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Abstract

The present study investigated birthdate (known as the Relative Age Effect; RAE) and birthplace as determinants of expertise in an international sample of elite ice hockey players. The sample included 566 World Junior (WJR) ice hockey players from four countries (Canada, $n = 153$; USA, $n = 136$; Sweden, $n = 140$; Finland, $n = 137$). Participants competed in the International Ice Hockey Federation World U20 Championship between 2001 and 2009. A series of Poisson regression models were conducted to examine the consistency of direct then interactive relationships between both birthdate and birthplace and WJR membership across the four countries (Canada, USA, Sweden, and Finland). Findings revealed a consistent RAE across the four countries for World Junior participation from 2000 to 2009. WJR players from the four countries were also less likely to be from major cities. In addition, there was no evidence in any of the four countries of an interaction between RAE and birthplace. Future research should explore the contextual and cultural factors that influence elite athlete development in smaller towns, cities and communities.

Keywords: *Elite athlete development, expertise, relative age effect, community size*

Introduction

For decades, individuals have been intrigued with understanding how an individual's early environment contributes to the attainment of success. In the realm of sport, researchers have attempted to identify if the size of a young athlete's birthplace can serve as a potential predictor of success in sport. Sport research in this area dates back to the late 1960s when Rooney (1969) uncovered geographical links between birthplace and participation in college football.

Curtis and Birch (1987) are credited as being influential on the emergence of research examining links between birthplace and athlete success. This team of investigators empirically examined the predictor of birthplace in the sport of ice hockey, investigating the size of community of origin in a sample of Canadian and US Olympic ice hockey players and Canadian professional players. They reported a curvilinear relationship between size of community of origin and being an elite athlete. Canadian players were found to be underrepresented in communities of less than 1000 inhabitants and in communities with over 500,000 inhabitants.

Shortly after the work of Curtis and Birch (1987), Carlson (1988) qualitatively explored socialisation into elite sport. Based on interviews with Swedish elite tennis players, Carlson suggested that rural areas were more fertile than urban areas in promoting elite athlete development. While rural communities were perceived to offer fewer organised sport opportunities, the athletes from rural communities reported greater access to facilities and increased opportunities for play and practice.

Since the seminal work of Curtis and Birch (1987) and Carlson (1988), researchers in a number of countries (Australia, Canada, Israel, Germany, United Kingdom, USA) have explored the size of an athlete's early developmental environment as a predictor of expertise in sport (Abernethy & Farrow, 2005; Baker & Logan, 2007; Baker, Schorer, Cobley,

Schimmer, & Wattie, 2009; Côté, MacDonald, Baker, & Abernethy, 2006; Fraser-Thomas, Côté, & MacDonald, 2010; Lidor, Côté, Arnon, Zeev, & Cohen-Maoz, 2010; MacDonald, Cheung, Côté, & Abernethy, 2009; MacDonald, King, Côté, & Abernethy, 2009; Schorer, Baker, Lotz, & Büsch, 2010). This research examined professional and amateur athletes from a number of sports including American football, basketball, baseball, golf, handball, ice hockey, soccer, swimming and volleyball as well as Olympic level athletes from summer and winter games. While the bulk of the research has sampled adult, male elite athletes, recent studies have investigated female elite athletes (Baker et al., 2009; Fraser-Thomas et al., 2010; MacDonald et al., 2009b) and adolescent athlete samples (Baker & Logan, 2007; Fraser-Thomas et al., 2010; Schorer et al., 2010). In general, there is growing evidence to indicate that elite athletes are less likely to come from communities that are too small (< 1000 inhabitants) or too large (> 500,000 inhabitants) (Côté et al., 2006; MacDonald et al., 2009a). However, discrepancies have been noted in terms of the optimal size of the early developmental environment for athletes in different sports and countries. In addition, the mechanisms attributed to smaller communities have been largely speculative in nature.

Most frequently, the community size of an athlete's birthplace has served as the proxy for the location in which the young athlete was introduced to sport and spent their developmental years (Carlson, 1988; Côté et al., 2006; Curtis & Birch, 1987). It is important to acknowledge that birthplace does not always coincide with the place of development and that athletes may migrate between locations. For example, athletes born in small rural communities may move to larger urban centres during their childhood. This point was recently raised by Schorer and colleagues (2010) who suggested that the place of an athlete's first club team may be a more appropriate proxy. However, previous research supports the use of birthplace as a meaningful proxy for early developmental context. Using a subsample of elite athletes, minimal migration was reported between communities during the players' developmental years (ages 10–14 years) (Carlson, 1988; Curtis & Birch, 1987). In addition, US census data suggests that minimal net migration changes exist between metropolitan (areas surrounding large and densely populated cities) and non-metropolitan areas in the census of 1980, 1990, and 2000 (Schachter, Franklin, & Perry, 2003). Therefore, despite possible movement of athletes between cities of different sizes during their early development, one can argue that birthplace is a reliable proxy for assessing a child's place of development and socialisation into sport.

