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The Relative Age Effect In Junior College Baseball

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The Relative Age Effect in Junior College Baseball

(TITLE)

BY

Thomas C. Beals

THESIS

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Abstract

Previous research has suggested that older athletes within age groupings are often perceived to be more talented simply due to advanced maturity. This perception leads to biased selection to higher levels of competition and skewed participation rates favoring the oldest participants among groups. This resulting skewed distribution is termed Relative Age Effect (RAE). While RAE has been studied in various sports and multiple settings, college athletics has not been extensively studied. In addition, athletic organizations associated with academic institutions often group their participants according to their academic status, not strictly by age. This factor, termed Academic Timing, can result in the ages of competitors spanning more than a single calendar year. Therefore, the purpose of this study was twofold: 1) investigate whether RAE influenced the selection of junior college baseball participants; and 2) study whether Academic Timing influences the formation of RAE. Participants were 150 baseball players from a junior college located in the Midwestern United States. Results showed that, without consideration for Academic Timing, RAE was not found to cause significant differences [χ^2 (3, n = 150) = 3.97, p = 0.26] in the birth rate distributions of the baseball players. However, when the effect of Academic Timing was considered, a significant difference [χ^2 (1, n = 150) = 6.83, p = 0.009] was found when comparing the birth rates of participants born before and after the mid-point of the participation year. In addition, the birth rate distribution value [χ^2 (3, n = 114) = 5.23, p = 0.156], though not significantly different than expected, was greater when only those participants born during the expected participation year were included. The results of this study indicate RAE could bear more influence among American student-athletes than was previously reported.

These findings suggest RAE does influence the selection of collegiate athletes and should be further investigated. Also, future investigations of RAE among athletic leagues associated with academic institutions should include considerations for Academic Timing.

Key words: Relative Age Effect, Academic Timing, Baseball, College Athletics

Dedication

To Nicole, my wife. You supported and encouraged me throughout graduate school, and especially during the completion of this thesis. My obligations often left you as a single parent, and I could not have completed this without your commitment.

To my children, Logan and Avery. While I would rather have spent with you the time it took to complete this project, I hope you see this as an example of the value of working now to do what is necessary in order to enjoy the rewards later.

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Table of Contents

Introduction....1

The History of Relative Age Effect....4

Psychological and social research....4

Academic performance research....5

Transition into athletics....9

Mechanisms Contributing to Relative Age Effect....11

Physical characteristics....11

Psychological and experience factors....14

Alternatives to Relative Age Effect....16

Dropout....16

Sports education....18

Techniques for Investigation of Relative Age Effect....22

The participation year....22

Procedures and statistical analysis....25

Prevailing Trends....29

Gender issues....30

Increased effect with greater skill level and time....32

Decreased incidence in American sports....34

Relative Age Effect in baseball....37

Methods....43

Subjects....43

Procedures....43

Data reduction 43
Data separation 44
Data analyses 46
Traditional evaluation 46
Evaluation of the influence of Academic Timing 47
Results 50
Traditional Evaluation 50
Evaluation of the Influence of Academic Timing 50
All participants 50
On-Time Participants 52
Discussion 53
Conclusion 61
Limitations 62
Future Research 63
Appendix 65
References 68

List of tables

Table 1. Sample Quartile Data Presentation with Assumed Even Distribution 27

Table 2. Sample Monthly Data Presentation with Q1 and Q4 Grouped for Comparison 28

Table 3. Distribution of Births Compared to an Assumed Even Distribution 50

Table 4. Distribution of Births with Consideration to Academic Timing 51

List of figures

Figure 1. Percentage of On-Time Participant Births per Quartile of the Participation Year 52

Introduction

In America, athletics represent not only an opportunity for youth participants to pursue healthy levels of physical activity, but also to attempt to achieve financial gains through acquiring professional contracts or college scholarships. In turn, high level athletic organizations focus significant resources into talent identification efforts (Thompson, Barnsley, & Dyck, 1999). In most cases, these organizations see talent development similar to the description of a bucket offered by Lewontin (2000) where genetics dictate the capacity of the bucket and environment; encompassing factors such as available competition, quality of coaching, and motivation, among others, stipulates the contents of the bucket (Baker, Horton, Robertson-Wilson, & Wall, 2003). Despite the efforts and perspective of athletic organizations, research has suggested that advanced maturity in an athlete is often mistaken for advanced skill (Thompson, Barnsley, & Battle, 2004). These errors in assessment may lead to a greater likelihood of older peers within an age group being selected to higher levels of competition. When compounded by multiple other factors, these errors can lead to skewed participation rates where older peers are much more likely to participate than the younger. This skewed participation rate is termed relative age effect (RAE).

Adapted from findings in the academic domain (Barnsley, Thompson, & Barnsley, 1985; Cobley, McKenna, Baker, & Wattie, 2009), RAE as investigated in athletics (Barnsley, et al., 1985; Grondin, Deshaies, and Nault, as cited in Musch & Grondin, 2001) refers to the difference in participation rates found in individuals grouped together as a single age group. For example, if all children born in a given year are grouped together for the purpose of athletic competition, the children born in the early months of the competition year will be several months older than those born in the later months. Research (Barnsley & Thompson, 1988; Barnsley et al., 1985; Baker, Horton et al., 2003; Sherar, Baxter-Jones, Faulkner, & Russell, 2007) has suggested that the older children bear significant advantages over the younger in many forms of athletic competition. These advantages can lead to disproportionate representation, particularly in males, of the older peers in all tiers of competition such as youth leagues (Helsen, Starkes, & Van Winckel, 2000; Thompson, Barnsley, & Stebelsky, 1992) up to collegiate (Glamser & Marciani, 1992), international (Delorme, Boiche, & Raspaud, 2009; Helsen, Van Winckel, & Williams, 2005) and professional levels (Barnsley et al., 1985; Dudink, 1994; Grondin & Koren, 2000). In addition, RAE has been found not only to bear influence over multiple levels of competition, but to potentially increase as the level of competition increases (Cobley, Baker, Wattie, & McKenna, 2009; Delorme et al., 2009; Musch & Grondin, 2001; Vincent & Glamser, 2006). Despite this evidence of the significant influence of RAE, research (Daniel & Janssen, 1987; Grondin & Koren, 2000) also suggests that adequate measures to stifle RAE are not being pursued as the effect may be increasing with time.

While RAE has been extensively studied and strongly suggested to exist in multiple sports and at various levels of competition, research investigating RAE within the collegiate setting of American athletics is lacking. Previous review articles (Cobley, McKenna et al., 2009; Musch & Grondin, 2001) have identified only one study that evaluated university athletes. In addition, no study involving junior college (JC) level athletes has been completed. This omission is notable for two reasons. First, RAE has been shown to have varying degrees of influence based on the level of competition

(Cobley, Baker et al., 2009; Musch & Grondin, 2001; Vincent & Glamser, 2006). Junior college athletics presents a unique tier of competition; superior to youth organizations, but, in most cases, inferior to that of four-year institutions. Second, research (Côté, Macdonald, Baker, & Abernethy, 2006; Grondin & Koren, 2000; Stanaway & Hines, 1995) has suggested American athletes are less susceptible to RAE. A population of JC athletes presents a unique opportunity to study an athletic organization which evaluates and recruits talent primarily from a system based on academic status rather than strict calendar year age groupings. This may provide insight into how age groupings based on academic years influence the formation of RAE within athletic populations.

Therefore, the purpose of this study is to investigate whether RAE influences the selection of baseball players at the JC level. This evaluation will be accomplished by utilizing birthdates, obtained from athletic pre-participation physicals and team rosters, and comparing the distribution of birth months to expected birth rates. A second method of investigation, which will additionally consider the subjects' year of birth, will then be used in order to further study the extent to which RAE influences JC baseball participant selection.

Factoring in the findings of previous research in terms of level of competition, baseball studies, and American athletic leagues, it is hypothesized that a significant RAE will not be found among JC baseball players when examined by traditional means, which considers only the athlete's month of birth. However, a secondary hypothesis is that when the subjects are evaluated based on their academic age, which requires the athlete's year of birth to be additionally considered, significant differences in birth rate distributions will be evident.

The following is a review of literature relevant to RAE divided into four main sections: (1) The history of Relative Age Effect, (2) Mechanisms contributing to relative age effect, (3) Techniques for evaluation, and (4) Prevailing trends.

The History of Relative Age Effect

Current theories on the mechanisms that cause RAE vary and are not strictly limited to physical maturity. In this section a brief review is provided in order to explain how these theories evolved. First, a background of the psychological and social research, which fed into areas of academic research, will be provided. Information regarding the transition of RAE from the academic realm into athletic studies will follow.

Psychological and social research. Initially, research focused simply on the timing of the births and the seasonal variations in the number of births in different countries and climates. Gini (as cited in Cowgill, 1966) is credited as the first researcher to compare birth rates from various countries in an effort to identify the effects of changing seasons on human populations. Labeling the subject matter Season of Birth, Huntington (1938) published research that suggested the period of the year in which a person was born dramatically influenced their life, including the person's likelihood to be afflicted by insanity or tuberculosis. This research has evolved into many different areas that have investigated the influence a person's date of birth may have on the course of their life. Included in these findings was a possible connection between birth months and schizophrenia, with increased incidence found in individuals born in February and March (Mortensen et al., 1999). This link was found to be consistent in those both with and without family history and to be among the most important risks associated with the condition. While the connection between the timing of births and increased risk of schizophrenia is largely accepted, the cause of the abnormal distribution remains a matter of debate and the focus of continuing research.

Another troubling illustration of the powerful effect of the timing of one's birth is the connection associated with suicide. By adjusting birth dates to compensate for the varied arbitrary starting dates of different school systems, it has been suggested that students who attempted suicide were more likely to be born in the second half of the school year, making them younger than the majority of their academic peers (Thompson et al., 1999). Association of date of birth with suicide suggested that a person's relative age may have a dramatic effect on their psyche. This particular study led to further investigation that attempted to evaluate whether younger students were more likely to suffer from decreased self-esteem (Thompson et al., 2004). The study revealed a linear increase in self-esteem levels as the student's age at entry into the educational system increased. This finding suggested younger students within individual academic classes are more likely to have decreased feelings of self-worth. It was hypothesized that these feelings could bear direct influence on not only the tendency toward irrational activity, such as suicide attempts, but also a student's self-perception of academic ability. Self-perception also appears to be a significant contributor to RAE in athletics and will be discussed in terms of athletics in a later section.

Academic performance research. Prior to findings connecting relative age to self-esteem, a student's date of birth had been found to influence academic performance. Research (Bell & Daniels, 1990; Cobley, McKenna et al., 2009; Thompson, 1971) has indicated that older students were more likely to perform at higher levels in academics and were more often accepted into advanced curriculum. The effect is strong enough in the academic setting that outstanding academic achievers were found to be four to five times more likely to be born in the first half of the academic year (Cobley, McKenna et al., 2009).

Though theories are abundant as to how this uneven distribution evolves, the concept of Streaming has been suggested as a plausible explaination (Allen & Barnsley, 1993; Bedard & Dhuey, 2006) and is most congruent with current theories of athletic RAE. Streaming involves categorizing students according to ability and tailoring their educational experience accordingly. As an example, consider a situation where the best readers in a second grade classroom are grouped together and introduced to higher levels of reading materials than those in the class who are not as advanced. These students will be more likely to advance their reading skills even further, setting them up for more success in following years. Additionally, they are more likely to benefit from an effect of Teacher Expectation suggested by Rosenthal and Jacobson (1968). This concept suggests that if teachers are aware of a pupil's previous success, the educator will expect further success, making it more likely the student will achieve better.

