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A serial examination of Academic Timing and Relative Age Effects among U Sports basketball players

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Abstract

Relative age effects (RAEs) describe relative (dis)advantages experienced by athletes born earlier in the year compared to their younger counterparts due to organizational cutoff dates. Interuniversity sport offers a unique environment where student-athletes of varying absolute ages compete for positions on a single team. This context can influence the academic timing of student-athletes, which describes the difference in student-athletes' current and projected athletic eligibilities, and the impact this has on their participation in interuniversity sport. The purpose of this serial investigation was to examine the influence of academic timing on RAEs in U Sports basketball. The results revealed that RAEs were stronger among 'on-time' student-athletes, with more student-athletes born in the first half of the year than the second throughout the time period considered in this study. U Sports administrators may want to consider the influence of academic timing on RAEs to inform future policy decisions.

Keywords: relative age effects; academic timing; U Sports; basketball; interuniversity sport.

Résumé

Les effets de l'âge relatif décrivent les (dés)avantages vécus par des athlètes nés tôt dans l'année comparativement à leurs pairs plus jeunes, ces avantages étant dus à des dates limites de nature organisationnelle. Le sport universitaire est un contexte où les étudiants-athlètes d'âge très variables sont en compétition pour les postes d'une seule et même équipe. Ce contexte peut influencer le cheminement académique de ces étudiants-athlètes, défini comme les différences entre l'éligibilité anticipée et courante. Ce cheminement peut également influencer leur participation au sport universitaire. Le but de cette étude était d'investiguer l'influence du cheminement académique sur les effets de l'âge relatif au basketball universitaire. Les résultats révèlent que les effets de l'âge relatif sont plus importants chez les étudiants qui cheminent normalement étant donné le plus grand nombre d'étudiants-athlètes nés dans la première partie de l'année que dans la seconde durant la période considérée pour l'étude. Les administrateurs de sport universitaire pourraient prendre en compte cette influence du cheminement académique dans leurs décisions sur les politiques à adopter.

Mots clés: effets de l'âge relatif; cheminement académique; sport universitaire; basketball; sport universitaire.

Introduction

Human performance is influenced by complex factors that are interconnected. Baker and Horton (2004) posited that human performance is shaped by direct and indirect factors. Direct factors are those that an athlete contributes to their development, such as their genetics. Indirect factors, such as the cultural importance of a sport, can also impact overall performance. An athlete's birth month is one indirect factor that has been shown to have a critical role in future athletic success (Baker et al., 2004).

Barnsley et al. (1985) were among the first to find that birth month impacted participation in elite levels of hockey; specifically, athletes born in the earlier part of the selection year (i.e., January, February, March) had a better chance of making it to the National Hockey League (NHL) than those born in the latter part of the selection year (i.e., October, November, December). Similarly, Barnsley and Thompson (1988) demonstrated that dropout rates of youth hockey players are higher among those born in the second half of the year. Thus, cutoff dates used to group athletes appear to pose a disadvantage for those born in the latter half of the selection year because they can be up to one year younger (Barnsley et al., 1988). These (dis)advantages, called relative age effects (RAEs), play a role in player selection for 'elite' teams, where relatively older players have a greater chance of being identified as talented because of perceived physical and psychological differences over their relatively younger teammates (Helsen et al., 2005). Since the time of these foundational studies, RAEs have been demonstrated in a number of different sports (e.g., soccer, rugby) and competitive levels (see Cobley et al., 2009 and Smith et al., 2018 for a summary of this work).

For athletes competing in interuniversity sport, RAEs seem less evident (Beals et al., 2018; Chittle et al., 2016, 2018b). In American Junior College baseball, Beals et al. (2018) initially revealed no RAEs among the student-athletes in their study. Similarly, Chittle et al. (2018b) found no RAEs among Canadian U Sports Football athletes in their initial analysis. However, academic timing (AT) appeared to moderate the impact of RAEs on the athletes in these studies. Dixon et al. (2013) described AT as the influence that student-athletes' academic eligibility has on their potential success and participation in post-secondary sport. When analyzed as a moderating factor of RAEs in interuniversity sport, the birthdate distribution of student-athletes tends to vary based upon the AT of student-athletes (Beals et al., 2018; Chittle et al., 2018b).