In addition to the growing body of literature on birthplace, researchers have established a consistent relationship between an individual's month of birth relative to their peers and attainment of expertise (see Cobley, Wattie, Baker, & McKenna (2009) and Musch & Grondin (2001) for reviews). This phenomenon is known as the Relative Age Effect (RAE) and has been the subject of a significant amount of research over the past 25 years. RAE has been reported in a range of sports (e.g., ice hockey, soccer, baseball) and found to be prevalent in sports with age-grouped cohorts (Cobley et al., 2009; Musch & Grondin, 2001). For example, in ice hockey, age groupings are typically based on the calendar year of January to December. Study results consistently show that athletes born in the first three months of the year (January–March) are overrepresented compared to athletes born in the remaining months of the year (Barnsley & Thompson, 1988; Cobley et al., 2009; Sherar, Bruner, Munroe-Chandler, & Baxter-Jones, 2007). Similarly, RAE has been reported for young athletes born early in the selection year for such sports as soccer, swimming, and tennis (Baxter-Jones & Helms, 1994; Brewer, Balsom, & Davis, 1995). Despite the substantial body of research reporting RAE in sport, it is important to acknowledge that there have been a small number of studies which have reported no RAE (MacDonald et al., 2009a; Schorer et al., 2010) or an opposite trend (Ste-Marie, Starkes, & Cronin, 2000).

RAE in sport has primarily been attributed to differences in maturity between young athletes. It has been suggested that the maturational differences between older and younger athletes are a function of the chronologically older athletes (i.e., athletes born early in the selection year) being mistaken as "more talented" or "more promising" when in fact they may simply be more mature than their younger counterparts (Helsen, Starkes, & Van Winckel, 1998; Helsen, Van Winckel, & Williams, 2005). Athletes born early in the year may be almost a full year older than their peers and benefit from physical and cognitive developmental advantages compared to athletes born later in the selection year (Bisanz, Morrison, & Dunn, 1995; Delorme & Raspaud, 2009). The misidentification of physically larger youth being more talented results in these athletes receiving more attention from coaches during practice and being given more opportunities to play during games (Delorme & Raspaud, 2009; Helsen et al., 1998; Sherar, Baxter-Jones, Faulkner, & Russell, 2007). Collectively, these factors result in a pattern which allows the relatively older athletes to develop better skills than younger athletes and therefore be more likely to be selected for higher levels of competition during development (Delorme, Boiché & Raspaud, 2010a; Sherar et al., 2007a).

This misidentification process can serve as a ''spring-board'' for future success in sport for the relatively older athlete (Ward & Williams, 2003). In addition, this pattern of selection has been found to contribute to an increase in the number of dropouts for athletes born late in the selection year (Barnsley & Thompson, 1988; Helsen et al., 1998). For example in the sport of soccer, from the age of 12 years on, higher numbers of dropouts have been reported for those players born toward the end of the selection year (Helsen et al., 1998). In a more recent study, Delorme, Boiché, and Raspaud (2010b) showed that soccer participants in age groups as young as seven years of age followed a biased distribution similar to RAEs. The Delorme et al. 2010b findings imply that athletes ''self-select'' themselves into sports that favour their development early on. Additionally, athletes born later in the year may subsequently dropout of the sport if they consider themselves physically inferior to their peers. The implications of these findings suggest that RAEs are potentially more complex than originally thought and require additional research to understand how they interact at a young age and affect long-term participation in sport.

Collectively, birthplace and RAE are linked to the attainment of expertise in sport. However, it is unclear if birthplace and RAE interact and create a synergistic effect in helping athletes outperform others. Support for the exploration of the interaction between birthplace and RAE can be drawn from theory and a previous attempt to examine this interaction. Bronfenbrenner's (1979) bioecological theory of human development suggests that an individual's development will be strongly influenced by individual (i.e., birthdate) and environmental (i.e., birthplace) factors. Building upon this supposition, Côté and colleagues (2006) investigated if birthplace and RAE were independent from each other in predicting elite performance in sport in a sample of professional ice hockey (National Hockey League; NHL), basketball (National Basketball Association; NBA), baseball (Major League Baseball; MLB), and golf (Professional Golf Association; PGA) male athletes. Chi-square analysis revealed that city size did not moderate any relative age effects indicating that the effect of birthplace and birthdates on expertise are independent of each other. Given this theoretical underpinning and the limited existing evidence, it is important to investigate if and how the concepts interact.