Related findings have suggested that younger classmates had a higher likelihood of learning difficulty and disproportionate referrals for special needs classes (Bookbinder 1967 in Cobley, McKenna et al., 2009). Subsequent findings suggested decreased achievement among the age-disadvantaged members of academic classes (Maddux, 1980). In contrast to findings in the athletic domain, studies of RAE in academics suggest the effect decreases as students get older (Allen & Barnsley, 1993; Bedard & Dhuey, 2006; Bell & Daniels, 1990; Maddux, 1980). Multiple studies have shown decreased evidence of RAE among students in eight and ninth grade compared to those in first or even fourth grade (Bedard & Dhuey, 2006; Bell & Daniels, 1990; Maddux, 1980). In attempting to explain why the trend declines, it is suggested that, when compared to athletes and the likelihood of discontinuing sporting participation, students are much less likely to drop out of school (Helsen et al., 2005). This continued participation presents the younger and lesser-achieving students the opportunity to continue to learn and a greater likelihood of catching up to their academic peers.

An exception to common trends within education research was found in the subject of physical education (Cobley, McKenna et al., 2009). Students ranging in age from eleven to sixteen showed no significant RAE among those identified as talented in the subjects of English, math, or science. In contrast, physical education students showed an overrepresentation of those born in the oldest age grouping, lending support to a strong physical component associated with RAE.

As indicated by Huntington's original label of Season of Birth, early research into RAE was based on hypotheses that considered only the time of year and the changing seasons. This led investigators to group their subjects into four month categories, instead of three month groupings common to athletics, and label the groupings according to the season (summer, autumn, or spring) in which the person was born (Bell & Daniels, 1990; Maddux, 1980). These hypotheses prevailed in educational research and evolved into alternative suggestions to RAE. One theory suggested that women carrying children during the winter months were more likely to contract infection and illness, which could be damaging to the developing child's mental capacity. This hypothesis has not been supported by subsequent research as studies have shown a connection with prenatal illness only to potential neurological deficits (Bell & Daniels, 1990; Cobley, McKenna et al., 2009).

Another hypothesis was that performance distortions arose because children born of a certain time of year potentially received differing nurturing experiences due to the seasons of the year. According to Allen and Barnsley (1993), a commonly held explanation was that children have critical phases during maturation that are enhanced by contact with adults. Children who reached these phases during winter months spent those phases indoors in closer proximity to adults. Those reaching the same level of maturity in the summer would be more likely to spend the phase outdoors. This theory was tested against RAE in a study in which they compared students exhibiting high achievement in school districts in both Canada as well as Great Britain. The two districts were chosen because, though they were in separate countries, they were located on the same latitude. This was thought to help ensure that the climates each group of students were raised in were similar. The weather would therefore not influence their development. In the Canadian schools, children were permitted to start school during the calendar year in which they turned six, making those students born early in the calendar-year the oldest in each grade. In England, students born in September are the first to become eligible to begin school. The results of the study showed the older students in both countries to be more likely to be superior academic performers, decreasing the probability that birth season alone, as was the case in the studies related to schizophrenia, influenced academic performance. This connection of birth date to achievement influenced the transition of RAE into the athletic domain.

Transition into athletics. As mentioned previously, physical education was found to be one subject where RAE was found among students even after the effect had waned across other subjects (Cobley, McKenna et al., 2009). Even though this connection has been made obvious by years of research between physical maturity and RAE, the logical transition into athletic domains was slow to emerge.

As the research evolved, so too has the terminology. Various studies have used terms such as season of birth (Cowgill, 1966; Mortensen, et al., 1999; Thompson , 1971), the birthday effect (Thompson et al., 1999), birth date effect (Allen & Barnsley, 1993; Edwards, 1994; Glamser & Marciani, 1992) and age position effect (Cobley, McKenna et al., 2009). While variations still exist, the most prominent terminology in current research in both the academic and athletic domains is RAE. The main difference between RAE in academics compared to athletics is that academic research has been focused on finding performance differences whereas athletic research assesses differences in volume of participation. In general, the full population of children attend school. Therefore, studies in the academic domain are able to assess performance measures associated with RAE. Athletic participation, however, is optional and is often selective. Because of this selection, increased volume of participation itself can be seen as an indication of increased athletic performance.

Two studies were published at nearly the same time and are credited with adapting the concept of RAE to athletics. Grondin, Deshaies, and Nault (as cited in Cobley, Baker et al., 2009) investigated ice hockey players from youth levels through college as well as volleyball participants from ages twelve through nineteen. The results showed RAE occurring as early as ages ten and eleven among hockey players. In addition, greater than seventy percent of the players were born in the first half of the year in the higher levels of competition. The volleyball results were less conclusive and even demonstrated inverse proportions in some age and skill groupings.

Barnsley et al. (1985) also were among the first to adapt the concept from education and are often credited with defining the concept as it relates to athletics. Their study investigated the distribution of births of professional hockey players participating in the National Hockey League (NHL) as well as two other high level competitive leagues in Canada for sixteen to twenty year olds. The rates of birth were compared to the birth rates for males in Canada, which was relatively constant on a monthly basis and was equivalent for the first and second halves of the year. In all three leagues, it was found that participants were much more likely to have been born in the first half of the year and the percentage of births exhibited a linear decline from the beginning to the end of the year. Players in the NHL were nearly twice as likely to have been born in the first three months of the year than the final three months, while players in the elite Canadian leagues were four times more likely to have a first quarter birthday. In addition to presenting striking statistics, Barnsley et al. was the first study to correlate the selection of talented individuals to upper level athletic tiers of competition to the process of Streaming in education. This selection process is currently believed to heavily influence the occurrence of RAE in athletics.

Preliminary research into the connection between a person's birth season helped to form the basis for research in both the academic and athletic realms. This research has supported the suggestion that RAE exists in both domains. This discovery, in turn, has promped researchers to study the causative factors that potentially lead to the effect. The next section provides information on the finding related to these causative factors.

Mechanisms Contributing To Relative Age Effect

When considering children, for example one child who recently turned seven compared to a child who will soon turn eight, the maturity differences can be significant. As the children age, the difference in their relative age compared to their total age will diminish to the point where, in adulthood, their maturity will be relatively equal (Helsen, Starkes, & Van Winckel, 1998). If increased physical characteristics associated with increased age were the only factor contributing to RAE, then the statistical differences in birth distributions would gradually decrease in congruence the decreased difference in relative age (Musch & Grondin, 2001). However, birth rate distribution differences associated with RAE remain beyond the age of physical maturity (Allen & Barnsley, 1993). Physical characteristics have been shown to influence the causation of RAE (Sherar, Baxter-Jones et al., 2007), but other factors appear at work in complicated interactions comprising the effect as a whole. The separate elements comprising RAE are discussed in this section.

Physical characteristics. Measures of height and weight variability associated with maturity, which occur earlier in females, peak by age fifteen in males (Musch & Grondin, 2001). While they disappear with age, these advantages in physical maturity are thought to be the first causative factor and contribute significantly to RAE. Though physical size differences are not the only component of RAE, increases in size do appear to provide an advantage in some athletic contests, thus offering a point of entrance into the discussion. Surprisingly, though the idea of increased physical maturity is accepted as being central to the causation of RAE and easily studied, few attempts have been made to isolate this characteristic as an advantage. This is, perhaps, due to the invasive and sensitive nature of directly assessing maturity. Though recent effort has been made to develop a more practical manner of assessing maturity (Mirwald, Baxter-Jones, Bailey, & Beunen, 2002), findings in the area are limited. In a review article, Musch and Grondin (2001) were only able to identify four studies that investigated the influence of skeletal maturity, height or weight data of elite competitors in relation to RAE. One additional study (Sherar, Baxter-Jones et al., 2007) was discovered in research conducted for this paper. In all examples, the supposition of physical maturity advantages was supported. Despite the relative dearth of studies illustrating the connection between increased physical maturity and performance, the idea that increased physical maturity among the oldest within an age group is a commonly accepted premise.

Older children within each grouping are likely to benefit simply by being bigger, faster, stronger, and more coordinated (Barnsley et al., 1985; Barnsley, Thompson, & Legault, 1992; Cobley, Baker et al., 2009). To illustrate the significance of the potential size difference, a child who recently turned ten and ranks in the fifth percentile of growth charts would be eleven inches shorter and nearly sixty pounds lighter than a child nearing his eleventh birthday who ranks in the ninety-fifth percentile (Helsen et al., 2005). These differences in physical characteristics can then lead to significant advantages in competition for placement and playing time on a team. In hockey, for example, skating ability is a major discriminating factor in selection and an older child is more likely to possess the motor skills necessary be a more accomplished skater (Daniel & Janssen, 1987). Body checking, again a key component of hockey, is aided by increased body size (Barnsley et al., 1985). Finally, the equipment necessary to participate in a sport, such as the protective pads worn by goalies, can encourage the selection of larger children (Grondin & Trudeau 1991 in Delorme et al., 2009). Given the stated lack of evidence available in the form of direct study to support the influence of physical characteristics contributing to RAE, perhaps the best method to offer validation is to present situations where physical stature advances are negated and RAE is consequently found to be less influential.

Research supports decreased incidence of RAE in athletic competitions, such as gymnastics and dance, where physical maturity may be considered detrimental to performance (Delorme et al., 2009; Vaeyens, Lenoir, Williams, & Phillippaerts, 2008). It is also suggested that sport participation choices may be greatly influenced by a child's rate of physical maturity, with most early maturing children opting for athletic competitions that place greater importance on height, weight, speed and strength while those maturing later are more apt to pursue sports that favor smaller body structure, flexibility, and increased strength compared to body weight rather than overall strength (Baxter-Jones, Helms, Maffulli, Baines-Preece, & Preece, 1995; Vaeyens et al., 2008).

Another mechanism that can negate physical advantages is decreased competition for positions on an athletic team. This can occur via two distinct causes. The first being a decrease in the available number of competitors for a team, inferring that the popularity of a given sport may influence the level of RAE found in the sport. If there is little or no competition for spots on a team, then no RAE can be expected for selection to the team (Musch & Grondin, 2001; Okazaki, Fontana, & Gallagher, in press). The second is by a sport being comprised of multiple positions with well-defined and differing characteristics, such as basketball (Delorme et al., 2009). The different qualities preferred at the different positions could afford those without physical advantages the opportunity to compete. This idea is supported by the lack of findings of RAE in studies involving basketball (Côté et al., 2006; Daniel & Janssen, 1987).

While it seems almost intuitive that advances in physical maturity would contribute to RAE, multiple other factors are at work that may not seem as obvious. Once a child's increased physical maturity has influenced selection into a sport or onto a team, multiple other factors begin to play a role in promoting RAE as well and will be discussed in the section that follows.

Psychological and experience factors. A common popular adage suggests that success breeds success. This saying can be applied to the understanding of RAE (Barnsley et al., 1985). Athletic organizations have been found to divide children into categories based on ability as early as age six (Boucher & Mutimer, 1994; Helsen, Starkes & Van Winckel, 1998). Certainly an accurate assessment of skill is, at best, difficult at this stage of development and advanced physical maturity plays a large part in "talent" discrimination. While this may seem like an innocuous error in talent assessment, it can have permanent psychological effects as well as leading to wide discrepancies in accumulation of experience.