U Sports (formerly known as Canadian Interuniversity Sport and the Canadian Intercollegiate Athletic Union) is the governing body for interuniversity sport in Canada, which is comprised of 56 institutions across four regional conferences. There are 12 sports sanctioned by U Sports, nine of which include both male and female leagues, one for males exclusively (i.e., football) and two for females (i.e., field hockey and rugby; U Sports, 2019). Currently, there is limited research that analyzes the impact of AT on RAEs among U Sports athletes, and the research that does exist is cross-sectional in nature. Specifically, there are no studies that target men and women U Sport basketball athletes. Research on the impact of AT on RAEs among this group may help identify processes and procedures in the Canadian basketball youth development system that may cause some athletes to be advantaged over others. As Canadian demographics change, basketball is becoming one of the most popular sports in Canada (Snelgrove & Selvaratnam, 2019). Consequently, there is a need to know more and understand if relative age patterns are the same or different compared with data from other countries and sports. In an effort to help fill this gap in

the literature, this serial investigation examined RAEs and AT among female and male U Sports basketball athletes over an eight-year period.

Literature Review

Relative Age Effects (RAEs)

There are several factors that contribute to RAEs in sport. These include physical, psychological, and competition factors, as well as experience **(**Musch & Grondin, 2001). Youth athletes who are relatively older are generally more physically and psychologically mature, which can lead to more positive experiences. For example, two athletes competing in the same age cohort can be almost a full calendar year apart in their birthdays (i.e., one born in January and one born in December of the same year), thereby allowing the relatively older athlete more training time and competition experience. As a result, relatively older youth athletes may obtain advantages of maturity and skill development that would lead them to have more positive perceptions of their experience. In contrast, the relatively younger youth athlete may have an experience where they are consistently behind in the number of training and competition hours and, as a result, may get frustrated and discouraged, causing them to be cut from teams or drop out of sport **(**Musch & Grondin, 2001).

Andronikos et al. (2016) highlighted that RAEs do not impact all sports equally and in some sports (e.g., swimming, skiing, taekwondo), RAEs are not evident whatsoever. Notable reasons for an absence of RAEs are the structure of athlete groupings (based on age, weight, size, or skills) and prioritizing long-term development over short-term individual or team performance (Andronikos et al., 2016). Relative age effects are often observed when the focus of youth sport is on winning. It is in this context where athletes with maturation advantages tend to thrive because coaches may choose athletes who are faster and stronger (Andronikos et al., 2016). For instance, in a population of European youth soccer players (U15-U18), Helsen et al. (2005) demonstrated that there was an overrepresentation of athletes born in the first three months of the year compared to those born in the latter part of the year. Thus, it appeared that relatively older athletes, who were likely more physically precocious, were more commonly identified as talented than their younger peers (Helsen et al., 2005).

Considering the multiple factors that influence RAEs, Wattie et al. (2015) created a developmental systems model to explain RAEs in sport, based on Newell's model of interacting constraints. These include individual (e.g., birthdate, height, sex, and psychological factors), task (e.g., demands of the sport, such as strength, speed, agility), and environmental constraints (e.g., broader social constructs that shape social structures, such as age grouping policies, and the socio-cultural context). An athlete's birth month is considered an individual constraint, while sport cutoff dates are considered environmental constraints. Unlike youth sports, which are typically grouped into one- or two-year age cohorts, the interuniversity sport structure allows athletes to vary greatly in age. In U Sports, student-athletes have five years of competitive eligibility, but there is no age limit (except for football) for athlete participation (U Sports, 2018a). Thus, even if student-athletes commence university at the same chronological age, there can be a five-year difference in age between the oldest and youngest student-athletes on a single team.

RAEs in Basketball

Individual constraints can affect an athlete's chance of making a team, especially in sports that rely on physical attributes such as strength, speed, and agility. Height is a desirable characteristic in basketball athletes, therefore, RAEs disadvantage relatively younger athletes who

may be shorter in their youth (Delorme et al., 2009). Research conducted by Ibáñez et al. (2018) on elite European U-18 basketball demonstrated that coaches tend to recruit older and more mature athletes who have strength and height advantages over their relatively younger peers. These authors also suggested that RAEs only exist for certain positions, namely those that benefit from increased strength and size (e.g., forwards and centers).

Similarly, Delorme and Raspaud (2009) found a significant height difference in the population of French youth basketball players ages 7-18 years. Specifically, athletes born in the first (January, February, March) and second (April, May, June) quartiles of the year had a significant height advantage over those born in the third (July, August, September) and fourth (October, November, December) quartiles. Comparable findings were obtained by Rubajczyk et al. (2017) who found that birth month, height, and sex were significant predictors of youth basketball success (i.e., performance index ratings). These findings indicate that an athlete's birth month may impact their success of being selected for an elite youth team.