Therefore, the purpose of this study was to extend previous literature and investigate RAE and birthplace as determinants of expertise in an international sample of elite ice hockey players. We used recent participants in the International Ice Hockey Federation (IIHF) World U20 Championship (commonly referred to as the "World Junior Hockey Championship") as a sampling frame. Players from four

countries (Canada, USA, Sweden, and Finland) constituted the study sample. In doing so, our specific objectives were to examine: (1) the relationship between birthdate and World Junior (WJR) membership, (2) the relationship between birthplace and WJR membership, and (3) the potential interaction between birthdate and birthplace and WJR membership, across the four countries. Based upon previous research in sport expertise (Cobley et al., 2009; Côté et al., 2006) and Bronfenbrenner's (1979) developmental theory, it is hypothesised that: (1) RAE will be present in WJR players from Canada, USA, Sweden and Finland, (2) WJR players will be more likely to be born in communities of <500,000 inhabitants, and (3) there will be an interaction between birthdate and birthplace in predicting WJR players across the four countries.

Methods

Participants

The sample included 566 WJR hockey players from four countries (Canada, $n = 153$; USA, $n = 136$; Sweden, $n = 140$; Finland, $n = 137$). Since its inception in 1977, the IIHF World U20 Championship has become a prestigious elite international tournament featuring the top junior hockey players from around the world. Each participant had competed in one or more of the IIHF World U20 Championships between 2001 and 2009. Demographic information for the participants including player names and date of birth were collected from the official WJR hockey website (http://www.iihf. com/iihf-home/history/past-tournaments.html; www. iihf.com). Based on this information, birthplace data for each participant were obtained and validated from related websites (www.eurohockey.net; www. hockeydb.com; www.nhl.com). The population size of each participant's birthplace was then retrieved from one of four population database websites (http:// www.columbiagazetteer.org, www.world-gazetteer. com, citypopulation.de/index.html, www12.statcan. ca/english/Profil/PlaceSearchForm1.cfm).

In total, 601 players from four countries were initially identified from the official WJR hockey website as being a past participant of a IIHF World U20 Championship from 2001–2009. However, population size information was not available for 24 of the birthplaces listed for participants on the WJR website (14-Sweden, 7-Finland, and 3-USA). Consequently, demographic information was collected for 577 of the 601 WJR players. Inspection of the data revealed that 11 athletes (5-Sweden, 4-Finland, and 2-USA) were born outside of their country of representation and were excluded from the analyses. A total of 566 of the 601 (94.1%) 2001–2009 WJR

players from Canada (100%), USA (96.4%), Sweden (88.1%), and Finland (92.6%) were included in the analysis.

Procedure

To evaluate the birthplace effect, the birthplaces of the WJR players were compared with a distribution of males in the general population using census data. The Census Bureaus of the countries of interest were contacted to obtain information about the country's demographic makeup. Specifically, a distribution of seven- to nine-year-old males from the 1990 or 1991 census (Canada-1991, USA-1990, Sweden-1990, Finland-1990) were obtained and these distributions were used to develop estimates of population counts to be used as denominators (offsets) in later regression analyses. At the study's onset, WJR participants from six countries (Canada, USA, Sweden, Finland, Russia and Czech Republic) were initially examined for possible inclusion in the study. However, due to insufficient census data being available, two countries (Czech Republic & Russia) were removed from the analysis. Males seven to nine years of age were selected as they were representative of the participants' early developmental years in minor hockey. To permit comparison between countries, the distribution of males was further segmented into five community size categories: (1) $<10,000$, (2) 10,000 to $<30,000$, (3) 30,000 to $<100,000$, (4) 100,000 to $<500,000$, (5) $\geq 500,000$ based upon the population categories used in the census data from Canada and the other three countries. Similar to other studies investigating birthplace and athlete development (Carlson, 1988; Côté et al., 2006), the birthplace of the athletes was used as a proxy for the location in which the young athletes were introduced to sport and spent their developmental years.