As mentioned earlier, Streaming and Teacher Expectancy functioned to influence student performance. These concepts are also relevant to athletics. Consider, as an example, a seven year old returning for a second season of athletic participation after being selected to the "elite" team the previous year. Further, assume this selection was largely because the child was one of the older and larger six year olds during the prior season. By being selected to the higher level team, the child was likely to be exposed to higher competition, better coaching, and other advantages not experienced by six year olds who were not chosen to the elite team (Barnsley et al., 1985; Bedard & Dhuey, 2006). Because of the advantages, which were afforded during the prior year, the child is more likely to achieve better during the current year, receive more recognition as a skilled player, and develop a self-perception of being skilled at the sport (Barnsley & Thompson, 1988; Barnsley et al, 1985). In addition, the player is more likely to be perceived as a higher caliber player by coaches aware that the player was previously chosen for an elite team (Boucher & Mutimer, 1994). This makes it more likely that the child will experience more success and increases the probability that the child will continue participation within the sport (Barnsley et al, 1992).

Previous research (Baker, Côté, & Abernethy, 2003; Baker, Horton et al., 2003; French & McPherson, 1999; Gladwell, 2008) has suggested that difference in skill among older competitors is a result of accumulated practice, a concept that will be further expanded upon in the next section. This idea is relevant to RAE study because, as suggested above, often it is the older and more physically mature children who are presented with the opportunity to accumulate practice hours and have greater quality in experience. Included in this experience are such aspects as better coaching, better facilities, more games, and the opportunity to compete against better skilled players (Barnsley et al., 1992). Beyond contributing to physical improvement within the sport, this higher quality experience also increases understanding and competence within the sport as well as facilitating faster decision making (Cobley, Baker et al., 2009; French & McPherson, 1999).

The previously mentioned factors contribute to RAE and promote abnormal distributions of birthrates among athletic competitors. However, RAE is not the only effect capable of influencing the rate of selection to elite levels of performance. The next section will address these other factors.

Alternatives to Relative Age Effect. Researchers have explored multiple explanations for selection to higher levels of competition. These alternative areas of research help to further the understanding of RAE and, with one noted exception, can be seen as components of RAE, causing an increase in the overall influence.

Dropout. In the discussion of academic research, it was noted that increased performance among older students and decreased performance among their younger classmates was evaluated as two separate, though synergistic, occurrences. Similarly, after research revealed increased prevalence of older participants continuing in a sport, studies of athletic participation have also, labeling the phenomenon dropout, studied those who chose not to continue participation. Dropout in athletic participation is identified by the decrease in numbers of participants from year to year (Barnsley & Thompson, 1988). The significance of dropout is that it leads to overall decreased participation. Research (Barnsley & Thompson, 1988; Delorme, Boiche, & Raspaud, in press; Thompson, Barnsley, & Stebelsky, 1991) has shown that younger participants tend to be under-represented within older age groupings of a sport. These findings indicated that it is the younger athletes who tend to leave the sport. This decrease in participation has been observed as early as age twelve (Barnsley & Thompson, 1988; Delorme et al., in press; Helsen, Starkes, & Van Winckel, 1998) and creates a potential argument as to whether selection of older peers or dropout of younger peers contributes more to RAE overall.

While the instances of dropout from athletic participation are complimentary to the creation of RAE, the circumstances leading to dropout can be seen as a separate and unique mechanism affecting participation. As previously established, older peers are likely to be more physically mature. Conversely, the youngest among a group would be expected to be smaller and less skilled. This could lead to decreases in playing time in games (Delorme et al., in press; Vaeyens et al., 2008) and increased frustration over failures associated with being less physically mature, partially leading to dropout (Barnsley & Thompson, 1988; Barnsley et al., 1985). The mechanism at work here is similar to that which led to findings of decreased self-esteem among students (Thompson et al., 2004).

Increased rate of dropout among the younger participants within an age group serves to promote skewed distributions of birth dates in favor of the older participants. In addition, it is important to consider that increased incidence of dropout decreases the total number of available athletes competing within a sport. It has been hypothesized that dropout among younger players can eventually decrease the quality of top tier teams. When athletes eliminate themselves from competition, particularly before the years of full physical maturity and before they have the opportunity to fully develop their skills, the pool of talent available for teams to choose from is decreased (Barnsley et al., 1992; Daniel & Janssen, 1987).

While the factors leading to dropout and the effects that result can be studied as a separate and independent phenomenon, dropout can certainly be considered as a contributing factor to the broader RAE. Another such contributing factor, sports education, deals instead with the athletes remaining in competition and is the next topic to discuss.

Sports education. The term sports education is presented by Ashworth and Heyndels (2007) in their study of soccer athletes to refer to developing soccer skill. Their definition, the factors that help to transform potential into ability through training and competition, can be applied to most sports. In the case of this review, the context is being expanded to include ideas presented in studies involving multiple other sports. The concepts presented include aspects related to the practice of a sport, quality of coaching, Peer Effect, and location of birth. All of these aspects have been shown to contribute to the development of athletic talent.

Two similar, yet distinct, theories related to practice of skills are embedded in research. The Ten Year Rule, introduced following a study of top level chess players (Simon & Chase, 1973), deals with quantity of practice. The theory suggests that competitors, regardless of skill, are required to invest approximately ten years of practice and participation in an activity in order to have the opportunity to become top level performers. An alternate mutation of the same concept, referred to this as the Ten Thousand Hour Rule, illustrated its influence in athletics as well as industry (Gladwell, 2008). Helsen, Starkes, and Hodges (1998), demonstrating results congruent with both the Ten Year Rule and the Ten Thousand Hour Rule, adapted this concept to athletics by showing the differences in accumulated hours of practice between soccer players of various levels of achievement. Their results showed that, over the course of their careers, international competitors accumulated an average of 9332 hours, national competitors 7449 hours, and provincial players only 5079 hours. It was also reported that significant differences in accumulated amounts of practice were evident when the athletes were ten years into their respective careers.

The second theory to address the practice of skills, Ericsson's Theory of Deliberate Practice (Ericsson & Charness, 1994; Ericsson, Krampe, & Tesch-Romer, 1993; Starkes & Ericsson, 2003), suggests quantity of practice alone will not garner results. Practice has to have quality in the form of direction, effort and attention. This form of practice may not be enjoyable or reap immediate benefits. Helsen, Starkes, and Hodges (1998) addressed this aspect of practice as well and found similarities in practice volume in the athletic domain to those reported initially by Ericsson, but did not replicate findings of decreased enjoyment associated with practice of athletic skill. This discrepancy was explained by the inherently social aspect of athletics, potentially adding to enjoyment of practice, compared to the musicians studied by Ericsson who would not have had as much social interaction in their practice sessions.

Both the Ten Year Rule and Theory of Deliberate Practice, though recognized in research as possible separate causative mechanisms to skill acquisition, can be seen as contributing factors to RAE. As stated previously, RAE is largely influenced by the increased physical maturity of older athletes within age groups. This advanced physical maturity increases the likelihood of them being chosen for elite levels of competition at an early age, which increases the probability of repeat selection to elite teams as they advance in age. Elite teams are more likely to have higher volumes of practice and offer such advantages as increased levels of competition and superior instruction with technological advantages such as video study, and increased amounts of individualized instruction (Baker, Horton, et al., 2003). Compounded each year and accumulated over time, these advantages of increased exposure of the older athletes to greater quantity and quality of practice can help contribute to age-advantaged athletes being more likely to continue participation within a sport to the highest levels.

Correspondingly, quality of instruction received by an athlete is likely to influence the quality of an athlete's performance. The ability of a coach to effectively and efficiently organize practice can greatly shape the environment in which an athlete learns (Baker, Horton et al., 2003), leading to a higher quality sports education. Multiple studies (Allen & Barnsley, 1993; Barnsley & Thompson, 1988; Barnsley et al., 1992; Helsen, Starkes, & Van Winckel, 1998) have associated higher quality coaching with upper tier teams among age groups. Thus, the selection of a child early in their life based mainly on the advantage of increased physical maturity can expose the child to higher quality coaching, further propagating RAE.

It was previously discussed that competition is necessary for RAE to occur. It can also be argued that competition is a component of sports education. When an athlete is selected for an elite team, it is reasonable to expect the elite team to seek out competition against other elite teams. This exposes the athlete to higher caliber competitors (Barnsley & Thompson, 1988). In addition, the player is also exposed to the previously mentioned increased practice alongside higher quality players. Practicing with and competing against better players is likely to increase the quality of a player's sports education and is referred to by Ashworth and Heyndels (2007) as Peer Effect. It is noteworthy that Peer

Effect is hypothesized to be most beneficial long term to the youngest within a group. However, as their data and other studies have shown (Boucher & Mutimer, 1994; Helsen, Starkes, & Van Winckel, 1998; Sherar, Bruner, Munroe-Chandler, & Baxter-Jones, 2007), fewer of the youngest within the group are selected to upper levels or remain in competition long enough to experience the benefit. As is the case with many of the other previously mentioned theories, Peer Effect, as it functions much like Streaming in education, can be seen as a contributing process to RAE.

One theory that is presented as being completely independent of RAE is the Birthplace Effect (Côté et al., 2006). In the study of several professional sports organizations, it was found that athletes from very small communities as well as very large urban areas were proportionally under-represented. In contrast, athletes born in cities ranging in population from 1000 to 500,000 were statistically more likely to reach professional ranks. In the author's estimation, these results are completely independent of the influence of relative age. While there exist no studies to refute this finding, it is plausible that communities of the stated size afford unique advantages to a developing athlete. These advantages include the perfect mixture of ingredients, which are also likely to contribute to RAE. These communities offer a large enough population base to provide adequate competition and improved facilities, yet are small enough to foster relationships between athletes and quality coaches. Though there is no indication in current research, it is possible that future research could link common factors of RAE and Birthplace Effect.

To this point, the mechanisms that appear to promote the formation of RAE have been discussed. These mechanisms can be direct, such as physical maturity, experience and psychological influences. These mechanisms can also be alternative theories, which can help contribute indirectly to the overall effect. The next section will detail how RAE is detected and investigated.

Techniques for Investigation of Relative Age Effect

Key to the evaluation of any proposed effect is the establishment of parameters of measurement. The techniques used to investigate RAE enable researchers to control for the arbitrary starting dates of different athletic organizations and to assess the magnitude of effect present within a population. The following section will detail the techniques used in research to evaluate RAE.

The participation year. In order to investigate RAE within a group of subjects, they first have to be grouped according to their relative age. Perhaps the most essential consideration is correctly establishing who among the group should actually be considered the oldest. An example of how detrimental an error in this process can be to a study is found by considering results published by Daniel and Janssen (1987) regarding baseball participation. Their study considered September as the first month of the baseball participation year and it was concluded that no RAE existed in Major League Baseball. When the baseball data analysis was repeated using August, for reasons that will be discussed in detail in a later section, as the first month of the baseball participation year, the results showed a significant RAE did exist (Thompson et al., 1991).

Though it is common in baseball studies (Côté et al., 2006; Daniel & Janssen, 1987; Grondin & Koren, 2000; Thompson et al., 1992) and in a myriad of studies

(Delorme et al., in press; Dudink, 1994; Edwards, 1994) in other sports, alternative beginning dates for the participation year are not always required. Many athletic organizations do adhere to the calendar year to determine their participation year. Most studies evaluating hockey (Barnsley & Thompson, 1988; Boucher & Mutimer, 1994; Daniel & Janssen, 1987; Sherar, Bruner et al., 2007) have tested leagues with calendar year cut-off dates. Soccer leagues, largely due to an edict made effective in 1997 from the game's international governing body, Federation Internationale de Football Association (FIFA) (Helsen et al., 2005), present an interesting situation where older studies (Barnsley et al., 1992; Helsen, Starkes, & Van Winckel, 1998) utilize an alternative beginning date and more recent studies (Delorme et al., 2009; Helsen et al., 2005; Vincent & Glamser, 2006) adhere to the calendar year.