Relative age effects have been found at elite levels of basketball but appears to decrease as the age of the athletes increases (e.g., Arrieta et al., 2016; García et al., 2014). At the 2013 European basketball championships, RAEs were present in the under 16 (U16), under 18 (U18), and under 20 (U20), age groups. However, the strength of these effects decreased as the age of the athletes increased (Arrieta et al., 2016). Moreover, relatively older players received more playing time and had overall better performance scores than their relatively younger peers. In a similar study, Garcia et al. (2014) analyzed birthdate data from participants in the U17, U19, and U21 international championships. Their study revealed RAEs among the U17 and U19 athletes, but not among the U21 athletes, with gradually diminishing impacts of these effects as the ages of the athletes increased.

It appears that RAEs may not be as prevalent in basketball players after adolescence. Werneck et al. (2016) analyzed basketball athletes at the 2012 London Olympics and found no RAEs to be present, except for team France. This difference across countries may be attributed to differing selection criteria between countries and sport developmental systems. For example, youth basketball in France tends to overemphasize early success therefore, teams place a higher importance on age and development stage rather than the potential of an athlete to improve and mature (Werneck et al., 2016). In contrast, Cote et al., (2006) concluded that there were no RAEs evident in the National Basketball Association (NBA).

Academic Timing

In North America, sport and academic systems are tightly integrated. Students have the opportunity to participate in interscholastic sport at the elementary, secondary, and post-secondary level, forming a developmental youth sport system within the school setting. Typically, interscholastic athletes are grouped by grade, instead of age, which can result in an age gap between students competing on the same team. Differing ages can occur for reasons such as parents holding their children back from commencing elementary school on time, students failing a grade, or students completing an extra year of high school, causing them to be one or more years behind their peers. When student-athletes reach university, they may be delayed for other reasons such as redshirting[1] or sitting out a year after transferring from another school (Chittle et al., 2016). Students who are relatively younger than their peers and wish to pursue post-secondary athletics

[1] Chittle et al. (2018a) defined 'redshirting' as a method used by student-athletes to preserve a year of athletic eligibility. Student-athletes are members of their varsity teams but do not participate in league competition.

may benefit from delaying their entrance to school. Doing so enables relatively younger student-athletes to gain an extra year of physical and mental development, while preserving their competitive eligibility (Glamser & Marciani, 1992).

To account for these potential age differences among student-athletes when studying RAEs in interuniversity contexts (i.e., academic timing), researchers categorize them in three different ways: 'on-time,' 'delayed,' or 'advanced.' A student-athlete who commences elementary school when they are eligible as defined by their educational system and follows the chronological steps through school without repeating a year and/or delaying their entry into university is considered 'on-time,' while a student-athlete who is held back or sits out a year would be considered 'delayed.' Finally, student-athletes who are ahead of their cohort in eligibility because they started school early or skipped a grade are considered 'advanced' (Dixon et al., 2013).

To analyze the effect of AT on RAEs at the interuniversity sport level, Chittle et al. (2016) studied Division I basketball student-athletes from the National Collegiate Athletic Association (NCAA). These researchers found that RAEs did not exist when the student-athletes were examined all together. However, once AT was taken into consideration, there was an over-representation of relatively older 'on-time' student-athletes among their sample. Consistent with Chittle et al. (2016), Beals et al. (2018) found no evidence of RAEs among junior college baseball athletes, although there were trends showing slightly more athletes born in the first half of the year than the latter half. When AT was considered, these authors uncovered strong RAEs among on-time athletes, with 60.7% of the student-athletes having birth dates in the first half of the year (Beals et al., 2018). Moreover, Chittle et al. (2018a) noted that student-athletes who were delayed were more likely to be born in the second half of the year. Therefore, AT has a moderating effect on RAEs, suggesting that student-athletes with late birthdays who delay their athletic eligibility may mitigate these effects.

There seems to be a trend in interuniversity hockey and football, specifically, where student-athletes tend to be delayed more than one year. Chittle et al. (2018b) found that at least 30% of the delayed student-athletes in Canadian interuniversity football were delayed, with some being delayed by 12 years. One explanation for the exaggerated delays among interuniversity hockey and football student-athletes is that the physical nature of these sports requires considerable strength, giving an advantage to athletes who have more time to develop. Another reason may be the opportunity for male hockey and football players to compete in alternative leagues (e.g., Canadian Hockey League) prior to entering university, causing them to be delayed for more than one year, and therefore, having more time to physically mature than those who are on time (Chittle et al., 2018a; 2018b).

