Relative age effect in elite sports: Methodological bias or real discrimination?

NICOLAS DELORME¹, JULIE BOICHÉ², & MICHEL RASPAUD¹

¹Laboratoire Sport et Environnement Social, Université J. Fourier-Grenoble 1, Grenoble, and ²Centre Universitaire de Recherche en Activités Physiques et Sportives, Université de la Réunion, Le Tampon, France

Abstract

Sport science researchers refer to a relative age effect when they observe a biased distribution of elite athletes’ birth dates, with an over-representation of those born at the beginning of the competitive year and an under-representation of those born at the end. Based on the complete sample of French male licensed soccer players (n = 1,831,524), we suggest that there could be an important bias in the statistical test of this effect. This bias could in turn lead to the false conclusion of systemic discrimination in the recruitment of professional players. Our findings question the accuracy of previous research on the existence of this effect in elite soccer.

Keywords: Relative age effect, soccer, discrimination, bias

Introduction

Over the last two decades, the relative age effect has received a lot of attention from sport science researchers (Cobley, Baker, Wattie, & McKenna, 2009; Musch & Grondin, 2001). Among elite athletes, this effect is illustrated by an over-representation of players born during the first two quarters of a competitive year, and an under-representation of players born during the last two quarters. This biased distribution is due to the age categories determined by sport organizations. Such organizations traditionally group young participants in categories of two consecutive years of birth. Although such a system is used to balance the competition between players, it generates important differences in relative age: two children competing in the same category can be 23 months apart in age if they are not born in the same year, while children who are born in the same year can be up to 11 months different in age.

Consequently, children born early in the competitive year are more easily identified as “talented” or “promising” than their counterparts born later in the year during assessments organized by sporting bodies (Helsen, Van Winckel, & Williams, 2005). Indeed, their initial advantage in relative age is accompanied by more advanced physical (Delorme & Raspaud, 2009) and cognitive (Bisanz, Morrissin, & Dunn, 1995) development. Due mostly to their more developed physical attributes (e.g. height, weight or strength), those children and adolescents benefit from a “biased” view of their potential, which facilitates their recruitment to high-level structures. Once this first step is achieved, they can take advantage of an early exposure to elite practice with highly qualified technicians. This access to top-level competition can be a springboard to their future sport career (Ward & Williams, 2003; Williams, 2000), considering the technical and strategic skills it may bring. [For an exhaustive presentation on the mechanisms, factors, and moderators of the relative age effect, see the review of the literature by Musch and Grondin (2001).]

This asymmetrical distribution of elite players’ birth dates has been observed in various sports, including baseball, cricket, tennis, football, and rugby union (Cobley et al., 2009; Musch & Grondin, 2001). Most of this type of research, however, has focused on ice hockey and soccer. In soccer, a relative age effect has been reported for the
professional championship of many countries: United Kingdom (Dudink, 1994), Belgium (Helsen, Starkes, & Van Winckel, 1998), Spain (González Aramendi, 2007), France and the Netherlands (Verhulst, 1992), Australia, Brazil, Germany, and Japan (Musch & Hay, 1999). Based on the consistency of such research in elite sport, Musch and Grondin (2001, p. 163) conclude their review of the literature thus: “taken together, a growing body of research reviewed in this article suggests that RAEs [relative age effects] are a pervasive phenomenon in competitive sport”.

Some authors have suggested that this effect is discriminatory for players born late in the competitive year. In this vein, Edgar and O’Donoghue (2005, p. 1014) underline the potential gains for a tennis player’s career, in terms of money, television coverage, recognition, and celebrity lifestyle, and suggest that “it would be desirable that everyone would have an equal opportunity to become a professional tennis player regardless of season of birth”. For these authors, even if this discrimination is inadvertent, it needs to be cautiously examined, given the lucrative nature of certain sports. Others argue that sport should facilitate every child’s blossoming and health (Musch & Grondin, 2001). Indeed, the system appears detrimental for certain children’s motivation, which may lead them to drop out and does not contribute to the physical activity habits they should adopt during adulthood. In a more pragmatic vein, some authors note that the relative age effect, as an artificial consequence of the youth competition structure, generates a loss of potentially talented players, which in the long term contributes to a reduction in standard of professional and national teams (e.g. Pérez Jiménez & Pain, 2008).