As was suggested in the previously mentioned study involving the Canadian and British schools (Allen & Barnsley, 1993), a change in the dates defining the participation year could instigate a change in the distribution of birth rates. In the context of athletics, Helsen et al., (2000) investigated a single soccer league over the course of two years; the years proceeding and following the FIFA rule change. This rule change altered the first month of the participation year from August to January. The year prior to the rule change, all four age groupings studied showed significantly higher births in the three months at the beginning of the participation year, August through October, than the final three months. The distribution of the birth rates, however, changed very quickly in response to the rule change. In just the first year of the rule change, January became the most common month of birth for the participants of all but the oldest age grouping.

Given these findings, which suggest that a change in the definition of the participation year can immediately influence participation, it is of particular interest to note that the entrance requirements for public schools throughout North America can vary by up to six months (Barnsley et al., 1992). This brings to light an interesting void in RAE research. With the lone exception of a study done by Glamser and Marciani (1992), most of the RAE studies involving athletics have evaluated participants who were part of organized leagues outside of an academic setting. In the case of their study, however, the effect of the potential differences in school district's start dates was not considered. Instead, another issue was exposed.

Relative Age refers to the difference in age among those considered to be a single age group. Glamser and Marciani (1992) was the first study to recognize the complication presented by athletic teams associated with academic institutions. Glamser and Marciani intended to investigate RAE in football and baseball at two colleges, but discovered some of the football athletes were two years behind their expected academic status based on their date of birth. Since age disparity of nearly one year can occur within a single year's grouping, this revealed potential age disparity of nearly three years within an individual academic class. The magnitude of the baseball data was not as severe, but over twenty-five percent of the players were found to be one year behind their expected academic status. It was reported that, when all football participants were evaluated, the births were evenly distributed. However, when only those who were considered academically on-time were considered, nearly two-thirds were born in the first half of the participation year. Additionally, they were nearly five times more likely to have been born in the first three months of the participation year than the final three months.

Glamser and Marciani (1992) noted that student-athletes could become older than their classmates in ways that varied from academic failure to parents intentionally delaying a child's entrance into school. While competing for athletic teams associated with academic institutions, student-athlete participation is not strictly regulated by the defined participation year of a sport, but rather by their academic status. High school athletes then compete against each other for selection to college teams. Glamser and Marciani termed this influence, which allows for age differences of greater than a single year, Academic Timing. Their study suggested that, while redefining the participation year was not necessary, Academic Timing may complicate the assessment of the true magnitude of RAE in populations associated with academic settings. Despite these findings, subsequent research has not attempted to investigate the interaction between RAE and Academic Timing.

Procedures and statistical analysis. Once the dates are determined for the beginning and end points of the participation year, the obtained data must be evaluated. To do so, a basis for comparison has to be established. The year has to be segmented into intervals for comparison, and a means of statistical analysis employed. Various procedures and statistical analysis have been utilized in the study of RAE and are discussed within this section.

Relative Age Effect studies seek to investigate the distribution of the rates of birth of a population sample compared to an expected distribution rate. In order to achieve this, a standard for comparison has to be defined. Multiple studies (Boucher & Mutimer, 1994; Delorme et al., 2009; Grondin & Koren, 2000; Helsen, Starkes, & Van Winckel, 1998) have obtained birth statistics to serve as a comparison. These statistics are typically specific to the geographic area from which the subjects are drawn and provide data from the years in which the subjects were born.

Conversely, some studies (Barnsley & Thompson, 1988; Barnsley et al., 1992; Côté et al., 2006; Thompson et al., 1991) simply choose to assume that birth rates are constant throughout the year. The rationale for such an assumption does vary. In some cases (Barnsley et al., 1992; Côté et al., 2006), the population studied is not homogenous enough to identify a single geographic area's statistics for comparison. Barnsley and Thompson (1988) justified their use of an assumed distribution of birth by citing the large fourteen year span of birth years of their subjects. This approach was further validated by showing that there was no statistically significant difference between actual rates of birth and an assumed even distribution for a sample year within the span.

Following the establishment of a basis for comparison, the data must be subdivided into intervals. Most commonly, studies (Baker, Horton et al., 2003; Barnsley & Thompson, 1988; Delorme & Raspaud, 2009; Vincent & Glamser, 2006) present their data in terms of three month groupings called quartiles. The first quarter of the participation year is labeled Q1 and each successive three month grouping is numbered according to succession (Q2, Q3, and Q4). An example is shown in Table 1. This manner of grouping then allows for the volume of birth dates per quarter to be compared against the expected rate of births by using the chi square goodness of fit technique (Barnsley & Thompson, 1988; Delorme & Raspaud, 2009; Grondin & Koren, 2000; Okazaki et al., in press). This analysis is used to evaluate the probability that the variations seen among a population occurred by chance. The chi square analysis is a very common tool in RAE research.

Table 1

Sample Quartile Data Presentation with Assumed Even Distribution

	Q1 Jan-Mar	Q2 Apr-June	Q3 July-Sep	Q4 Oct-Dec	Total
Group 1	30	26	24	20	100
Group 2	35	26	24	15	100

The smallest interval, employed by relatively few studies (Barnsley et al., 1985; Boucher & Mutimer, 1994; Daniel & Janssen, 1987; Helsen et al., 2000), is monthly. This results in twelve separate intervals for evaluation and typically is reserved for studies with larger populations. In cases where monthly intervals are used, one common form of statistical analysis is Spearman Rank order correlation (Barnsley et al., 1985; Boucher & Mutimer, 1994). This technique is useful in investigating the correlation between the normal sequence of months and which months have the highest volume of births. If births are randomly distributed, the resulting correlation would be weak. However, a strong correlation between those months containing the highest number of births and months that occur first in the participation year is indicative of RAE. Studies (Barnsley et al., 1985; Boucher & Mutimer, 1994) that used monthly increments typically included quartile valuations with chi square analysis to supplement the monthly evaluations.

In a series of studies (Helsen, Starkes, & Van Winckel, 1998; Helsen et al., 2000; Helsen et al., 2005), Helsen et al. utilized a unique method in assessing RAE not employed in other studies. The birth data was displayed in monthly increments. The differences between observed and expected birth rates were evaluated through the use of the Kolmogorov Smirnov one sample tests rather than Spearman Rank order correlation. These two procedures are similar and their differences are not expanded as they are not relevant to this discussion. The pertinent aspect of these studies' data displays was, as an added notation within the monthly table, the birth rates for the first three months of the participation year were grouped together and presented for comparison against the cumulative number of births in the last three months of the participation year. The total births for each of these three month intervals were presented as a percentage of the total births. An example of this method is shown in Table 2. Though this method does not afford a level of probability or significant statistical evaluation, it does offer a simple means of comparison.

Table 2

Sample Monthly Data Presentation with Q1 and Q4 Grouped for Comparison

	Month of Birth												
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
Group 1	18	16	14	11	13	15	18	7	8	10	8	12	150
		n = 48 (32%)									n = 30 (20%)		

The final increment, which has been used in a limited number of studies (Edwards, 1994; Sherar, Bruner et al., 2007), is half year. Studies employing half year divisions of the participation year typically present their data and allow for simple comparison between the two totals, though Edwards (1994) did employ chi square for the half year data. Typically, studies (Barnsley et al., 1985; Daniel & Janssen, 1987) have used half year increments only to supplement the presentation of data.

Finally, it is worth noting the problems of assigning increments and statistical analysis caused by Academic Timing. As mentioned previously, Glamser and Marciani (1992) found age disparities of greater than a single year in their study. To illustrate this, their data was presented in monthly increments with separate presentations for those who were on time academically and those who were not. However, because the span of time for each academic class was larger than a year, statistical analysis in a means consistent with previous RAE research was not employed.

This section focused on the means by which RAE is investigated. The identification of the correct parameters for the participation year as well as the procedures and statistical analysis methods employed are important in the detection of potential RAE. Presentation of the various means of investigation was intended to strengthen the understanding of the significance of RAE findings, which are presented in the next section.

Prevailing Trends

A recent study (Cobley, Baker et al., 2009) found thirty-eight separate RAE studies evaluating fourteen different sports from sixteen countries. Hockey and soccer players, each investigated in over thirty percent of the studies, were the most common subjects with baseball being studied thirteen percent of the time. While not all of the studies found RAE, the combined data from all of the reviewed studies showed that for every two participants born in Q4, there were three born in Q1. Other significant findings of previous RAE research, starting with gender issues, are contained within this section.

Gender issues. The results of one of the first RAE studies suggested RAE was more likely to influence male participants (Musch & Grondin, 2001). Research on the topic of RAE since then has been dominated by male subjects. The limited number of studies done on the female athletic population, with females representing roughly two percent of the total number of athletes studied (Cobley, Baker et al., 2009), has resulted in conflicting opinions as to whether RAE exists among female athletes. Further, there are several theories as to why RAE seems to exhibit less influence over female athletes.

It is important to note that studies (Baxter-Jones & Helms, 1994; Delorme et al., in press; Delorme & Raspaud, 2009; Okazaki et al., in press) have observed evidence of RAE within female athletic populations. In one case, research (Baxter-Jones & Helms, 1994) suggested no difference in the influence of RAE between males and females in multiple sports. Another study (Delorme et al., in press) was able to suggest RAE in various levels of competition in female soccer. The third study (Delorme & Raspaud, 2009) evaluated French basketball and suggested RAE to be greater in the female population than the male group. The findings of these three studies contradict the results of previous research that has suggested that females are less likely to be influenced by RAE.

A primary example of the differences of male and female RAE was presented in a study (Vincent & Glamser, 2006) that compared male and female soccer players. Both genders were competing at multiple equivalent levels of competition. Though the male subjects displayed a greater percentage of early born subjects at each level, the female data was negative for RAE for the entire population and only suggested RAE among a select grouping chosen for play at the regional level.

While research has provided somewhat conflicting evidence as to whether RAE exists in female athletics, it would be difficult to suggest that there exist no differences between the influence of RAE in male and female athletics. Theories as to the origin of these differences are plentiful and varied (Delorme & Raspaud, 2009; Helsen et al., 2005; Musch & Grondin, 2001; Vincent & Glamser, 2006), but two of these theories are more prevalent.

The first suggested explanation revolves around two differences in female athletics. Athletic events that permit less contact are less likely to be influenced by RAE (Delorme et al., 2009) and it is possible that female sports place a higher priority on technical skill rather than physical contact, decreasing the importance of physical maturity (Helsen et al., 2005). Also, as stated previously, competition for available positions is thought to be one of the main contributing factors to RAE. Female athletics tend to have lower participation rates and would therefore be less likely to develop RAE (Delorme et al., 2009).

The second theory is based not around differences in the competition, but rather differences in the competitors. Differences in physical maturity are largely negated by the onset of puberty (Musch & Grondin, 2001), which occurs earlier in females (Delorme & Raspaud, 2009; Vincent & Glamser, 2006). Since female athletes reach full maturity earlier than males, competitive differences associated with relative age are negated earlier (Helsen et al., 2005; Vincent & Glamser, 2006). It has also been suggested that athletic performance in females might actually be hindered by the onset of physical maturity (Vincent & Glamser, 2006).