As early research suggests, RAEs can influence experiences of athletic success and failure, and cause athletes to drop out of sport prematurely (Barnsley et al., 1985). Delaying entrance to university is a potential method used by student-athletes to level the playing field, especially for those born in the second half of the year (Chittle et al., 2018b). Therefore, athletes who can gain another year of physical maturity may be exposed to better athletic opportunities (Andronikos et al., 2016). Only two studies have considered AT as a moderator to understand RAEs among interuniversity basketball athletes (Chittle et al., 2016; 2018a), both of which were cross-sectional in nature. Moreover, one of these studies was conducted with NCAA basketball athletes in the United States, who have dramatically different expectations than those competing in Canada (for an explanation of these differences, please see Fumano, 2016). The popularity and prestige of college basketball may influence youth development differently in the United States than in Canada by pushing athletes with physical advantages at younger ages toward participating in more

competitive teams and leagues. Due to the rising popularity of basketball within Canada (Snelgrove & Selvaratnam, 2019) and the differences between American and Canadian college basketball (Fumano, 2016), there is a need to determine the potential impacts of RAEs on AT among Canadian student-athletes. Thus, the aim of this serial investigation is to: a) provide insight into RAEs and AT among basketball student-athletes within U Sports, and; b) explore trends in RAEs and AT among these student-athletes over time.

Method

Participants

Female and male student-athletes competing on U Sports basketball teams from the 2006/07 through 2013/14 seasons were the target population for this study. The data were gathered from hard copies of team eligibility certificates provided by U Sports administrators and data entry were conducted by hand. In some datasets, not all teams provided complete birth date or eligibility year information. Hence, student-athletes with missing birth dates and/or eligibility years (n = 679) were removed from the study due to an inability to determine their eligibility status or birth quartile. Additionally, student-athletes from outside Canada were also removed from the data (n = 611) due to the potential for differing youth sport structures and selection criteria between countries (Werneck et al., 2016). Thus, the total number of student-athletes included in the current study was 7,677 from a total of 42 U Sports institutions. This research project received clearance from our home institution's Research Ethics Board.

Athlete Groupings

Student-athletes were separated based on sex and categorized into quartiles (Q) according to their relative ages. January 1st is recognized in Canada as the most common cutoff date for youth basketball (R.Yeung, personal communication, March 23, 2021) and was employed in our study to determine the relative ages of the student-athletes. Therefore, student-athletes were categorized into the following birth quartiles: Q1 (January, February, March), Q2 (April, May, June), Q3 (July, August, September), Q4 (October, November, December). Student-athletes were then separated based on their AT status. Specifically, a student-athlete's AT status was determined by comparing their current year of athletic eligibility with what would be expected based upon their date of birth. Based on information from the Government of Canada (2017), the earliest that students can enter kindergarten is in their fifth year of age.[2] Consequently, so long as they do not skip a grade or become delayed, Canadian students would be eligible to commence university in their 18th year. To illustrate, student-athletes born in 2002 who begin kindergarten in 2007 should be entering their first year of university in the fall of 2020, which would represent their first year of athletic eligibility. These students would be considered on-time. Conversely, student-athletes born prior to 2002, who enter university with a younger cohort in 2020 would be delayed. Finally,

[2] In Canada, most students can enter kindergarten in their fifth year of age. Without being able to identify exactly what age each student-athlete began kindergarten, we chose to use the age at which most students would have entered kindergarten for the purposes of our analysis (School Age Calculator, n.d.).

students born after 2002, who enter university with an older cohort in 2020 would be advanced. Using these criteria, student-athletes were separated into on-time, delayed or advanced groups[3].

Data Analyses

A series of 48 chi-square goodness of fit tests (χ^2) with a *p*-value of $p < 0.05$ were conducted with SPSS (version 26.0) in order to test for significant differences between the birth distribution of the U Sports basketball student-athletes and what might be expected in the general population. To reduce the chances of making a Type I error, the target population (observed values) were compared with the general population (expected value; Delorme et al., 2010) Thus, the expected birth distributions were collected from the Human Fertility Database (2013), which provided monthly birth data for the general Canadian population. Data from the general population were extracted based on the range of the majority of birth years (1984-1990) for student-athletes in this study. Each of the eight seasons of data were analyzed separately and split according to the sex and AT status of student-athletes.

For student-athlete groups whose birth distributions were significantly different from the expected birth distributions, standardized residuals (SR) were calculated to determine which specific quartiles were significantly different. Effect sizes were calculated using Cramer's phi (φ), with values of 0.1, 0.3, and 0.5 representing small, medium, and large effect sizes, respectively (Cohen, 1988).