Because of the potential economic, psychological, and health-related outcomes of the relative age effect, most authors agree on the need for action to reduce or even eradicate this phenomenon. In this regard, it was proposed to establish among young participants new categorization systems, either based on biological (e.g. Baxter-Jones, 1995) or chronological age (e.g. Boucher & Halliwell, 1991; Hurley, 2009; Hurley, Lior, & Tracze, 2001), so as to deal with the negative correlates of the differences in relative age. As sport organizations apparently ignore this phenomenon, some authors have even called for direct intervention by governments (e.g. Hurley et al., 2001).

In summary, the relative age effect is seen as discriminatory because it places players born late in the competitive year at a disadvantage by reducing their chances of reaching the elite level of a sport. The aim of the present study was to assess the empirical basis of this discrimination. We believe an important methodological bias arises in studies reporting a relative age effect among elite athletes, which questions the validity of the conclusions drawn. In the literature, the presence of a relative age effect is traditionally determined by examining whether there is a significant difference between the theoretical expected distribution of players by month (or quarter) and the observed distribution, which is done by performing a chi-square goodness-of-fit test or a Kolmogorov-Smirnov one-sample test. Based on these studies, four strategies can be identified for calculating the expected distribution:

1. An even distribution of birth dates by month or quarter is posited (e.g. Barnsley, Thompson, & Legault, 1992). This strategy is frequently used when the research concerns an international sample.
2. An even distribution is posited, controlling for the number of days in a month/quarter (e.g. Edgar & O’Donoghue, 2005). Once again, an international sample is often the justification for this choice.
3. The birth dates statistics by month, sex, and year for the corresponding national population are considered, using weighted mean scores (e.g. Helsen et al., 1998).
4. The statistics of a European country are considered, using weighted mean scores, in a study of a European sample (e.g. Helsen et al., 2005). This procedure is based on the work of Cowgill (1966), suggesting that the distribution by month/quarter is similar among European countries.

In the absence of specific methodological constraints – for instance, an international sample – and in an attempt to obtain accurate results, it is recommended to use the third procedure to calculate the expected birth dates distribution. Whatever the strategy chosen, all four of the above procedures may lead to a biased final interpretation. Indeed, whether the reference considered is an even distribution (procedures 1 and 2) or national standards (procedures 3 and 4), there is an implicit assumption that the distribution of birth dates of the licensed players for a given activity is similar to that of the corresponding national population taken as the reference. Yet to our knowledge this assumption has never been tested in any sport. It is noteworthy that, except in a handful of cases, elite athletes come from the national population of licensed athletes. As has previously been underlined, the differences in relative age are accompanied by significant disparities between players in the same age category, in terms of cognitive and physical development. It is thus logical that sports in which physical attributes represent an
advantage, such as ice hockey and soccer, will be less attractive to young people born late in the competitive year, and thus who are less physically mature.

As indicated above, the unequal distribution of birth dates among elite players would thus be partly due to a selection system that values physical development and discriminates against players born late in the competitive year. However, to definitively conclude that such discrimination exists, it is necessary to show that the distribution of birth dates of licensed players by month or quarter is identical to the distribution observed in the corresponding national population. If it is shown that there exists an unequal distribution among the entire population of licensed players in a given activity, the selection system and the recruitment operated by the different professional organizations should not be singled out as being responsible for the unequal distribution among the elite. In contrast, a “self-restriction” process inhibiting certain youngsters and preventing them from even beginning the activity, as well as an early drop out of players born at the end of the competitive year, could account for this phenomenon at the highest level.