While some debate remains concerning the differing mechanisms that influence RAE among male and female competitors, RAE has been connected to male athletics on a much more consistent basis. Other factors that have been associated with the increase of RAE will be discussed in the next section.

Increased effect with greater skill level and time. In a previous section, competition for available spots on a team was introduced as a factor that can contribute to RAE occurrence. Research (Cobley, Baker et al., 2009; Helsen, Starkes, & Van Winckel, 1998; Thompson et al., 1992; Vincent & Glamser, 2006) has also shown RAE increases in correlation to the skill level of competition. In one case (Helsen, Starkes, & Van Winckel, 1998), RAE was not found among youth soccer players aged six to ten participating in a non-selective youth league. However, a significant RAE was found for this age grouping among players selected to play in the elite leagues. This trend was also found in another study (Vincent & Glamser, 2006) among older soccer competitors. Though RAE was found at the state level of competition, the intensity increased at the regional level of competition. Stronger yet was the RAE among those competing for the national team.

This trend is not limited to soccer. Similar, yet less profound, findings were presented for baseball players when the birth distribution of all of the players in a league was compared to the distribution of those in the league selected for tournament play (Thompson et al., 1992). Another example is found in a study of youth hockey competitors (Barnsley & Thompson, 1988). This study evaluated three tiers of competition at various age groupings against an assumed even distribution of births. The birthdays of the players in the middle tier were not statistically different than expected.

However, the birthdates of players in both the lowest and highest tiers of competition were different than expected. The highest tier was comprised of an abnormally high ratio of players who were born near the beginning of the year while the lowest tier contained an over representation of age-disadvantaged players.

Analyzing the combined results of multiple other studies, Cobley, Baker et al. (2009) presented findings that support the suggestion that RAE increases with increased skill level, but found that the correlation has limitations. Their findings suggested that RAE decreased among the highest skill grouping. In attempting to explain these results, one of the hypotheses of Cobley, Baker, et al.'s study was that RAE decreased because athletics at the highest levels do not contain age groupings. Similarly, maturity differences deteriorate by adulthood, which also coincides with their finding that RAE decreased in populations over the age of eighteen. An alternative suggestion, presented by Delorme et al. (2009), is that talent selection in professional sports is often heavily influenced by the team's desires to perform well and make a profit. Though these two theories are divergent in nature, both are plausible factors in decreasing the incidence of RAE in professional sports.

While the results accumulated by Cobley, Baker et al. (2009) suggested RAE is less likely to occur in professional sports, studies (Daniel & Janssen, 1987; Grondin & Koren, 2000) have suggested that this trend could be changing. Daniel and Janssen (1987) investigated professional hockey players and found no evidence of RAE prior to 1975. However, their data from the 1985 season exhibited a stronger RAE than the data from Barnsley at al. (1985) taken just two years earlier. Grondin and Koren (2000) found similar results in their study of all historical Major League Baseball players through the

1992 season. Evaluation of players born in the 1940's did not reveal significant RAE findings. Players born in the 1950's, however, were found to have birthdates influenced by RAE. In addition, the effect was stronger in those born after the 1950's, thus indicating a continuation of the trend.

While the factors discussed in this section largely influence an increase in RAE, research discussed in this section suggested the decrease of RAE among athletes in professional sports. This subset of athletes comprises a large portion of those discussed in the next section.

Decreased incidence in American sports. Another subset, similar to those at the highest levels of competition, which has shown decreased sensitivity to RAE is American athletes. Stanaway and Hines (1995) suggested decreased incidence of RAE among American athletes by analyzing samples taken from American professional baseball and football. They reported finding no RAE in either group. While the validity of their study, due to unexplained procedures and potentially flawed analysis, which will be discussed in a later section, may be questioned, further investigation lends support to their assessment.

First, there seems to be a surprising gap in the amount of RAE research investigating American athletes. Excluding the study done by Stanaway and Hines (1995) as well as studies done on the entire population of the National Hockey League, which has American franchises but has a relatively low percentage of American-born players (Allen & Barnsley, 1993; Côté et al., 2006; Daniel & Janssen, 1987), six studies remain that have directly studied American athletic populations. Four of these studies (Côté et al., 2006; Daniel & Janssen, 1987; Grondin & Koren, 2000; Thompson et al., 1991) investigated professional athletes while single studies have investigated collegiate athletics (Glamser & Marciani, 1992) and elite amateurs (Vincent & Glamser, 2006). Since the majority of American studies have focused on professional athletes, a population already suspected as having a decreased incidence of RAE, it might be assumed that RAE in American athletics has been misrepresented by the overuse of professional subjects. Further studies, however, seem to support the original claim of decreased RAE among American athletes.

Three studies (Côté et al., 2006; Daniel & Janssen, 1987; Grondin & Koren, 2000) investigated professional American athletes alongside those of various other nationalities. Daniel and Janssen (1987) were the first to include American subjects in their research, studying players from Major League Baseball (MLB), the National Football League (NFL), and the National Basketball Association (NBA). The NBA data showed no skewed distribution of birth rates, but did not have a similar league for comparison. The NFL data also showed no statistically significant variation in distribution, a finding that was congruent with the Canadian Football League. The MLB data was also presented as being absent of RAE. This finding, however, was later challenged by Thompson et al. (1991) who noted that Daniel and Janssen had incorrectly used September as the beginning of the participation year. When Thompson et al. studied MLB data utilizing August as the beginning of the participation year, RAE was found to exist. Grondin and Koren (2000) later offered support to this, again finding evidence of RAE in MLB. However, their study compared MLB data to information from the Japanese professional baseball league. The Japanese data exhibited a much stronger RAE.

More recently, Côté et al. (2006) presented further examples of the limited influence of RAE in American athletics. The investigation of American professional basketball players and golfers revealed no evidence of RAE. Supporting previous findings, MLB subjects were shown to exhibit RAE. The NHL population was divided into two components for investigation. American-born participants did show a statistically significant RAE, but the effect was much stronger among Canadian-born players. While it can be argued that American athletics have shown decreased instances of RAE simply due to the majority of studies focusing on professional athletes, research has shown that American professional athletes exhibit weaker RAE when compared to their foreign counterparts.

The remaining studies involving American athletes have presented some interesting findings as well. Thompson et al. (1992) and Vincent and Glamser (2006), as mentioned previously, presented findings that suggested RAE increases in congruence with level of competition. The population in the Vincent and Glamser study, American youth soccer players in the Olympic Development Program, was younger than typical professional players and was found to be significant for RAE among all levels for the males and among the top tier for females. It is interesting to note that, in addition to being younger, the subjects from this study were also not participating in a league affiliated with academic institutions or selecting its participants from such a league. Unlike the subjects studied by Glamser and Marciani (1992), who were also slightly younger than professional athletes, Vincent and Glamser's population would not have been subjected to the complication of Academic Timing. Therefore, their participation was strictly regulated by age and, not surprisingly, found to have a stronger RAE. It is also, then, extremely important to consider that the major professional athletic leagues in America (MLB, NFL, and NBA) select their participants largely from academic-based competitive leagues via drafts.

While RAE has been suggested to bear less influence on American sports, baseball has been found to be one sport where American athletes are subject to RAE. The following section will elaborate specifically on RAE as it pertains to America's pastime, baseball.

Relative Age Effect in baseball. The majority of previous RAE research has been focused on two sports, hockey and soccer (Cobley, Baker et al., 2009). Most likely this is a result of the global popularity of soccer and the significance of hockey in Canada, where many of the studies have originated. Few sports, however, are as engrained in American culture as baseball. This has partially influenced the selection of baseball for inclusion in this study. As this study will focus on subjects participating in baseball, it is imperative to provide a review of literature that has dealt specifically with baseball.

The study of RAE in the context of baseball has most often included professional athletes. Daniel and Janssen (1987) were the first to study MLB players and reported an absence of RAE among baseball players. It was later found, however, that their study was potentially flawed as it used September as the first month of the participation year. Subsequent studies (Thompson et al., 1991; Grondin & Koren, 2000) would establish August as the correct beginning of the participation year. This date was established based on regulation in place for most baseball leagues in America including Little League

Baseball, the major organization for youth baseball, and American Legion Baseball, a competitive organization for competitors up to nineteen years of age.

Following the establishment of an appropriate competition year, RAE has been consistently found among MLB players. Thompson et al. (1991) used the same data from the 1985 season as was presented by Daniel and Janssen (1987), using August as the beginning of the participation year, and also studied data from the 1990 season. In both seasons, RAE was found to exist, providing the first empirical evidence of a possible existence of RAE among MLB players. Three studies (Côté et al., 2006; Grondin & Koren, 2000; Spira, 2008) have since supported these findings.

Stanaway and Hines (1995), discussed previously in terms of American athletics, published findings that suggested RAE was not found among MLB players for the 1994 season. Though their final conclusion was negative for RAE, it is important to note that their data did reflect RAE when the entire population of six-hundred players was studied. Three random samples, each containing just over a fourth of the total population, were not found to have birth rate distributions significantly different than expected. The three random samples were selected based on the number of available subjects used for a secondary investigation presented in the same article of football players. It is questionable whether the results of the evaluation of smaller random samples should be considered more valid than the findings based on the entire population.

To further the understanding of how RAE influences baseball, it is important to again consider the potential influence of an athlete's place of birth. As mentioned previously, Grondin and Koren (2000) found RAE in MLB, but the Japanese professional league exhibited a much stronger influence. This suggested that a factor within the

American athletics system dampens the influence of RAE. Other studies (Côté et al., 2006; Spira, 2008), however, have presented findings that contribute to the conversation, but may not aid in reaching a definitive conclusion. Spira (2008) presented data that separated American-born MLB players from the rest of the league. The foreign-born players' birth distributions did not appear to be skewed in relation to the beginning of the baseball participation year while the month with the highest number of American-born players was August. These results, though the presentation did not include statistical analysis, suggested that the foreign players' birth distributions could potentially be masking a stronger RAE among the American players when the entire population of MLB is considered. The final study (Côté et al., 2006) to present data derived from MLB suggested that RAE is stronger in baseball than among American-born players participating in the National Hockey League. Taken collectively, these studies suggest that baseball is the most likely of popular American sports to be influenced by RAE.

Basketball was used as a previous example of a sport that may stifle RAE due to multiple positions with specific characteristics decreasing competition for available spots (Delorme et al., 2009). This theory could bear influence in baseball as well. Baseball teams allow nine players to participate in a game at a time. Many levels of competition, including the American League of MLB, allow for a tenth player as the designated hitter plays offense in place of the pitcher, who serves only as a defensive player. In addition, left-handed players are often preferred as hitters, first basemen, and pitchers. Findings of RAE have been linked to specific positions in other studies (Ashworth & Heyndels, 2007; Edwards, 1994). However, Thompson et al. (1991) were unable to associate RAE with any of the multiple variables they assessed: including handedness, position, and performance measures. Grondin and Koren (2000) did find evidence that RAE did not influence players who either hit or pitched left-handed, suggesting the decreased instance of left-handedness in the general population decreased competition for these participants.

Only two examples exist of baseball studies that do not include professional players. Thompson et al. (1992), mentioned previously in the context of competition level's influence on RAE, studied baseball players from ages four through eighteen. It is important to note that this population of players was taken from leagues in Ottawa, Canada. Among the competitors in the leagues, which were not selective and only required a player to register in order to participate, RAE was not found among any of the age groups. Further analysis did reveal RAE among twelve year olds when the more selective "major" league was compared to the "minor" league. In the same study, significant differences in birth rate distributions were also found among players selected for tournament play at the end of the season when compared to players not selected.