Results

The data for this serial investigation included eligibility and birth date information for 3,807 female and 3,870 male U Sports basketball student-athletes. Of the female student-athletes, 2,258 (59.31%) were on-time, 1,420 (37.30%) were delayed, and 118 (3.10%) were advanced, while the male data included 1,338 (34.57%) on-time, 2,412 (62.32%) delayed, and 120 (3.10%) advanced student-athletes. For the purposes of this study, only on-time and delayed student-athletes were analyzed, as the number of advanced student-athletes only accounted for 3.10% of the overall sample and was insufficient to ensure adequate power.

The data for the overall samples of female student-athletes revealed significant differences between the observed and expected birth distributions in five of the eight years (2006-07, 2008-09, 2010-11, 2011-12, 2012-13). Please refer to Table 1 for a summary of the chi-square and effect size results. In the overall male data, there were two years that demonstrated statistically significant differences between the observed and expected birth distributions (2012-13 and 2013-14). Both overall female and male groups displayed a general over-representation in Q1 and Q2 and under-representation in Q3 and Q4, although these differences were not significant in all eight years. Specifically, the overall female sample had significantly more student-athletes born in Q1 (2010-11, 2011-12, and 2012-13) and/or Q2 (2006-07) in four of the eight years and significantly fewer student-athletes born in Q3 (2010-11 and 2012-13) and/or Q4 (2008-09, 2010-11, 2011-12, and 2012-13) in four of eight years. In contrast, among the overall male sample there was a significant over-representation of student-athletes who were born in Q1 in 2012-13 and 2013-14 and a significant under-representation of student athletes who were born in Q4 in 2012-13.

[3] Student-athletes who progressed through the Quebec education system and competed within the Réseau du sport étudiant du Québec (RSEQ), competed outside of the RSEQ, or transferred into the RSEQ from other parts of Canada were classified in a manner consistent with Chittle et al. (2018b).

Table 1 *Summary of Statistical Results for Relative Age Data in U Sports Basketball for Student-Athletes Participating in 2006-07 through 2013-14.*

Year		Expected Distribution	Observed Distributions					
			Overall		On-Time		Delayed	
			Female	Male	Female	Male	Female	Male
2006-07	X^2		7.861*	2.485	10.632*	8.067*	2.584	0.632
	φ		0.1245+	0.0691	0.1448+	0.1244+	0.0714	0.0348
	Q1	24.05%	24.65	25.91	25.08	29.32	24.61	23.75
	Q2	26.08%	30.97*	27.64	32.34*	30.89	27.75	26.25
	Q3	25.85%	23.47	23.80	25.41	21.99	20.94	24.37
	Q4	24.01%	20.91	22.65	17.16*	17.80	26.70	25.62
2007-08	X^2		3.220	7.450	3.631	8.972*	1.421	6.363
	φ		0.0775	2.3664	0.0823	0.1349+	0.0515	0.1089
	Q1	24.01%	26.12	23.13	25.52	24.88	27.27	21.36
	Q2	26.07%	27.80	31.16	29.43	32.68	23.53	30.65
	Q3	25.83%	24.07	23.32	24.32	26.34	24.60	21.67
	Q4	24.10%	22.01	22.39	20.72	16.10*	24.60	26.32
2008-09	X^2		9.331*	3.064	15.453***	8.401*	0.725	5.909
	φ		0.1432+	0.0795	0.1843+	0.1316+	0.0399	0.1104+
	Q1	24.04%	27.03	27.22	26.86	28.34	25.65	26.26
	Q2	26.12%	30.11	25.98	35.12**	30.48	23.56	23.02
	Q3	25.86%	23.30	23.71	21.07	25.67	26.18	21.94
	Q4	23.98%	19.56*	23.09	16.94*	15.51*	24.61	28.78
2009-10	X^2		4.968	3.738	10.503*	9.854*	3.236	1.855
	φ		0.1029+	0.0879	0.1496+	0.1427+	0.0831	0.0028
	Q1	24.03%	25.80	27.48	27.14	29.71	22.29	26.42
	Q2	26.20%	29.42	26.45	32.50*	31.43	24.57	24.08
	Q3	25.83%	22.60	23.76	21.79	23.43	23.43	24.08
	Q4	23.93%	22.17	22.31	18.57	15.43*	29.71	24.42