Based on the birth dates of all French male players affiliated to the French Soccer Federation (FSF) for the 2006–2007 season, the aims of this study were twofold. First, we wished to determine whether the distribution of birth dates in this sample was identical to that observed in the French population for the corresponding years of birth. Second, we wished to determine whether using all licensed players versus the national population as the reference to calculate the expected distribution of birth dates has an impact on the conclusion drawn regarding the distribution observed among elite players (i.e. French players of the first division championship).

Materials and methods

Data collection

For the purpose of the present study, the birth dates of all male French players affiliated to the FSF (n = 1,831,524) during the 2006–2007 season were collected from the federation database. Foreign players were excluded from the sample to ensure that all participants were subject to the same cut-off date for age categorization, and to enable a relevant comparison with the distribution of birth dates observed among the French population. The birth dates of players from the French first division championship (n = 351) were collected through the rosters of the Professional Soccer League (PSL). Once again, foreign players were excluded from the sample. Among males, the FSF distinguishes seven age categories: “under 7 years”, “under 9 years”, “under 11 years”, “under 13 years”, “under 15 years”, “under 18 years”, and “adults”.

Data analysis

For each of the seven FSF age categories, as well as for the sample of players from the PSL, the players’ birth dates were classified into four quarters. Since the cut-off date used to form age categories has been modified by the FSF (Jullien, Turpin, & Carling, 2008), the players born before 1982 were classified from Q1 (August–October) to Q4 (May–July) and the players born in 1982 and after were classified from Q1 (January–March) to Q4 (October–December).

Regarding the players affiliated to the FSF, the expected distribution for each age category was calculated based on the national birth statistics by month and year for males, using weighted mean scores. Those data were obtained through the National Institute of Economic Statistics and Studies. For professional players, two chi-square goodness-of-fit tests were carried out using the following procedures for the calculation of expected distribution of birth dates:

a. The national birth statistics by month and year for males, using weighted mean scores.

b. The statistics by month and year observed for the whole corresponding population of male players affiliated to the FSF, using weighted mean scores.

The tests were conducted with the Statistica 6.1 software (StatSoft, Inc.) with statistical significance set at $P<0.05$.

Results

Table I presents the distribution of birth dates by quarter for each age category identified for male players by the FSF, during the 2006–2007 season.

A chi-square goodness-of-fit test taking the distribution of licensed players as the observed distribution and national values as the expected distribution reveals statistically significant differences for all age categories: under 7 years ($\chi^2 = 566.75$, d.f. = 3, $P<0.0001$), under 9 years ($\chi^2 = 237.90$, d.f. = 3, $P<0.0001$), under 11 years ($\chi^2 = 269.97$, d.f. = 3, $P<0.0001$), under 13 years ($\chi^2 = 346.07$, d.f. = 3, $P<0.0001$), under 15 years ($\chi^2 = 619.08$, d.f. = 3, $P<0.0001$), under 18 years ($\chi^2 = 752.99$, d.f. = 3, $P<0.0001$), and adults ($\chi^2 = 1721.87$, d.f. = 3, $P<0.0001$). The results reflect a classical relative age effect with an over-representation of players born...
in Q1 and Q2, and an under-representation of players born in Q3 and Q4.

Tables II and III present the results of analyses of birth date distribution by quarter for professional players using as the theoretical distribution the corresponding national population and the whole population of licensed players respectively.

If the national population is used as reference to calculate the expected distribution, the results indicate a significant relative age effect among professional players from the PSL ($\chi^2 = 8.31$, d.f. = 3, $P < 0.05$). Conversely, if the population of licensed players is used to calculate the expected distribution, one cannot conclude there is a biased distribution among first division players ($\chi^2 = 4.69$, d.f. = 3, $P < 0.20$).

**Discussion**

Because the method traditionally used to determine the presence of a relative age effect among elite athletes does not evacuate a bias linked to the choice of national standards in the calculation of the expected distribution for the statistical test, the first aim of this study was to compare the distribution of birth dates for the whole population of male players affiliated to the FSF, and in the French population.

