Towards a unified understanding of relative age effects

NICK WATTIE1, STEPHEN COBLEY1, & JOSEPH BAKER1,2

1 Carnegie Faculty of Sport and Education, Leeds Metropolitan University, Leeds, UK and 2 School of Kinesiology and Health Science, York University, Toronto, Ontario, Canada

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Abstract
When athletes are placed into annual age groups to organize and coordinate sport participation, certain (dis)advantages occur as a result of the subtle age differences within these groups. These differences, termed “relative age effects”, have been consistently related to youth and adult sport attainment. However, there has been a lack of consistency in the terminology used in this area of research. In this paper, we consider the operational terms used in relative age research, discuss appropriate applications of terminology, and suggest directions for future research. Importantly, we argue for a unified understanding of what “relative age” means, stressing the need for clarity in directing future advances in the field.

Keywords: Sport, youth, relative age, development, constituent year effect

Introduction
The term “relative age” has traditionally been used to refer to the subtle age differences between those in the same annual age group (Barnsley, Thompson, & Barnsley, 1985). Since correlations between educational attainment and school pupils’ relative age were first reported (Armstrong, 1966; Freyman, 1965), a substantive amount of research in the domains of education and sport (for a review, see Musch & Grondin, 2001) has sought to replicate these patterns and explain their occurrence. However, as research in this area has progressed, there has been a clear lack of consistency in the operational terms used and, in some cases, misapplication of the underlying framework. As research continues to progress, there is a need to establish clear and consistent definitions to avoid confusion with other existing research frameworks. To this end, the objectives in this paper are to consider operational terms in relative age research, clarify appropriate applications of terminology, and suggest directions for future research.

An overview of relative age research in sport
Common practice in sport settings has been to group children and youth according to chronological age, as a way to ensure that each child can learn developmentally appropriate skills and is able to compete in an environment of equal footing in relation to his or her peers. Typically, this has led to the use of annual age-grouping systems, whereby a selection date is used to group children into age-specific cohorts. For example, using a selection date criterion of 1 September, children eligible to play “Under 7s football” in England must be more than 6 but less than 7 years old between 1 September and 31 August of that playing season. The result is that relatively older children within an annual age group are more likely to be selected for school sports teams (Cobley, Abraham & Baker, 2008; Wilson, 1999) and competitive youth sports teams (Barnsley & Thompson, 1988). These inequalities, which provide an advantage to relatively older players, persist into adolescent levels of play and subsequently into elite and professional competition (Barnsley et al., 1985; Grondin, Deschaies & Nault, 1984). Although soccer and ice hockey have been the
most extensively studied sports (for a review, see Musch & Grondin, 2001), relative age effects have also been observed in several other sports, including tennis (Dudink, 1994), baseball (Thompson, Barnsley, & Stebelsky, 1991), cricket (Edwards, 1994), netball (O'Donogue, Edgar, & McLauglin, 2004), and volleyball (Grondin et al., 1984).

In explaining relative age effects, it has typically been suggested that relatively older children are advantaged due to greater physical and psychosocial maturity as well as increased experience of sport. A leading hypothesis explains that greater maturation is equated either with “talent” or with performance, and as a result relatively older participants are more likely to be favourably appraised compared with their peers. This results in relatively older players being selected to higher calibre teams, where they may receive better coaching and competition, helping to perpetuate their advantage over relatively younger players.

While annual age groupings create relative age differences and the associated maturational differences in the first place, they are not sufficient to create relative age effects in sport. The cultural popularity and importance of a sport influences the existence of relative age effects via the number of people wishing to play that sport (Musch & Grondin, 2001; Wattie, Baker, Cobley, & Montelpare, 2007; Wattie, Cobley et al., 2007). If the number of people wishing to participate grossly exceeds the infrastructure available (i.e. available teams, leagues, playing-space), more competition exists for participation. Relative age effect-causing conditions become further exacerbated in the contexts of sporting structures that emphasize the values of winning and the need to identify and develop “talent” at a young age for the elite stage. Increased participation, coupled with sport selection programs, appears to perpetuate relative age effects. Such a position is supported by consistent findings in soccer, the most popular sport globally, and ice hockey, the most popular sport in Canada.

In summary, relative age research examines the immediate and prolonged influence of a social construct (i.e. annual age grouping) in sport and education. However, within the relative age literature there are inconsistencies in the use of operational terms used to describe attainment inequalities. As summarized below, these inconsistencies constrain and complicate advances in research in this area.