The final study to include baseball participants (Glamser & Marciani, 1992) also represents a unique level of competition as collegiate athletes at two separate universities were investigated. These universities were four-year institutions competing in National Collegiate Athletic Association Division I, the highest level of college athletics. While results in terms of birth distributions were presented, statistical analysis of the data was not performed. Thirty-four of the sixty-three participants were born in the first half of the participation year, but over a quarter of the participants were identified as having an advantage in terms of Academic Timing. Due to its limited sample size and inconclusive results, the validity of this study could be questioned. However, the study does present motivation for further investigation. Specifically, Glamser and Marciani initiated the issue of Academic Timing at a level of competition and age grouping that is below professional ranks but still affords a highly selective and competitive environment. Glamser and Marciani also noted within their study that, since community baseball leagues (Little League Baseball, American Legion Baseball) influence selection and development of talent well before participants reach ages where they are able to compete in leagues associated with academic institutions, the participation year established by the community leagues would still apply in terms of RAE. It was also suggested that Academic Timing can serve to amplify the effect of RAE. These factors have greatly influenced the decision to pursue the current study.

The prevailing trends in RAE research offer multiple insights into RAE. In most cases, male subjects are more likely to be influenced. It has also been suggested that RAE increases, to a certain point, in congruence with increases in skill levels of participation (Cobley, Baker et al., 2009). It is also interesting to note that, while it has been suggested that RAE bears less influence over American athletes, the strength of RAE could be increasing with time. While the previously mentioned trends are not exclusive to baseball, the sport is the focus of this study and, therefore, the trends specific to baseball were discussed.

The previous literature review has attempted to offer insight into RAE research. In the first section, the history of RAE research was presented. This history began with investigation into the variation of birth rates during different seasons in different countries and included findings suggesting that a person's birth season can potentially bear influence over their life. Research then explored the connection between age of students and performance in the academic setting and found that older students were more likely to achieve greater success. Based on the findings in the academic domain, RAE research was adapted to evaluate athletics. In the athletic domain, researchers found evidence that suggested that older athletes were more likely to participate than their younger peers. The mechanisms, both direct and indirect, which potentially contribute to RAE were presented in the second section. Among others, advanced physical maturity, increases in competition, and advantages in experience appear to promote the formation of RAE.

The third section presented the means by which RAE has been investigated. The correct identification of the participation year was illustrated to be the initial step in evaluation. Though the means of statistical analysis have varied, most often chi square tests are used. These methods of investigation have been used to establish the prevailing trends, which were presented in the final section of the review. Research findings suggest that male athletes, particularly in higher levels of competition, are more likely to be influenced by RAE. Contrary to these findings, research has suggested that the participation rates of American athletes are less likely to be influenced by RAE. One American sport that has been found in multiple studies to potentially be susceptible to RAE is baseball.

As previously mentioned, the purpose of this study is to investigate the possible influence of RAE on the selection of JC baseball players. It is hypothesized that RAE will not be found among JC baseball players when examined by traditional means. A second hypothesis is that RAE will be found among JC baseball players when their academic age is considered. The methods utilized in this investigation are presented next.

Methods

Subjects

Participants of this study were 150 intercollegiate baseball players at a junior college located in the Midwestern United States. Participants were drawn from the competitive seasons from 2003 to 2010. Since junior colleges are two-year institutions, each year's team had both freshmen and sophomore participants, giving the study a range of nine academic classes. This nine year span captured those who entered college in the fall semesters of 2001, who participated as sophomores on the 2003 team, through 2009. Institutional Review Board approval was granted following an Expedited Review procedure, including a waiver of informed consent, prior to extracting information from existing data.

Procedures

Data reduction. Following approval, 298 pre-participation physicals were obtained from records maintained at the college. Records were maintained in yearly groupings. According to the college's rules, pre-participation physicals were required of any individual wishing to participate in any baseball activities and were required to be renewed yearly. Players who submitted physicals could be excluded from being listed on the team roster for several reasons. First, players could have been excluded from the roster due to lack of baseball ability. In addition, players with sufficient baseball ability could have been excluded if they suffered an injury severe enough to prevent them from playing for the majority of the season or for failing to comply with academic or behavior standards. Therefore, an individual who submitted a physical was not necessarily considered to be part of the team, and an individual who participated for more than one year would have submitted more than one physical.

From each pre-participation physical was extracted a first and last name as well as the subject's year and month of birth. As mentioned, the physicals were maintained in yearly groupings, and each year's physicals were then compared to the team roster for that season. Players could be excluded from the roster for reasons other than lack of talent, but utilizing only those on the rosters ensured that the subjects in this study were players with the skill required to be included on the team. The 241 players appearing on the team rosters were organized as a group while the 57 players not appearing on the roster were separated into another group. Since existing data was used and the reason why some subjects were not included on rosters was not able to be determined, only the information from players listed on team rosters was used for this study. The rosters were also used to assist in determining the year of college entry for each player as the rosters labeled each player as a freshman or sophomore.

Data separation. Once each year's team members had been identified with the roster, each year's team was compared to the previous year's (with the exception of 2003 as no data was available from the previous year) and the following year's (with the exception of 2010) to identify duplicate data entries due to a player's participation, as both a freshman and a sophomore, in multiple years. The players who appeared on multiple rosters were further examined. The earliest roster on which they appeared was considered their year of entry. This secondary method of assessing entry year was necessary as a player, potentially due to either injury or academic problems, could be listed as a freshman on the team roster despite being in his second year of college. This method was used to help differentiate players who were older than expected prior to entering college from those whose academic status changed while they were in college. This procedure was used to determine the entry year of four players who each were listed on three separate rosters. When duplicate entries were detected, the data for the two entries was compared to ensure the consistency of the data and then merged. This procedure resulted in 150 separate data entries, which represented each roster player.

The non-roster players were arranged by date of birth to evaluate for duplicate entries, though none were found. Once it was ensured that no duplicate data existed within either the roster group or non-roster group of players, the two groups were compared to detect subjects who appeared in both groups. Eighteen entries were found to be duplicated between the two groups. These entries were the first to be assigned four digit identification numbers. For each of these players, two separate data entries were maintained. The first was grouped with the roster players and was assigned the number "1" as the first digit. A duplicate version of the information was also kept in the non-roster group with a first digit of two. The final three digits for the duplicate entries were the same (a single player who appeared as both roster and non-roster would have an entry of 1357 and 2357). Following this, each of the remaining roster players were assigned four digit numbers beginning with one and ending in a unique set of three digits while the remaining non-roster players were assigned four digit numbers beginning with two and ending in a unique set of three digits. This numbering system was employed to assure the separation of the roster and non-roster players during data analysis. While non-roster players' information was not part of the study, the information was maintained so that further analysis, if later deemed useful, could be performed. Once identification numbers were assigned, the names of the subjects were disassociated with the data and only the identifying four digit numbers were used for the remainder of the study. Only roster players, those whose four digit number began with one, were used in this study.

Data analyses. In all of the previous studies of RAE, researchers have established procedures that limited the participation year to a well-defined twelve month span. In these traditional evaluations of RAE, it was not necessary to consider the year of birth of the subjects as the rules governing their participation typically limited participation based strictly upon age. However, when athletic participation is associated with academic institutions, a situation can occur where participants' birth dates are not necessarily confined to a single year's period. For the current study, two separate procedures were used in an attempt to investigate the effect of Academic Timing.

Traditional evaluation. For the initial evaluation, traditional means of assessing RAE were employed. Only the subject's month of birth was used for data analysis. Based on previous findings relevant to the study of RAE in baseball, August was used as the beginning of the participation year. Subjects born in August, September or October were coded as Q1. Grouping was continued based on three month intervals so that players born in November, December or January composed Q2, February, March and April births were grouped as Q3, and Q4 contained players born in May, June or July. The sum total of subjects contained in each Q group was then calculated. The observed frequency for each Q group was compared with a theoretical expected frequency that assumed even distribution of births for each three month span. This comparison was achieved using the chi square goodness of fit technique. The statistical package SPSS version 17.0 (SPSS Inc., Chicago, IL) was used for data analyses. A theoretical expected birth rate distribution was assumed based on two factors. First, the current study's births spanned a ten year period. Barnsley and Thompson (1988) previously validated the use of assumed distributions in cases where the subjects' dates of birth span several years. Secondly, birth statistics for a population representative of the subjects used in the study could not be found. The current study contained males only. Though birth location could not have been determined based on the available information, junior colleges do not typically recruit players on a national basis. Available statistical sources (National Center for Health Statistics, 1995) did not provide data for male births only. In addition, the statistics represented national birth rates rather than rates relevant to the subjects of the current study.

Evaluation of the influence of Academic Timing. As previously noted, Academic Timing, though it does not alter the definition of the participation year, can create a situation where athletes grouped together as a single academic class can have age differences of greater than a single calendar year. In order to investigate how Academic Timing influences RAE, in addition to their month of birth, each subject's year of birth was also considered. Initially, all participants were investigated. New categories were used to classify subjects whose dates of birth were outside of the expected participation year. Finally, only those born within the expected participation year, considered to be On-Time Participants, were studied.

All participants. The second evaluation was aimed at providing insight as to how Academic Timing influences RAE. The data was first arranged according to the players' entry year into college. August was again used as the beginning of the participation year. A single year span of expected birth dates was then established for each yearly group.

This range was based on the assumption that students who enroll in college in the fall after graduating high school should do so prior to their nineteenth birthday. Therefore, nineteen was subtracted from the year of college entrance to provide an expected year of birth for the subjects within each group. Using subjects entering college in 2009 as an example, their dates of birth were expect to range from August of 1990 through July of 1991. Subjects whose date of birth was within the expected range formed the group labeled On-Time Academically. They were coded as previously described to quartile groups based on their month of birth. However, twenty-five subjects were found to be older than expected as they were born prior to beginning of the participation year. The members of this group were coded as Q0. In addition, eleven subjects were found to have been born after the expected date range, making them younger than expected. The members of this group were coded as Q5. Because it was not possible to assign an expected distribution rate to those who were not On-Time Academically, the chi square test was not used to evaluate the data while it was separated into six categories. Instead, to investigate the influence of Academic Timing, the midpoint of the participation year, February 1, was used to separate the data into two groups. Based on this, the participation year was divided in half and the sum of Q0, Q1 and Q2 (Group X) was compared to the sum of Q3, Q4 and Q5 (Group Y). Once the data was combined into two groups, the chi square test was used for comparison with the expectation that each group should contain half of the subjects. Previous studies (Edwards, 1994; Sherar, Bruner et al., 2007) have utilized the midpoint of the participation year as a point of separation, though no previous study has done so while identifying subjects with birth dates outside of the expected participation year.

On-Time Participants. In addition, following the precedent set by Glamser and Marciani (1992), those athletes considered On-Time Academically were evaluated separately. To perform this evaluation, subjects born outside the expected participation year (Groups Q0 and Q5) were eliminated. This procedure left only those who were considered to be On-Time Academically. The resulting group of 114 was studied by the traditional means of investigating RAE, described in the previous section. This procedure was intended to assess if RAE was more prevalent among On-Time Participants and, therefore, to provide further insight into the effect of Academic Timing.