Our results reveal a systematic significant relative age effect for all age categories distinguished by the FSF; that is, an over-representation of players born in Q1 and Q2 and an under-representation of players born in Q3 and Q4. These results thus indicate that the “classical” methods used to assess and interpret the presence of a relative age effect may not always be valid, but instead might introduce bias into the conclusions drawn about this phenomenon among the elite. Indeed, the presence or absence of this effect is usually examined by looking at the players’ birth date distribution, comparing them to national standards. Such a strategy is based on the implicit premise that the population of licensed players for one activity is similar to the national distribution. However, the present results suggest that, at least in the case of French soccer, there already is a disparity in the players’ birth date distribution, comparing them to national standards. This has crucial implications and calls for a methodological change in the calculation of expected distributions in studies of the relative age effect. A study aimed at demonstrating this effect should use as the theoretical distribution the population of licensed players, instead of the national corresponding statistics. Indeed, one could hastily conclude that an asymmetric distribution of birth dates among elite players results from a relative age effect, whereas it is only representative of the distribution observed in the population of licensed players. The over-representation of players born at the beginning of the competitive year, and the under-representation of those born at the end, may not be a consequence

**Table II. Season of birth of first division players (2006-2007): corresponding national population as the theoretical distribution**

| Category | Q1   | Q2   | Q3   | Q4   | Total | $\chi^2$ | $P$  |
|----------|------|------|------|------|-------|----------|------|
| League 1 | 108  | 89   | 81   | 73   | 351   | 8.31     | <0.05|
| ($\Delta$) | (+23) | (-4) | (-8) | (-11) |       |          |      |

**Table III. Season of birth of first division players (2006-2007): corresponding national population as the theoretical distribution**

Note: $\Delta$ is the difference between the observed distribution and the theoretical expected distribution.
of the selection system that values physical development of young players, which may place children and adolescents born during the first months of the year at a disadvantage, but could simply be the mimetic expression of the mass of licensed players.

On this perspective, it would be erroneous to conclude to discrimination towards players born at the end of the competitive year. The potential impact of this bias is far from negligible and might even lead to opposite conclusions about this phenomenon. In this vein, the results concerning the birth date distribution of the 351 French soccer players of the first division championship during the 2006–2007 season vary according to the reference used to calculate the expected distribution for the chi-square goodness-of-fit test. When the French population is used, there is a biased distribution, but with the population of soccer licensed players, a similar distribution is observed. In the first case, the researcher would likely conclude a discriminative effect due to the mode of recruitment of the various professional instances, whereas in the second case he or she would conclude the absence of such an effect. Because most players that reach the elite level emanate from the population of licensed players, and go through all the detection and selection sessions operated by federal organizations, we would recommend using the birth date distribution of this population, and not national data, to calculate the expected distribution. This precaution would avoid a bias that could markedly distort the results obtained.

Table III. Season of birth of first division players (2006–2007): whole population of licensed players as the theoretical distribution

|       | Q1    | Q2    | Q3    | Q4    | Total | $\chi^2$ | P     |
|-------|-------|-------|-------|-------|-------|---------|-------|
| League 1 | 108   | 89    | 81    | 73    | 351   | 4.69    | <0.20 |
| ($\Delta$) | (+16) | (-1)  | (-6)  | (-9)  |       |         |       |

Note: $\Delta$ is the difference between the observed distribution and the theoretical expected distribution.

This study further reveals a significant relative age effect for all age categories distinguished by the FSF. The fact that a biased distribution was systematically observed for regular players calls for additional work examining what mechanisms lead to such an effect. We assume that it results from two major processes: first, a phenomenon of “self-restriction” that prevents children and adolescents born at the end of the competitive year to begin to practise a particular sport; second, higher drop-out rates among those who begin to play but encounter a temporary physical inferiority, compared with players born early in the year who are in the same age category. Indeed, if the asymmetrical distribution observed at the higher level is not the result of a biased selection, it appears that the one observed for all licensed players reflects a systemic discrimination for young people born late in the competitive year. Given the multiple benefits of moderate sport participation for social acceptance, psychological self-perceptions, and health, such discrimination and its mechanisms deserve future examination in research on the relative age effect.

