer teams of different ranking. J Sports Med Phys Fitness 2006: 46: 515–519.

Lariviere G, Lafond A. Physical maturity in young elite ice hockey players. Can J Appl Sport Sci 1986: 11–24.

Lefevre J, Beunen G, Steens G, Claessens A, Renson R. Motor performance during adolescence and age thirty as related to age at peak height velocity. Ann Hum Biol 1990: 17: 423–435.

Malina RM, Meleski BW, Shoup RF. Anthropometric, body composition, and maturity characteristics of selected school-age athletes. Pediatr Clin North Am 1982: 29: 1305–1323.

Malina RM, Pena Reyes ME, Eisenmann JC, Horta L, Rodrigues J, Miller R. Height, mass and skeletal maturity of elite Portuguese soccer players aged 11–16 years. J Sports Sci 2000: 18: 685–693.

Ndong I, Gloyd S, Gale J. An evaluation of vital registers as sources of data for infant mortality rates in Cameroon. Int J Epidemiol 1994: 23: 536–539.

Pena Reyes MR, Cardenas-Barahona E, Malina RM. Growth, physique, and skeletal maturation of soccer players 7–17 years of age. Humanbiol Budapestinensis 1994: 25: 453–458.
Rampinini E, Coutts AJ, Castagna C, Sassi R, Impellizzeri FM. Variation in top level soccer match performance. Int J Sports Med 2007: 28: 1018–1024.
Rampinini E, Impellizzeri FM, Castagna C, Coutts AJ, Wisloff U. Technical performance during soccer matches of the Italian Serie A league: effect of fatigue and competitive level. J Sci Med Sport 2009: 12: 227–233.
Vincent J, Glamser FD. Gender differences in the relative age effect among US Olympic development program youth soccer players. J Sports Sci 2006: 24: 405–413.
WHO Multicenter Growth Reference Study Group. WHO Child Growth Standards: Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: Methods and development. Geneva: WHO, 2006.