To evaluate RAE, birthdates for all players were collected from the official WJR hockey website (http://www.iihf.com/iihf-home/history/past-tournaments.html). The birth month for each of the players was categorised into quarters (Q1 = January, February, March; Q2 = April, May, June; Q3 = July, August, September; Q4 = October, November, December) to reflect the calendar year of Canadian, US, Swedish and Finish hockey from January 1st to December 31st.

Statistical analysis

For each of the four countries in the study, we described the proportion of WJR players who were: 1) born in each of the four quarters of the year (January to March; April to June, July to September; October to December); 2) born in communities of varying sizes ($<10,000$; 10,000 to $<30,000$; 30,000 to $<100,000$; 100,000 to $<500,000$; $\geq 500,000$). Chi-Square analyses were conducted to examine variations of these proportions across the countries. Next, a series of Poisson regressions models were created within countries to estimate the effect of both birth quarter and community size on the likelihood of being named to each respective WJR team. Estimates of the total number of live births for males with the same birth years as the WJR participants were estimated based upon census data in each country. The latter estimates were employed as offsets in the Poisson regression models. Results are presented as adjusted relative risks, 95% confidence intervals, and associated tests for linear trend.

The final step in the analysis was to examine the interaction between birthdate (birth half, as cell sizes precluded using birth quarters in the interaction terms) and birthplace (the five categories of community size) as determinants of WJR participation. This was done by including an interaction term in each country specific Poisson Regression model. All analyses were conducted using SAS Version 9.1.3.

Results

Birthdate and birthplace

Table I provides a comparison of birthdates (quarter) and birthplaces (community size) among players who represented each of four countries in the IIHF World U20 Championship for the years 2001–2009. In each of the four countries, the largest percentages of players were born in the first half of the year (January through June), consistent with expectations. This effect was observable in all countries: Canada (66.6%), USA (68.4%), Sweden (65.0%), and Finland (64.2%).

Similar analyses are also presented for the size of communities where these players were born. Statistically significant ($P < 0.001$) differences can be observed in the player distributions across the countries (Table I). To illustrate, in Canada the largest percentages were observed for players born in community sizes of less than 10,000 and between 100,000 to 500,000 while in Finland, players mainly come from communities of 30,000 to 500,000.

The effects of both birthdate and birthplace on participation in the IIHF World U20 Championship obtained from a multiple Poisson regression model are summarised further in Table II. In each of the four countries, consistent effects were observed in association with the first two birth quarters of the year. Across all countries in the study, players born between January and March were approximately 2- to 3-fold more likely to be selected to play for their country. Effects associated with birthplace were less consistent. In Canada, players from communities of 100,000 to $<500,000$ were 1.6-fold more likely to

Table I. World junior hockey players 2001-2009 in four countries, by birth quarter and size of community.

| | Country | | | | | | | | | | | | | | | | | |
| | Canada | | | | USA | | | | Sweden | | | | Finland | | | | |
	No.	(%)	Offset	Pop %	No.	(%)	Offset	Pop %	No.	(%)	Offset	Pop %	No.	(%)	Offset	Pop %	P-value
Birth quarter (Birth year 1981 to 1991)																	
Q1 (Jan to Mar)	51	(33.3)	1265887		59	(43.4)	8535318		53	(37.9)	320190		44	(32.1)	219462		0.11
Q2 (Apr to Jun)	51	(33.3)	1384037		34	(25.0)	9331947		38	(27.1)	350074		44	(32.1)	239946		0.30
Q3 (Jul to Sept)	28	(18.3)	1362411		24	(17.7)	9186136		25	(17.9)	344604		31	(22.6)	236196		0.56
Q4 (Oct to Dec)	23	(15.0)	1262195		19	(14.0)	8510423		24	(17.1)	319256		18	(13.1)	218822		0.86
Community size (1000s) (1991)																	
<10	40	(26.1)	1634013	31.0	22	(16.2)	8088876	22.8	32	(22.9)	75987	5.7	14	(10.2)	306297	33.5	0.04
10 to <30	22	(14.3)	820908	15.5	20	(14.7)	6972417	19.6	25	(17.9)	410616	30.8	22	(16.1)	253152	27.7	0.40
30 to <100	24	(15.7)	1038015	19.7	40	(29.4)	8297721	23.3	50	(35.7)	532845	39.9	43	(31.4)	169317	18.5	<0.001
100 to <500	40	(26.1)	1011177	19.2	36	(26.5)	6656409	18.7	11	(7.9)	232353	17.4	58	(42.3)	185661	20.3	<0.001
≥500	27	(17.6)	770418	14.6	18	(13.2)	5548401	15.6	22	(15.7)	82323	6.2	0	(0.0)	0	0	<0.001