Year		Expected Distribution	Observed Distributions					
			Overall		On-Time		Delayed	
			Female	Male	Female	Male	Female	Male
2010-11	X^2		15.767***	4.707	13.061**	14.314**	6.643	0.748
	φ		0.1824+	0.0972	0.1660+	0.1695+	0.1184	0.0387
	Q1	24.14%	28.90*	26.10	27.66	27.81	30.06	23.43
	Q2	26.26%	30.59	28.71	32.98*	33.14	29.45	27.39
	Q3	25.78%	21.31*	24.90	22.34	27.22	18.40	24.09
	Q4	23.82%	19.20*	20.28	17.02*	11.83**	22.09	25.08
2011-12	X^2		17.875**	5.179	13.658**	9.698*	3.807	0.767
	φ		0.1944+	0.1026	0.1699+	0.1404+	0.0897	0.0395
	Q1	24.19%	30.23**	27.84	29.43	30.57	29.10	25.79
	Q2	26.28%	29.39	26.22	31.32	26.11	28.04	26.41
	Q3	25.76%	22.62	25.61	23.77	29.30	22.22	23.90
	Q4	23.77%	17.76**	20.32	15.47**	14.01*	20.63	23.90
2012-13	X^2		34.210***	16.762***	30.549***	20.810***	9.595*	7.033
	φ		0.2618+	0.1853+	0.2649+	0.2065+	0.1387+	0.1200+
	Q1	24.26%	35.07***	31.56**	36.69***	36.42**	30.94	29.59
	Q2	26.29%	25.45	24.18	25.32	29.14	24.86	29.49
	Q3	25.77%	20.44*	25.61	23.05	23.84	17.13*	26.79
	Q4	23.68%	19.04*	18.65*	14.93**	10.60***	27.07	22.12
2013-14	X^2		5.204	9.980*	5.272	6.860	5.094	4.742
	φ		0.1149+	0.1651+	0.1157+	0.1369+	0.1137+	0.1138+
	Q1	24.38%	29.19	30.87*	29.39	33.01	27.97	29.20
	Q2	26.34%	23.60	23.22	26.12	29.15	19.58	21.60
	Q3	25.78%	24.87	26.23	26.12	24.27	23.78	26.80
	Q4	23.49%	22.33	19.67	18.37	14.56	28.67	22.40

Notes: Expected distributions derived from the Canadian Human Fertility Database for 1984 through 1995 birth years; X^2 = Chi-square; φ = Cramér's phi (effect size); Q = Quartile (e.g., Q1 = Quartile 1, Q2 = Quartile 2, etc.); * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; + = small effect size.

Of the on-time female student-athletes, significant differences were detected in six out of the eight years (all but 2007-08 and 2013-14). The birth distributions of the on-time samples of male student-athletes were significantly different from the general population in seven of the eight years (all but 2013-14). Like the overall samples of student-athletes, the on-time female and male student-athletes revealed a general over-representation of those born in Q1 and Q2 and a general under-representation in Q3 and Q4. The on-time female student-athletes were significantly more likely to be born in Q1 (2012-13) or Q2 (2006-07, 2008-09, 2009-10, and 2010-11) in four of the eight years and less likely to be born in Q4 in five of the eight years (all but 2007-08, 2009-10, and 2013-14). Among the on-time male samples, there was only one instance (2012-13) of student-athletes being born at a significantly higher rate than the general population in Q1, whereas the number of student-athletes born in Q3 (2007-08) or Q4 (all but 2006-07 and 2013-14) were significantly lower in six of the eight years.

Finally, the only sample of delayed student-athletes that showed a significant difference from the general population was females in 2012-13. Specifically, the number of student-athletes born in Q3 was significantly fewer than would have been expected in the general population. The results associated with the delayed female and male student-athletes did not reveal any consistent trends or distinct patterns through the eight years examined in this study.

Discussion

Relative age effects appeared as general trends in all samples of overall and on-time student-athletes, both male and female. However, these trends were magnified in the on-time groups. The overall female groups showed significant differences in six of the eight years (all but 2007-08 and 2013-14), showing significant over-representations in the first quartile and under-representations in the fourth quartile. The overall male samples of student-athletes displayed similar RAEs trends to their female counterparts, although with fewer significant differences (only in 2012-13, and 2013-14).

In basketball, it is advantageous for athletes to be tall. At youth levels, athletes who are relatively older may be taller than their relatively younger peers (Arrieta et al., 2016). Delorme et al., (2009) studied the dropout rates of youth basketball athletes in France. These researchers found that male and female athletes aged 7-17 years (except for 17-year-old females) born in Q1 and Q2 were consistently taller than athletes in Q4. Similarly, research by Delorme et al., (2011) supported the idea that youth basketball athletes (aged 13-17 years) born in Q1 and Q2 have significantly lower drop-out rates than athletes born in Q4. As development occurs through older age groups, relatively younger athletes may continue to be disadvantaged, which may help to explain the general RAE trend among the overall samples of female and male student-athletes.