Conclusion

If the present results, in themselves, do not demonstrate the absence of a relative age effect in elite sport, they nevertheless question the accuracy of the tests performed in previous studies of this phenomenon and consequently the conclusions drawn. In this regard, if a biased distribution already exists among the whole population of licensed players in one activity, it is normal that such asymmetry also arises among the elite. Taking the national population as the reference, one could be prone to hastily conclude that discrimination is in operation in the way professional sport organizations recruit their athletes.

References

Barnsley, R. H., Thompson, A. H., & Legault, P. (1992). Family planning: Football style. The RAE in football. *International Review for the Sociology of Sport*, 27, 77–88.

Baxter-Jones, A. (1995). Growth and development of young athletes: Should competition levels be age related? *Sports Medicine*, 20, 59–64.

Bisanz, J., Morrison, F. J., & Dunn, M. (1995). Effects of age and schooling on the acquisition of elementary quantitative skills. *Developmental Psychology*, 31, 221–236.

Boucher, J., & Halliwell, W. (1991). The Novem system: A practical solution to age grouping. *CAPHER Journal*, 57, 16–20.

Cobley, S., Baker, J., Wattie, N., & McKenna, J. (2009). Annual age-grouping and athlete development: A meta-analytical review of relative age effects in sport. *Sports Medicine*, 39, 235–256.

Cowgill, U. (1966). Season of birth in man: Contemporary situation with special reference to Europe and Southern Hemisphere. *Ecology*, 47, 614–623.

Delorme, N., & Raspaud, M. (2009). The relative age effect in young French basketball players: A study on the whole population. *Scandinavian Journal of Medicine and Science in Sports*, 19, 235–242.

Dudink, A. (1994). Birth date and sporting success. *Nature*, 368, 592.
Edgar, S., & O’Donoghue, P. (2005). Season of birth distribution of elite tennis players. *Journal of Sports Sciences*, 23, 1013–1020.

González Aramendi, J. M. (2007). El efecto relativo de la edad en el fútbol [The relative age effect in football]. *Archivos de Medicina del Deporte*, 24, 9–17.

Helsen, W. F., Starkes, J. L., & Van Winckel, J. (1998). The influence of relative age on success and dropout in male soccer players. *American Journal of Human Biology*, 10, 791–798.

Helsen, W. F., Van Winckel, J., & Williams, A. M. (2005). The relative age effect in youth soccer across Europe. *Journal of Sports Sciences*, 23, 629–636.

Hurley, W. (2009). Equitable birthdate categorization systems for organized minor sports competition. *European Journal of Operational Research*, 192, 253–264.

Hurley, W., Lior, D., & Tracze, S. (2001). A proposal to reduce the age discrimination in Canadian minor ice hockey. *Canadian Public Policy*, 27, 65–75.

Jullien, H., Turpin, B., & Carling, C. (2008). Influence de la date de naissance sur la carrière professionnelle des joueurs de football français [Influence of birth date on the career of French professional soccer players]. *Science & Sports*, 23, 149–155.

Musch, J., & Grondin, S. (2001). Unequal competition as an impediment to personal development: A review of the relative age effect in sport. *Developmental Review*, 21, 147–167.

Musch, J., & Hay, R. (1999). The relative age effect in soccer: Cross-cultural evidence for a systematic discrimination against children born late in the competition year. *Sociology of Sport Journal*, 16, 54–64.

Pérez Jiménez, I., & Pain, M. T. G. (2008). Relative age effect in Spanish association football: Its extent and implications for wasted potential. *Journal of Sports Sciences*, 26, 995–1003.

Verhulst, J. (1992). Seasonal birth distribution of West European soccer players: A possible explanation. *Medical Hypotheses*, 38, 346–348.

Ward, P., & Williams, M. A. (2003). Perceptual and cognitive skill development in soccer: The multidimensional nature of expert performance. *Journal of Sport and Exercise Psychology*, 25, 93–111.

Williams, A. M. (2000). Perceptual skill in soccer: Implications for talent identification and development. *Journal of Sports Sciences*, 18, 737–740.