Table II. Results of Poisson regression describing potential determinants of world junior hockey team membership in Canada, USA, Sweden, Finland 2001–09.

| | Canada | | USA | | Sweden | | Finland | |
	RR	(95% CI)	RR	(95% CI)	RR	(95% CI)	RR	(95% CI)
Birth quarter (Birth year 1981 to 1991)								
Q1 (Jan to Mar)	2.21	(1.35 to 3.61)	3.10	(1.85 to 5.19)	2.20	(1.36 to 3.56)	2.10	(1.20 to 3.69)
Q2 (Apr to Jun)	2.02	(1.24 to 3.31)	1.63	(0.93 to 2.86)	1.44	(0.87 to 2.41)	2.23	(1.29 to 3.86)
Q3 (Jul to Sept)	1.17	(0.68 to 2.02)	1.18	(0.65 to 2.16)	0.96	(0.55 to 1.69)	1.60	(0.89 to 2.85)
Q4 (Oct to Dec)	1.00		1.00		1.00		1.00	
P (trend)	0.001		<0.001		<0.001		0.01	
Community size (1000s) (1991)								
<10	1.00		1.00		1.00		1.00	
10 to <30	1.14	(0.68 to 1.91)	1.05	(0.58 to 1.93)	0.14	(0.09 to 0.24)	4.98	(2.61 to 9.51)
30 to <100	0.94	(0.57 to 1.57)	1.77	(1.05 to 2.98)	0.22	(0.14 to 0.35)	1.67	(0.82 to 3.39)
100 to <500	1.62	(1.04 to 2.51)	1.99	(1.17 to 3.38)	0.11	(0.06 to 0.22)	1.76	(0.89 to 3.50)
≥500	1.43	(0.88 to 2.33)	1.19	(0.64 to 2.22)	0.63	(0.41 to 0.99)	0.43	
P (trend)	0.05		0.08		0.15		0.43	

play for their country than players from the smallest (<10,000). In the USA, effects of a similar magnitude were observed for players in the 30,000 to <100,000 and 100,000 to <500,000 size communities. In contrast, players from Sweden were much more likely to come from small (<10,000) communities, and selected players from Finland were more likely to emerge from communities of 10,000 to <30,000.

Interactions between birthdate and birthplace

In order to test the hypothesis that birthdates and birthplace may interact to influence player selection, we further examined these two factors in a series of Poisson regression models. Although we continued to observe main effects, there was no evidence of an interaction existing between the two potential determinants of WJR membership (all *P* values > 0.20; see Table III).

Discussion

There are three main findings to this study. First, we observed a consistent RAE across the four countries for WJR participation from 2001 to 2009. Second, there was a general trend toward WJR players from the four countries not being from large cities. Third, there was no evidence of an interaction between RAE and birthplace in any of the four countries.

The consistent birthdate effect across the four countries including the two Scandinavian countries (Sweden, Finland) supports the study hypothesis and previous reviews (Cobley et al., 2009) observing RAE in a number of sports and countries predominantly in North America. The birthplace findings are consistent with the study's second hypothesis and support previous research indicating a curvilinear relationship between community size and expertise in junior and professional hockey players (Côté et al., 2006). In Canada and the USA, smaller city effects (100,000 to 500,000 residents) were reported while in the two Scandinavian countries, there were

pronounced small town effects; Swedish WJR players were more likely to be from a community size of <10,000 while Finish WJR players were more likely to come from a community size of 10,000 to 30,000. These findings are in support of common assumptions by the sport media about elite athlete development in hockey and examined two decades ago by Curtis and Birch (1987). While Curtis and Birch did not find empirical evidence to support the notion of a "small town effect" in hockey, this study did so for the countries of Sweden and Finland.

The inconsistency in the birthplace findings begs the question of why is there overrepresentation of elite young athletes from smaller towns in the two Scandinavian countries and not the two North American countries. One possible explanation to account for the inconsistent findings is the culture of sport and athlete development in Sweden and Finland. Carlson's (1988) study in Sweden suggested that smaller, more rural communities afforded greater opportunities for elite athlete development. Given that Carlson's sample of elite athletes were from a different sport (tennis), further research is necessary to delve into what early contextual and cultural factors in the small towns in Sweden and Finland are contributing to the elite development of WJR ice hockey players. Similarly, it is important to examine what early contextual and cultural factors in smaller cities in North America are contributing to elite hockey player development.