Results

Traditional Evaluation

The observed quarterly birth rate distribution of the subjects is displayed in Table 3. There was no statistically significant difference between the observed and theoretically assumed values, χ^2 (3, n = 150) = 3.97, $p = 0.26$. While the results do not illustrate a statistically significant variation from the expected random distribution of births, it is interesting to note that the final three quarters are evenly distributed while the first quarter contains the highest number of births. There are also two trends within the data that might suggest potential RAE. The first is the moderate increase of first half births (54%) and that the 32% of births in Q1is markedly higher than the 22.7% Q4 births. While statistical analysis did not suggest RAE, these two findings are congruent with trends within previous findings of RAE.

Table 3

Distribution of Births Compared to an Assumed Even Distribution

	Number of players						
	Birth quarter					Statistics	
	Q1 Aug-Oct	Q2 Nov-Jan	Q3 Feb-Apr	Q4 May-July	Total	χ^2	*p*
Number of births	48	33	35	34	150	3.97	0.26

Note. df = 3

Evaluation of the Influence of Academic Timing

All participants. The observed birth rate distribution with consideration given to Academic Timing is displayed in Table 4. Groups Q0 and Q5 represent subjects whose

Table 4

Distribution of Births with Consideration to Academic Timing

	Number of players							Statistics	
	Birth quarter								
	Q0 Pre Aug	Q1 Aug-Oct	Q2 Nov-Jan	Q3 Feb-Apr	Q4 May-Jul	Q5 Post Jul	Total	χ^2	*p*
Number of births	25	38	28	27	21	11	150		
		Group X			Group Y				
%		60.7% (n=91)			39.3% (n=59)			6.83	0.009*

Note. df = 1

**p* < .05

dates of birth were not within the expected twelve month range based on their year of college entry. The subjects in Q1 – Q4 were On-Time Academically. As previously stated, statistical analysis for this method of evaluation was not performed while the data was separated into six categories as expected values were not able to be determined for the Q0 and Q5 groups. However, the difference in the percentage of births prior to and after the midpoint of the participation year is greater than was found by traditional means. The percentage of players born in the first half of the participation year increased from 54% with the traditional investigation to 60.7% when investigated using this procedure.

The chi square test, χ^2 (1, n = 150) = 6.83, p = 0.009, was used to compare the distribution of births before (Group X) and after (Group Y) the midpoint of the participation year to the hypothetical values that assumed even distribution before and after the midpoint. The distribution was found to be significantly different than the expected distribution.

On-Time Participants. The previous chi square test investigating Academic Timing suggested that the birth distribution of the entire group of subjects was different than expected. To further investigate the influence of Academic Timing, the observed birth rate distribution among only those athletes who were considered to be On-Time Academically is displayed in Figure 1. Though this distribution was not significantly different when compared to the expected distribution, χ^2 (3, n = 114) = 5.23, $p = 0.156$, the number of births did decline in a linear manner from the beginning of the participation year to the end. The percentage of births in Q1 again was greater than the Q4 percentage. Also, there again is an increase in the percentage of participants, 57.9%, born prior to the midpoint of the participation year. This percentage is also greater than the 54% found in the traditional evaluation.

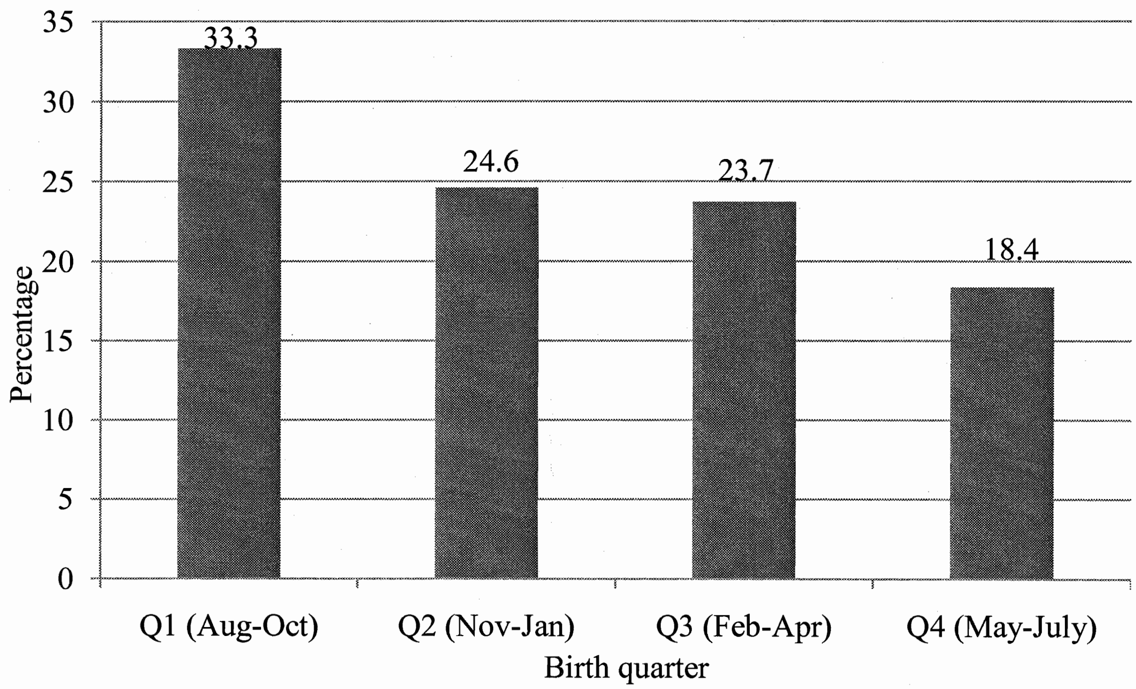

Figure 1. Percentage of On-Time Participant Births per Quartile of the Participation Year.

Discussion

The purpose of this study was to investigate whether RAE influenced the selection of baseball players at the junior college level. The investigation was performed both by traditional means of evaluating RAE and with respect to Academic Timing. It was hypothesized that RAE would not be detected among the subjects by traditional means of studying RAE. A secondary hypothesis, however, was that RAE would be evident when consideration was given to Academic Timing.

The first hypothesis, that RAE would not be detected among JC baseball players by traditional means of investigation, was supported by the data. However, some superficial indicators of RAE were present. First of all, the largest quartile grouping was the first, suggesting an increased likelihood for older participants to be selected. It was also noteworthy that the first quartile was the only group containing a greater number of births than the expected even distribution. The remaining three groups all contained less than the expected quarter of births. Secondly, following the method employed by Helsen et al. (Helsen, Starkes, & Van Winckel, 1998; Helsen et al., 2000; Helsen et al., 2005), it was also found that the first quartile grouping was larger than the fourth quartile. The slightly greater number of births in the first half of the year (54%) compared to the second (46%) is notable because the inequality presented despite the fact that Q2 actually had the smallest number of births. The lack of births in Q2, aside from sampling error, is difficult to explain. Still, the first half majority despite the shortage in Q2 helps to illustrate the magnitude of bias towards the oldest participants, those with Q1 births.

The second hypothesis, RAE would be found among JC baseball players when the subjects were evaluated with consideration given to Academic Timing, was partially supported. Evaluating the entire group based on whether they were born before or after the midpoint of the participation year did present evidence of RAE. Further, it is also important to note that, though the distribution was not statistically significant, the linear decline of birth rates from Q1 to Q4 exhibited by the on-time group is a classic presentation of RAE.

Inclusion of birth year information compared to an athlete's academic status allowed for better representation of the athlete's age when compared to his peers. This method helped to better illustrate the advantage held by some athletes that would not have been detected by previous studies. It is difficult to state, given the lack of previous studies that have considered academic status, whether the number of athletes found to have birth dates that fell outside of the expected twelve month span for their academic class is typical or expected. However, the thirty-six athletes, representing 24% of the sample investigated, which had dates of birth outside the expected span would appear to be a large enough segment of the whole to both justify the new procedure and warrant further investigation.

The conflict of these two findings opens up several options for discussion topics. First, since potential RAE was detected, it is necessary to discuss potential ways to combat the formation of RAE within athletic organizations. As stated by Musch and Grondin (2001), allowing RAE to influence participation rates, and conversely rates of discontinued participation, can have important ramifications not only in terms of athletics but also public health. Organized athletic leagues provide physical activity opportunities for young people, but also contribute to young people developing habits of including physical activity into their lifestyle. This could, perhaps, be seen as the most important reason to develop and implement strategies to decrease the likelihood of the youngest children within athletic age groupings from being prematurely excluded.

Several interesting suggestions were put forth by Barnsley and Thompson (1988). The first suggestion was to encourage education and awareness of RAE among coaches, athletic league organizers, and parents. Certainly, this effort is key. Attempts at change are often met with resistance when they are not supported by evidence and when those charged with implementing the change do not understand and support the reasons for the change. Coaches should be made aware that their teams' performance could be suffering by denying younger players the chance to develop. League organizers would certainly have interest in increasing participation rates. Parents are also integral to the implementation of change as they can provide encouragement to children to continue participation and support the efforts of the coaches and league organizers as they attempt to implement the changes.

Even though it is an important step, simply educating those involved with youth athletic leagues about the potential detriments of RAE will not solve the problem. Steps to restructure youth athletic leagues to stifle the potential development of RAE should be considered. One such step would be to consider alternate means of grouping rather than simply relying on chronological age (Barnsley & Thompson, 1988; Musch & Grondin, 2001). In some cases, height, weight, or a ratio of the two factors could be used. Other suggestions have included dental age, skeletal maturity, or other means of assessing biological age. Obviously, these means of assessment are more involved than simply grouping by age, but a recent study (Sherar, Baxter-Jones, et al., 2007) has attempted to explore innovative and less inconvenient means of determining biological age such as a multiple regression equation that incorporates height, mass, gender, sitting height, leg length and chronological age.

If implementing a change to biological age groupings is not feasible, perhaps the current methods of chronological grouping could be adapted. One suggestion is to initiate a quota system where the number of players with birthdates within specific ranges selected for higher levels of competition within leagues cannot exceed or fall below certain percentages (Barnsley & Thompson, 1988; Musch & Grondin, 2001). A similar suggestion is to develop teams specifically for players who are technically proficient, but lack the physical maturity to compete at the highest levels (Helsen, Starkes, & Van Winckel, 1998).

The previous suggestions for adapting chronological age groupings involved maintaining the current definitions of the participation year. Other suggestions, however, involve changing the beginning of the participation year. However, as Helsen et al. (2000) illustrated, simply changing the beginning of the participation year is likely to simply evoke a change in the distribution of births, not necessarily negate RAE. A strategy to potentially avoid simply shifting age-preference to a different segment of the year is found in several studies (Barnsley et al., 1985; Boucher & Mutimer, 1994; Musch & Grondin, 2001) and involves altering the length of the participation year. Suggestions for this vary, with some in favor of decreasing the participation year to nine months and others advocating a larger time span. Under either circumstance, the goal would be to create a situation where age-preference varies from year to year as children mature and, at some point during their development, each child will be among the youngest and oldest within their sport. An alternative but similar suggestion was presented by Musch and Grondin where organizers would make efforts to vary cut-off dates from sport to sport. This would allow an age-disadvantaged child in one sport the opportunity to seek a sport where the cut-off dates are more advantageous. Though these suggestions could cause some initial confusion, they do seem to be among the easiest suggestions to implement.

Some support for the alteration of the definition of the participation year does exist. Musch and Grondin (2001) noted that swimming, though evaluated in a limited number of studies, has not exhibited RAE among competitors. This is significant because swimming competitions often institute age requirements based on the date of the competition, not simply based on the calendar year, and therefore employ a constantly evolving age restriction. This method probably does not transfer well to team sports. Another proposal, expanding age groups, does not involve rotating the participation year, but is similar in that it creates circumstances where each player experiences both disadvantage and advantage based upon their age (Thompson et al., 1992). In supporting this proposal, it is noted that the baseball league investigated in their study contained age groupings larger than a comparable hockey league and resulted in less dramatic RAE findings.