The need for consistent and appropriate operational terminology

Although the current discussion has exclusively used the terms “relative age” and “relative age effects”, other terms such as “season of birth effect” (Edgar & O’Donoghue, 2004, 2005; Stanaway & Hines, 1995; Verhulst, 1992), “season of birth bias” (O’Donoghue et al., 2004; Simmons & Paull, 2001), and birth date effect (Baker & Logan, 2007; Dudink, 1994; Wilson, 1999) have also been used. However, using such terms interchangeably may be confusing and misleading. Using the term “season of birth” as opposed to “relative age” is problematic because it is associated with a separate area of research, with a different theoretical framework. Originating during the late 1920s (Barry & Barry, 1961), season of birth research examines the influence of different prenatal and perinatal seasonal environmental factors upon human development. For example, season of birth research hypothesizes that sunlight (i.e. vitamin D), temperature, and/or viral exposure during gestation are related to a number of health outcomes (Martin, Foels, Clanton, & Moon, 2004; Torrey, Miller, Rawlings, & Yolken, 1997). Over 250 studies from over 30 countries have been published on “season of birth” as a risk factor for developing schizophrenia and other cognitive disorders (for reviews, see Castrogiovanni, Iapichino, Pacchierotti, & Pieracci, 1998; Torrey et al., 1997). This line of research has also correlated season of birth with seasonal affective disorder (Levitan et al., 2006), as well as the risk of developing obesity in later life (Hillman & Conway, 1975; Phillips & Young, 2000; Wattie, Ardem, & Baker, 2008).

The assertion here is not that season of birth research is without merit, but that care should be taken when applying the two terms to avoid misunderstanding the unique theoretical frameworks of season of birth and relative age research. This point should not be taken lightly, as mechanisms from the “season of birth” framework (e.g. temperature and sunlight exposure during gestation) have previously been presented as alternative explanations for the occurrence of relative age effects (Martin et al., 2004; Musch & Grondin, 2001). Furthermore, use of the phrase “season of birth”, when actually referring to “relative age”, contradicts a critical element of relative age research: the central importance is a person’s age relative to that of their peers within the same annual age group, a characteristic dependent on time of birth relative to the selection date used to place a child in a specific age group; not the time of birth relative to a seasonal climatic cycle.

In fact, some of the most convincing research supporting the traditional relative age framework has shown that relative age effects exist independent of specific months or “seasons” of the year. For example, Musch and Hay (1999) observed that soccer participation within Germany and Brazil, countries using the same selection date criterion (1 August), demonstrated identical relative age effects. That these countries had identical relative age
effects, but are located in different hemispheres with opposing climatic seasonal cycles, strongly suggests that relative age and not seasonal conditions were responsible for attainment inequalities. Similarly, researchers have reported that when selection date criteria have been changed, relative age effects shift to reflect advantages for those born shortly after (i.e. first three months) the new selection dates (e.g. Helsen, Starkes, & Van Winckel, 2000; Musch & Hay, 1999). Barnsley and colleagues (Barnsley & Thompson, 1988; Barnsley et al., 1985) also debated the validity of seasonal explanations in ice hockey, pointing out that if seasonal factors were responsible, then those born in December would be similarly advantaged to those born in January, since the two months share nearly identical seasonal conditions. However, consistent attainment inequalities have been observed between relatively older players born in January and relatively younger players born in December (Montelpare, Scott, & Pelino, 1998; Wattie, Baker et al., 2007).

Although the use of alternative terminologies has been the most prevalent inconsistency in the relative age literature, a recent study by Medic and colleagues (Medic, Starkes, & Young (2007) stresses the need to discuss the different ways that the term “relative age” has been used. In Masters competitions, athletes are typically grouped into five-year age-bands (e.g. 40–44, 45–49 years). Subsequently, the authors applied the term “relative age” to describe an athlete’s age and year of participation within an age-band. For example, in the 45–49 age-band, those 45 years of age, and therefore in their first year of participation for that age-band, would be described as being relatively younger (as defined by Medic et al., 2007). Similarly, a 49-year-old would be in their fifth year of participation within the age-bands, and would be regarded as being relatively older. Medic and colleagues also referred to an athlete’s year of participation within an age-band as a “constituent year” (i.e. constituent year 1, constituent year 2, etc.).

Although this study is of interest because it contributes to our understanding of performance maintenance, ageing, and expertise, it is equally interesting because it constitutes a new development in relative age research. With the exception of Medic et al. (2007), all previous studies have applied the term “relative age” to refer to age differences within a given annual age group. However, the use of the term “relative age” in this context may be problematic.

In the traditional relative age framework, inequalities result from relative age differences caused by annual age grouping policies used in youth sport (these mechanisms have been discussed previously). Scientists concerned with the immediate effects of annual age grouping policies used in youth sport have examined relative age effects in youth and adolescent sport (where athletes are still grouped for participation using annual age groups). Researchers concerned with long-term effects have examined the existence of relative age effects at elite adult standards of play (where annual age grouping is no longer used to group athletes for participation). In so doing, they hope to determine what adult athletes’ relative ages would have been in the youth leagues of their sport (Barnsley et al., 1985; Grondin & Trudeau, 1991; Montelpare et al., 1998; Wattie, Baker et al., 2007).