Moreover, the over-representation of Q2 student-athletes may seem unusual when considering that traditional RAEs patterns are characterized by a decreasing linear progression from Q1 to Q4. However, Hancock et al. (2013) suggested that the Q2 phenomenon may occur when talented athletes in Q1 decide to play in more elite leagues, like the NCAA, leaving them unaccounted for in the U Sport system. The NCAA may be considered an attractive league for the top Canadian athletes who aspire to play basketball at the professional level. Of the total female and male NCAA basketball student-athletes, over 25% go on to play professionally upon concluding their interuniversity careers (NCAA, 2019). Thus, the prestige of the NCAA may lure Canadian athletes to play for institutions in America, which may partially explain why we witnessed a comparatively higher proportion of female and male student-athletes in Q2 in our study.

An alternative explanation for the over-representation of female and male student-athletes in Q2 could be the consequence of an increased incidence of injury among relatively older athletes born in Q1. Wattie et al. (2007) found that relatively older youth ice hockey players were more likely to visit hospital emergency rooms for hockey-related injuries than their relatively younger peers. Furthermore, the incidence of these injuries increased as players progressed through the developmental system and reached more elite levels of competition. Similarly, Stracciolini et al., (2016) analyzed data for a regional hospital and found that a higher number of injured athletes (between the ages 14-17) were relatively older than their relatively younger peers. As the amount of practice and playing time increases, so does the potential exposure to injury. Given that

relatively older basketball players are more likely to compete at higher levels of competition (e.g., Arietta et al., 2016; Garcia et al., 2014; Rubajczyk et al., 2017), and have been shown to receive more playing time (Arietta et al., 2016), it is plausible that they may also sustain more injuries than their relatively younger peers. Depending on the nature of the injury, Q1 athletes may drop out of the sport prematurely, thereby providing more opportunities for Q2 athletes to succeed.

Given the findings of Hancock (2017), it is not surprising that the Q2 phenomenon is more evident among the female basketball student-athletes in this study. Delorme et al. (2009) suggested that female athletes may drop out of sport during early development because of gender identity issues. Females who are strong and athletic may not fit societal stereotypes of femininity, causing young female athletes to drop out of sport. Thus, as Q1 athletes who are more developed drop out at earlier stages of their development, this leaves a gap to be filled by Q2 athletes.

Despite approximately two thirds of male U Sports basketball student-athletes being delayed, the birth distributions of this group were not significantly different from what was expected. Male athletes appeared to be approximately two times more likely than female athletes to be delayed, with a little over one third of female athletes categorized as delayed. Chittle et al. (2018a) found that among all U Sports athletes, males were 4.17 times more likely to be delayed than females. Similarly, Chittle et al. (2016) found NCAA Division I male basketball players more likely than female players to be delayed. According to Bassok and Reardon (2013), boys were twice as likely to be delayed from commencing kindergarten than girls. Moreover, these authors found that parents' decisions to hold back their children may be more dependent on relative age and physical development than cognitive or behavioral development. At the high school level, Brady and Allingham (2010) found that male students were more than twice as likely to take a 'victory lap' (i.e., a fifth year) of high school as their female counterparts. The most notable reasons for pursuing an extra year of high school were to participate in extracurricular activities (sports) and a perceived lack of maturity to enter university. Thus, the comparatively high number of delayed male student-athletes in our study may also be attributed to late entry into elementary school or an extra year of maturation in high school.

According to Dixon et al. (2013), student-athletes can be delayed for several reasons, including: redshirting and sitting out a year, failing a year of school, sitting out after transferring schools, or in some cases, purposely delaying entrance to university. Although intentionally delaying a year could be beneficial for student-athletes who are negatively affected by RAEs, such as those who are relatively younger, delaying can have long-term impacts. For example, Eide and Goldhaber (2005) highlighted that students who are delayed may miss out on opportunities for future employment and potential lost wages over the course of their careers. In contrast, former student-athletes are perceived as being more marketable (Chalfin et al., 2014), experience higher career satisfaction (Sauer et al., 2013), and earn more, on average, than their nonathlete colleagues (Henderson et al., 2016; Long & Caudill, 1991; Sauer et al., 2013).

One potential explanation for why female and male student-athletes in our study were delayed may be a result of U Sports transfer rules in place at the time the data were obtained for this study. As of the 2014-15 season, U Sports implemented an eligibility repatriation rule which allowed student-athletes transferring from a non-U Sports institution the opportunity to compete immediately, without having to sit out a year (U Sports, 2018a). Prior to this policy change, student-athletes who transferred from the NCAA or other Canadian post-secondary schools were required to redshirt for a year, thereby delaying their athletic eligibilities. Since our data include athletes who competed prior to the 2014-15 season, the number of delayed athletes in our sample may be comparatively higher than witnessed today.