An important consideration in attempting to better understand the role of context and culture is the integration of theory into future athlete development research. Despite the increasing attention of birthplace in the literature, few attempts have been made to theoretically examine the phenomenon and the underlying mechanisms associated with smaller cities and towns being associated with expertise development. One of the first attempts to integrate theory into birthplace research was Carlson (1988), who used Bronfenbrenner's "bioecological model of development" (Bronfenbrenner, 1979) to investigate the role of the environment in athlete development. Bronfenbrenner espoused that development results from the constant interaction between the individual and his or her environment. Surprisingly, minimal research has built upon Carlson's work and used Bronfenbrenner's framework in the area of birthplace and expertise.

A second theory which may significantly contribute to our understanding of the birthplace effect is Barker's "theory of behaviour settings" (Barker, 1978). Barker's theory proposes that the number of people in a behaviour setting will influence an individual's behaviour. Barker suggests that situations with fewer (i.e., undermanned) or more than (i.e., overmanned) the optimal number of participants needed to

Table III. Results of Poisson regression examining potential interactions between birth month (2 categories) and community size (4 or 5 categories) as determinants of membership on the world junior team – 4 country analysis.

	No. of categories		
Country	Birth month categories	Community size	*P*-value (interaction)
Canada	2	5	0.944
USA	2	5	0.950
Sweden	2	5	0.845
Finland	2	4	0.228

complete a task will result in different experiences for individuals involved. In undermanned settings, individuals are reported to experience a greater number of roles in the setting, put forward greater effort, and report more frequent occurrences of success and failure (Barker, 1978). In the sport domain, it may be hypothesised that smaller settings such as smaller communities may be more likely to be undermanned and afford youth with greater developmental opportunities. However, the theory has not been applied in sport psychology and expertise research on athlete development. This awaits future research.

In light of Bronfenbrenner's claim about the interaction between the individual and his or her environment leading to optimal development, the third aim of the study was to examine the potential interaction between RAE and birthplace. This aim was a novel aspect of the study as minimal research has investigated the interaction. However, the study findings did not support the theoretically driven hypothesis that there would be an interaction between RAE and birthplace. The results supported previous research (Côté et al., 2006) that RAE and birthplace are independent predictors of athlete development and sport expertise. Quite simply, why didn't athletes born early in the birth year who were also born in smaller communities have a greater likelihood of obtaining expertise? Drawing upon Barker's theory, it may be possible that smaller cities represent ''undermanned'' settings that create developmental conditions that are beneficial to all athletes independent of their relative age. From this perspective, smaller cities would provide an environment in which competition for spots on select teams is reduced because of the smaller number of athletes available, therefore, diminishing the need to select athletes based on their skill and maturation levels. Consequently, relative age effects may be reduced or even removed in smaller cities. This hypothesis needs to be tested directly with further research, however, it provides support for the ''maturation-competition'' hypothesis consistently put forward to explain relative age.

The study findings should be viewed within the context of its limitations. Although, it was considered that the use of census data for male youth from the four different countries was a strength of the study, it is also a possible limiting factor because the census data did not disclose the number of youth hockey registrations for each community size from each country. An examination of the minor hockey registration data may reveal an existing biased distribution within the population which may impact the analysis and conclusions draw from the research. If possible, future research in RAE and birthplace should consider using athlete registration data for the different community sizes from different countries as an optimal source of reference data (Delorme, Boiché,

& Raspaud, 2010a). A second limitation was the use of birthplace as a proxy for an athlete's place of development. While previous research (Carlson, 1988) has found birthplace to be a reliable proxy for developmental context, further research would benefit from a replication of the study with a more detailed account of each elite athlete's place of residence during development. A third limitation was that the study design precluded offering any definitive explanations for the study findings on RAE and birthplace across the four cultures. Additional research is necessary to investigate the mechanisms contributing to RAE and birthplace in different cultures and contexts.

Conclusion

The present study examined RAE and birthplace as independent and synergistic predictors of expertise in an international sample of elite ice hockey players. The results supported RAE across the four countries and offered support for smaller cities and towns promoting elite athlete development for ice hockey players from North American and Scandinavian countries. It was also found that birthdate (RAE) and birthplace were independent predictors of expertise. Given the independent effect of birthplace on expertise and the central role of sport in smaller centres (Tonts, 2005), a greater understanding of the contextual and cultural influences is necessary to inform elite athlete development.

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