However, the framework used by Medic et al. (2007) steps outside the aforementioned framework, does not retrospectively ascribe relative age based on annual age grouping policies of youth sport, and instead defines relative age more broadly. This distinction is important in terms of study design, and because this discrepancy encompasses different causal mechanisms. The inequalities observed among Masters athletes are more likely to be associated with age-related declines in performance. Although researchers have indicated variations in the rates of decline (e.g. Baker, Horton, Pearce, & Deakin, 2007; Bortz & Bortz, 1996; Starkes, Weir, Singh, Hodges, & Kerr, 1999), these studies collectively indicate that performance declines with advancing age after peak performance. Since Masters sport typically involves competitors who are past the age of peak performance (which differs by sport), it is reasonable to suggest that those at the start of a five-year age-band can function better than those at the end of the same age-band.

Most interestingly, perhaps, it is also possible that participation rate discrepancies among Masters athletes may be the result of self-selection processes based on psychosocial factors related to perceptions of success via peer-group comparison within an age-band. Comparatively, participation inequalities observed by traditional relative research result from being selected (or not selected) by an external party (i.e. the coach).

Another important difference between the traditional relative age framework and the new framework relates to the dynamics of an athlete’s relative age. According to Medic et al. (2007), an athlete’s relative age (i.e. constituent year) will change from year to year as they progress through an age-band. Comparatively, within the traditional framework, relative age remains a stable characteristic throughout the developmental stages of youth sport participation (unless selection date criteria change).

It could be argued that these differences are merely a reflection of the different participation structures of youth and Masters sport, and therefore that a demarcation between the two types of “relative
"age" may not be necessary. However, youth ice hockey in Canada utilizes annual age grouping and two-year competition age-bands. Nonetheless, previous relative age research in youth sports with two-year age-bands (i.e. with two constituent years) has used the traditional framework (e.g. Barnsley & Thompson, 1988; Wattie, Cobley et al., 2007).

To better understand why the traditional relative age framework has been used in this context, let us consider a group of athletes entering their first of two years of play in an Under-14s (Over-12s) age-band (see Figure 1). All the players that enter their first year of participation in this age-band (i.e. constituent year 1) are an annual age group defined by a selection date (e.g. 31 December), and therefore within a 12-month age range (i.e. a selection year). The next playing season, the aforementioned group progresses together upwardly into constituent year 2 (but still in the Under-14s age-band). Naturally, when our hypothetical annual age group enters their second constituent year, a new annual age group becomes eligible to occupy the first constituent year (Figure 1 also illustrates the different dynamics of the two frameworks).

The previous example demonstrates that the demarcation between youth and Masters sport may not be enough to warrant using the same term to describe different frameworks. It also shows that it is possible for the two frameworks to be observed simultaneously in the same context. Researchers could examine outcomes between athletes of different "relative age" as defined by the traditional relative age framework, and of different "relative age" as Medic and colleagues (2007) have described (i.e. athletes from different constituent years). While potentially educating, all aspects of such a study (methods, results, discussion) would be difficult to describe, and comprehend. It has been previously mentioned that an essential step towards eliminating relative age effects should be to raise awareness of relative age discrepancies (Musch & Grondin, 2001). Having two applications for the term "relative age" could make this aim particularly challenging.

In and of itself, the term "relative age" may be too vague and ambiguous to satisfy the demands of scientific rigour. However, it will be increasingly problematic to use the same terminology to describe and compare outcomes of two entirely separate frameworks of research. In light of the aforementioned issues, the use of alternative terminologies may be prudent in future research. One solution would be to maintain the designation "relative age" for work using the traditional framework (i.e. a social construct related to a selection date) and an alternative term for the new area of research suggested by Medic et al. (2007). For instance, the use of the term "constituent year effect" would be an appropriate and less confusing description of the underlying premise related to this work. Although this point may be contentious, alternative terminologies may reduce confusion and misinterpretation of the findings elicited by the two frameworks.

**Directions for future research**

Although a substantial amount of research has been carried out on relative age effects in sport, numerous avenues exist for future research. Most relative age research in sport has sought to simply identify the existence (or non-existence) of relative age effects in terms of who are selected for participation at a particular level of skill. However, many more possibilities exist and should be considered.