Contrary to other studies that have analyzed how AT influences RAEs patterns (e.g., Chittle et al., 2018b; Glamser & Marciani, 1992), and in alignment with Dixon et al. (2013), female student-athletes displayed slight RAEs trends in the overall samples. However, once AT was accounted for, RAEs became more evident among the on-time female and male student-athletes, and the proportion of female and male student-athletes born in Q4 was lower in comparison to the overall samples. This finding suggests that even though RAEs may be evident in the overall female population, AT still moderates RAEs and magnifies the effect among on-time student-athletes.

Limitations

One of the limitations to this study was the inability to analyze data from all student-athletes due to missing eligibility information. Consequently, the results of this study may not fully represent the student-athletes in the eight-year span that we examined. Secondly, by limiting the study to Canadian student-athletes, international student-athletes (6.79%) were not considered. The different sport structures and policies that exist across countries may result in differences in RAEs patterns. Moreover, it is possible that elementary school entrance ages may have changed throughout the time span that the student-athletes in our study began school. This may also cause the results to vary. Lastly, it was not possible to determine the reasons why student-athletes were delayed from the eligibility certificates. Such data would help determine if these delays were intentional or not, which could help researchers identify practical solutions to address RAEs.

Practical Implications

Policy changes that may limit the chronological ages of student-athletes and/or the number of years that athletes can be delayed and remain eligible to compete in interuniversity sport may prove beneficial in reducing the disparities among student-athletes. For example, in the 2014-15 football season U Sports implemented an age restriction policy in football that prevented student-athletes from being over the age of 25 to help mitigate these developmental inequities (U Sports, 2018). As basketball continues to grow at the interuniversity level in Canada, similar policy changes may be warranted in order to reduce the potential disparities in maturity between the oldest and youngest athletes on a team. One option could be to loosen restrictive policies that currently limit Canadian athletes to receiving maximum athletic awards equal to the value of their tuition and compulsory fees (U Sports, 2018b). In contrast, the NCAA allows institutions to provide student-athletes with ‘full-ride’ athletic scholarships, which include tuition, compulsory fees, room, board, and course-related books (NCAA, 2019b). Moving forward, policy changes regarding the value of athletic awards in U Sports could help retain talented Canadian athletes from pursuing options in the NCAA and potentially reduce the number of delayed student-athletes in U Sports basketball. However, such policy changes may increase competition among athletes within U Sports leading to strengthened RAEs. It is possible that the interuniversity system, in its current structure, has mitigated issues associated with relative age by permitting athletes to delay their participation. This may be evidenced by the fact that no RAEs were found among the overall sample of student-athletes in multiple years.

Future Research

Little is known about the implications of RAEs and AT on the athletic performances of interuniversity student-athletes. Thus, it would be beneficial to know if athletes in the first half of the year perform at differing levels (e.g., better performance metrics) than athletes in the latter half of the year. As evidenced by Fumarco et al. (2017), relatively younger athletes may not always be

disadvantaged by RAEs when they reach the most elite levels of sport. Moreover, research that focuses on performance measures among athletes born in each quartile could provide the basis for quartile-specific training for athletes, depending on their level of development. It would be advantageous to study the various reasons that athletes are delayed (e.g., redshirting, failing a year of school, and transfer habits) upon entering post-secondary school. Lastly, considering that our data were from student-athletes who competed prior to the implementation of the eligibility repatriation transfer rule by U Sports in 2014-15, future directions could also include replicating this study with post-2014-15 data to see if this policy change has helped mitigate the number of delayed student-athletes.

Conclusion

Through studying eight consecutive years of U Sports basketball student-athletes, we uncovered some consistent trends. Specifically, RAEs were evident to a small degree among the overall population of males and females and was magnified among the on-time student-athletes. The consistency of RAEs throughout this time period suggests that the effects have not been reduced, and on-time athletes who are born in the first half of the year are more likely to be advantaged in reaching the interuniversity level. Due to the unique nature of interuniversity sport, which allows student-athletes the freedom to delay their athletic eligibilities, student-athletes who are relatively older than others may gain an advantage over their relatively younger peers (Chittle et al., 2018a). This research provides insight for athletic leaders in post-secondary institutions regarding the advantages afforded to relatively older student-athletes and may provide guidance in mitigating RAEs for future generations.

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