Another suggestion offered by Thompson et al. (1992) was that the comparatively decreased RAE found in the baseball league was due to the difference in selection processes for elite teams between the hockey and baseball leagues. In the hockey league, elite teams are chosen at the beginning of the year and competition throughout the season is organized into tiers based on these selections. The baseball league, however, did not select their elite teams until the conclusion of a season in which all of the participants competed in a common league. This suggestion was offered as a secondary proposal with greater emphasis placed on the influence of the broader age groupings, but could actually be of greater influence. The longer evaluation period afforded by the completion of a competitive season prior to selection could lead to more accurate assessment of talent. In addition, more players within the league would benefit from the Peer Effect theory proposed by Ashworth and Heyndels (2007). Thus, it could be argued, that another simple method to employ to decrease RAE within an athletic population would be to delay the selection of elite teams until later in seasons. It has been additionally suggested (Barnsley & Thompson, 1988) that youth athletic leagues should evaluate whether such selection is even necessary within the youngest age groupings as these procedures could be detrimental to talent development and could influence some participants to drop out at young ages.

Given these suggestions, and the background information pertaining to influences leading to RAE, it is interesting then to discuss specifically American baseball. The results of this study, in addition to previously mentioned studies, suggest RAE does exist in American baseball. Additionally, this study has presented findings that suggest this RAE may be more pronounced than is superficially evident, particularly among participants who participate in leagues with academic associations. Previously, in discussing the effect of a change in the beginning of the participation year, it was mentioned that age requirements for entering public schools in North America can vary by up to six months (Barnsley et al., 1992). It is possible that this fluid age requirement is the first hinderance to the development of RAE in American baseball players.

This fluctuating age requirement must then be considered in addition to the fixed starting date of August implemented by non-academic baseball leagues. It is likely that the conflicting nature of these cut-offs could serve to help diminish the likelihood of RAE. If this is the case, future generations will be even less likely to be influenced by RAE since Little League Baseball, beginning in the 2006 season, changed the beginning of their competition year to May "(USA baseball," 2005). In addition, American Legion Baseball, beginning in 2003, adopted the calendar year as their definition of the participation year (J. R. Quinlan, personal communication, April 10, 2010). While neither of these changes seemed to be influenced by evidence of RAE, the two separate cut-off dates could help to inhibit future influence of RAE. It should also be recognized that school entrance dates, which trend toward fall dates to coincide with the beginning of the school year, will add yet another altered definition of the participation year. This could also help to diminish RAE among future American baseball players.

These changes could also have been an interesting factor in the current study. The change in the Little League Baseball participation year would not have affected any of the players in the current study. In order to have been influenced by this change, a player would have had to have been twelve years old or younger in 2006 when the change was implemented. This group of children will reach college age beginning in the fall of 2012. However, much of the group participating in this study would have been subjected to the new American Legion Baseball participation year. Information as to whether the players in the study participated in American Legion Baseball was not readily available. It should be noted that six American Legion teams compete within the district of the college used in this study, making it very likely that players have participated in American Legion

Baseball. Based on their ages at the time of the rules change, any of the players in the study who participated in American Legion Baseball would have done so after the change to the calendar year definition of the participation year.

Another factor that likely has helped to suppress RAE in the American baseball is the variation of potential ages of baseball players as they participate in high school baseball. As stated previously, entry age requirements for public schools can vary greatly, and factors such as academic failure can lead to a child being older than his academic peers. In addition to this, rules regarding age that govern participation are not consistent from state to state. For example, Midwestern states' age requirements for athletic participation were reviewed. Greatly differing requirements were found within this group. For example, Arkansas does not permit any athlete who turns age nineteen or older before September to participate in athletics during the school year (Arkansas Activities Association, 2010). Indiana, on the other hand, permits participation so long as an athlete does not turn twenty before the date of the state championship for the particular sport (Indiana High School Athletic Association, 2010). These varying requirements potentially allow great age disparities to emerge among high school athletes, but hinder the development of RAE since no single date is consistently used.

Finally, it must be recognized that Little League Baseball, American Legion Baseball and high school participation are not the only leagues that provide opportunity for America's youth to participate in baseball. For example, other organizations such as Ripken and Babe Ruth Baseball offer leagues for players in age groups that overlap and compete with Little League Baseball and American Legion Baseball. It is also common for independent teams, not affiliated with any particular league, to form within a community for the purpose of traveling to and competing against other independent teams. These teams are available at all age groupings. Each individual organization or independent team is able to establish their own regulations regarding age requirements, thus potentially limiting the influence of RAE among baseball players in America by introducing a plethora of arbitrary cut-off dates for the participation year.

While multiple theories have been discussed as to how to diminish the likelihood and the consequences of RAE in baseball, it is possible that these efforts may never need to be employed. Though the results of this study did suggest RAE of relatively small magnitude among JC baseball players, alterations to the definition of the participation year have already occurred among major baseball organizations in America. These alterations, when combined with conflicting school entry and participation requirements, create a situation where the definition of the participation year for baseball in America is likely too varied and inconsistent to support RAE in the future.

Conclusion

In conclusion, this study's purpose was to investigate whether RAE influenced the selection of baseball players at the junior college level. The results of the study suggested that, while RAE was not readily evident when traditional methods were employed, indications of potential RAE were present. In addition, the findings also suggested that the inclusion of Academic Timing considerations can help to detect RAE in settings, such as JC baseball, where participation is mediated by participants' academic status rather than strictly by their age.

Limitations

The primary limitation of this study was that it involved only one school's baseball program. This limitation has multiple ramifications. First, the players participating at this school were largely drawn from the immediate area surrounding the school. Thus, this study likely cannot be considered representative of JC baseball as a whole. Rather, local youth leagues and high schools have potentially influenced the probability of RAE formation. In addition, the area surrounding the school is predominantly rural and contains no major urban areas. This is significant as a previous study (Côté et al., 2006) noted the correlation of population to performance. Also, other factors outside of simple talent level could have influenced player participation. By using the data from a single school, the pool of subjects was potentially influenced both by the type of player desired by the coaching staff and the reputation among potential players of the school's academic and athletic programs.

Utilization of existing data was another limitation of this study. While this procedure allowed for a greater range of subjects to be studied, the lack of direct contact with the subjects prevented further investigation from occurring. Subjects were not able to be questioned as to their previous baseball participation. This information could have allowed for a better understanding of the participation year definitions of their local youth leagues as well as, potentially, the entry requirements for their school districts. The ability to extract information from the subjects could also have enabled investigation into the reasons why some of the players submitted physicals but were not included on team rosters. Given that non-roster players could have been excluded for reason other than lack of talent, such as injury or academic failure, this group was not considered homogenous enough for further investigation. If it was felt that the non-roster players were excluded simply on the basis of talent, investigation as to whether RAE was present could have contributed to the discussion.

Similarly, the final limitation was the lack of knowledge as to the personal history of the players within the study. First, this limitation contributed to the inability to identify a more representative set birth rate statistics for comparison. Also, it prevented investigation into the athletes' experiences, volume of practice, or other factors that could have contributed to their baseball participation.

Future Research

The implications of the current study for future research are promising. Foremost is the topic of Academic Timing as it relates to RAE. As stated, RAE has often been found to be decreased, if existing at all, among American athletic organizations. This study's suggestion that RAE among a group of American athletes was disguised by their Academic Timing could warrant a renewed investigation into the prevalence of RAE among other American sports. Certainly, future studies involving athletic organizations with academic associations or selecting their players from such athletic organizations should initiate procedures to control for the influence of Academic Timing.

Another possible suggestion for future research would be a more extensive investigation into RAE not only at the JC level, but at all levels of collegiate participation. As stated previously, one of the limitations of this study was the inclusion of only one school and college athletics, in general, have not been the topic of many RAE studies. Studies including more schools could promote the understanding of how RAE influences participation at these levels and among different sports' competitors.

Finally, potential exists for a longitudinal study to investigate how the changes in the definition of the participation year for Little League Baseball and American Legion Baseball influence either each league itself or the levels of competition that draw from their respective populations. Helsen et al., (2000) presented research that suggested that changes in the definition of the participation year could immediately influence the birth rate distributions among participants. The relatively recent changes could afford the opportunity to either replicate the work of Helsen et al. or to collect data at either the college or professional levels to study whether the changes influence the distribution of birth dates at these levels.

Appendix

Personal Communication

Below are two electronic mail communications. The first, an inquiry, was sent to American Legion Baseball by the primary investigator through a contact link found on the American Legion Baseball website. The second is the response received from a representative of American Legion Baseball detailing the change of the definition of the participation year.

-----Original Message-----

From: [redacted]@hotmail.com [mailto:[redacted]@hotmail.com]

Sent: Friday, April 09, 2010 10:47 AM

To: American Legion Baseball

Subject: Baseball: Age restrictions

Message sent from Thomas Beals who is a Fan at [redacted]@hotmail.com

I have been attempting to gather information for a thesis I am writing regarding the effect of age cut-off dates and participation in baseball. Thus far, I have not been able to obtain some necessary information regarding American Legion Baseball.

When I played, 1993 to 1996, I believe the date to establish a player's age was August 1st. Information available on the web now indicates that date to be January 1st.

1. When did this change occur?

2. What were the influences of the change?

3. Is there a press release, internet page, or other form of documentation noting this change?

Thank you for your time.

Thomas Beals

-----Reply Message-----

From: [redacted]@legion.org

To: [redacted]@hotmail.com

Date: Sat, 10 Apr 2010 16:03:32-0400

Subject: RE: Baseball: Age restrictions

Change went into affect in 2003 - primary reason - kids are being held out of school until older age. In MO for example kids must be 5 years of age by June 1 to attend kindergarten - players born after June 1 must wait until six to attend kindergarten - therefore they do not graduate until age 19. Biggest complain we received for 10 years was "my son played HS baseball, why can't he play Legion baseball"

THE AMERICAN LEGION

NATIONAL EXECUTIVE COMMITTEE

INDIANAPOLIS, INDIANA 46206

OCTOBER 10-11, 2001

Resolution No: 34

Origin: Americanism Commission

AMERICAN LEGION BASEBALL ELIGIBILITY DATE CHANGE

WHEREAS, American Legion Baseball designated the date of August 1 as its eligibility cutoff and has used this date to establish age eligibility since 1954; and

WHEREAS, USA Baseball, the national governing body for amateur baseball in the United States of America, of which The American Legion is a member, has recommended that the amateur youth eligibility date be changed to January 1 so as to comply with Olympic and International Sports competition; and

WHEREAS, USA Baseball has also recommended that amateur youth baseball organizations permit nineteen year old players to compete and that these changes take effect in 2003; and

WHEREAS, The Baseball and Recreation Subcommittee to the National Americanism Commission has studied these changes and recommends their adoption as does the majority of Department Baseball Chairmen; now, therefore, be it

RESOLVED, By the National Executive Committee of The American Legion in regular meeting assembled in Indianapolis, Indiana, October 10-11, 2001, That, effective with the 2003 season, The American Legion Baseball Program establish January 1 as the cutoff date to determine age eligibility in the program; and, be it finally

RESOLVED, That eligibility to participate in American Legion Baseball be extended to include players who have attained the age of 19.

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