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**Figure 1.** Comparison of constituent-year effect dynamics and relative age effect dynamics in youth sports with a multi-year age band structure.
To be clear, not all relatively young members of an annual age group experience failure as a result of the relative age inequality. In fact, some relatively younger athletes are selected for competitive youth sports teams and subsequently partake in elite competition during adulthood. A recent study by Sherar and colleagues (Sherar, Baxter-Jones, Faulkner, & Russell, 2007) found that although relative age effects existed in competitive youth ice hockey, relatively younger children who were selected did not differ in physical size and stature from their relatively older peers. These findings provide evidence that physical characteristics such as an above-average stature may increase the likelihood of being selected to competitive level teams and, perhaps more importantly, the data imply a selection bias by coaches, where players are selected on the basis of physical maturity and not necessarily components of skill. While these data are useful in suggesting something about the factors underpinning the creation of relative age effects, the measures examined have largely been gross proxies of maturity such as total stature and weight. More specific measures of physical (e.g. skeletal) maturity have the potential to add considerable depth to our understanding in this area.

Moreover, cognitive growth and maturity have received little or no attention. Martin et al. (2004) postulated that the development of certain parts of the brain is strongly correlated with chronological age, particularly in boys, who often do not reach full frontal cortex maturity until late adolescence. Frontal cortex abilities such as controlling attention and impulses, forming concepts, manipulating ideas, engaging in behaviour when a goal is remote, and control of gross motor activity are all important factors for relative age-mediated academic performance (Martin et al., 2004). Although these functions have been described in relation to performance in academic settings, and with regard to the appropriateness of specializing in one sport at an early age (Patel, Pratt, & Greydanus, 2002), such functions could be important prerequisites for complex tactical team sports, such as soccer and ice hockey. In the future, therefore, relative age researchers in sport may benefit from considering such factors when assessing differences between relatively older and younger athletes, particularly in the early levels of sport participation. Perhaps such chronologically related neurological and cognitive capabilities may be related to coaches’ perceptions of “coachable” or “smart” players, as a result of an athlete’s ability to conceptualize and learn offensive/defensive strategies alongside technical skills. Such research may be particularly helpful to coaches interested in developing informed training programmes based on consideration of different players’ developmental abilities and needs.

Although the majority of research has shown that relatively older players have consistent advantages over their relatively younger peers, recent research suggests that relatively younger members of a cohort may not be as disadvantaged as previously believed. Recent work examining injury trends in youth ice hockey found that relatively older players were more likely to sustain injuries requiring hospital treatment (Wattie, Cobley et al., 2007). Other preliminary data suggest relatively younger professional athletes are more sought after (Baker & Logan, 2007) and obtain higher salaries (Ashworth & Heyndels, 2007). Vaeyens and colleagues (Vaeyens, Philippaerts, & Malina, 2005) observed that once selected to teams, relatively older players had no advantage over their relatively younger team-mates in terms of playing or roster selections. In future, researchers may benefit from considering other ways in which sport-specific contexts influence relative age-associated outcomes. It can no longer be assumed that relative age acts to exclusively and uniformly advantage relatively older athletes. For example, it is possible that relatively older athletes also experience deleterious psychological outcomes associated with their relative age. While relatively younger athletes may be more likely to experience negative comparisons and low self-efficacy, relatively older athletes may experience disproportionate pressure to perform well or unreasonable high expectations from coaches and parents.

Researchers have also repeatedly promoted the need to examine relative age effects in female sports contexts (Musch & Grondin, 2001; Wattie, Baker et al., 2007). The limited relative age research in female sports suggests that gender plays an important role in determining an athlete’s experience, progress, and development in sport (Vincent & Glamser, 2006; Wattie, Baker et al., 2007). Further research on the interactions between gender and relative age may prove beneficial.

While numerous avenues for future research exist, it could be argued that one of the most important directions would be for researchers and practitioners alike to work towards eliminating relative age effects. To date, no research in sport has worked towards this goal. Despite changes and/or modifications to other aspect of sport (e.g. equipment, rules of play, and coaching), relative age effects have persisted in culturally popular sports for several decades. This stresses the need for creative research aimed at removing this participation and attainment inequality, and the challenge that researchers face in doing so. Research-driven interventions and collaborations with those interested in youth talent identification programmes need to be conducted. If relative age effects are to be eliminated, then the efficacy of interventions and coach-education curriculum will...
need to be tested and determined. With these points in mind, efforts of both theory-driven researchers and applied sport psychologists will be of great value.

**Conclusion**

To progress relative age research, scientists need to be cognisant and clear in their operational definitions and theoretical underpinnings. In this paper, we have attempted to establish some clarity, but invite a more thorough discussion of these issues. Another requirement is a proactive plan for future research in this area. At the very least, relative age research must move beyond studies that simply identify the effect in another context. More meaningful information may come from examinations where relative age effects are expected but not found. In addition, continued examination of the mechanisms driving these effects and their possible solutions is needed.

**References**


