Relative age effect on elite tennis strategy

Peter O'Donoghue

Cardiff School of Sport, Cardiff Metropolitan University, Cyncoed Campus, Cardiff, CF23 6XD, UK.

Abstract

Relative age influences participation in professional tennis. The purpose of the current investigation was to compare the %net points played between players born in the first 6 months of the calendar year (H1 players) and players born in the second 6 months (H2 players). There were 116 players included in the current investigation because net statistics were provided for at least 6 of their matches in the 2011 to 2013 US Opens and the 2012 to 2014 Australian Opens. Players were also classified by generation; born before 1st January 1985 or after due to the introduction of surface grading in 2002. The %net points for male players was significantly influenced by generation (p = 0.041) and the interaction of generation and half year of birth (p = 0.040). The 17 H1 male players born in 1985 or later played 12.1±2.5% net points compared with 10.4±2.8% for the 16 H2 male players born in 1985 or later. The H1 players may have developed a greater tendency to go to the net as junior players with a relative age advantage. These players have continued to play more net points as seniors even though they no longer have a relative age advantage.

Key words: net strategy, reliability, stabilisation, surface grading.

1. Introduction

Relative age results from the grouping of young athletes into age bands using cut-off dates. For example, the ITF (International Tennis Federation) uses a cut-off date of January 1st meaning that athletes born in January will be the oldest in their age group while athletes born in December will be the youngest. Therefore, a cohort of players in tennis will be players born between 1st January and 31st December in a given calendar year. During junior years, older players within cohorts are believed to have a relative age advantage over their younger counterparts. They have greater physical, social and cognitive development over younger players. This may lead to younger players within cohorts withdrawing from a sport prior to becoming a senior player. This may be due to a perception that younger players are less talented by coaches, selectors and the players themselves. A higher withdrawal rate by younger players within cohorts than by older players will eventually be reflected in an uneven distribution of birth months for senior players. Cobley *et al*. (2009) did a meta-analysis of 38 studies of relative age in sport published between 1984 and 2007. This found a consistent relative age effect on sports participation with higher numbers of participants having been born in the first half of the junior competition year. The highest relative age effect was found in 15-18 year old age

groups for the most popular male sports. Two studies of soccer players found further evidence that the cut-off date used for age banding was responsible for the uneven distribution of senior players (Musch and Hay, 1999; Helsen *et al.*, 2000). When cut-off dates were altered, there was an eventual corresponding change in the birthdate distribution of senior professional players in Australia (Musch and Hay, 1999) and Belgium (Helsen *et al*., 2000).

Tennis uses a cut-off date for age banding of 1st January. Therefore, for the remainder of this paper, tennis players born between 1st January and 30th of June are referred to as H1 players while players born between 1st July and 31st December are referred to as H2 players. Relative age effect has been found in both junior (Dudink, 1994; Baxter-Jones, 1995) and senior tennis players (Edgar and O'Donoghue, 2005). Baxter-Jones (1995) found that 85% of elite British junior players were H1 players while Dudink (1994) found that about half of top ranked 12 to 16 year old Dutch players were born between 1st January and 31st March. Edgar and O'Donoghue (2005) analysed the birth month distribution of elite players who competed in 2002 and 2003. They counted elite junior players as those who had earned more than 120 ITF junior ranking points while elite senior players were those who had played in the first round or later in a singles event at one or more Grand Slam tennis tournaments. The percentage of junior females who were H1 players was 55.5% compared to 60.6% for the senior females. By contrast, the percentage of junior male players who were H1 players was 63.2% which was higher than the 57.4% of senior males. This was interpreted as relative age effect being more physical for the males and more psychological for the females. The male players born in the second half of the year no longer had a relative age disadvantage as seniors and are better represented at the elite level.

There is also evidence that the performance of junior H2 male players improved as they got older (O'Donoghue, 2009). Specifically, the median ITF junior World ranking of a set of H2 junior male players rose significantly from 1525th to 1295th from 2004 to 2005 while there was a slight drop from 1345th to 1355th for the median H1 junior male player over the same period. A similar pattern has also been observed in senior female players. While the percentage of H2 female players decreased from junior to senior ranks, the H2 female players who remained in the sport enjoyed a greater improvement in senior Grand Slam singles participation from 2006 to 2009 than the H1 players (O'Donoghue, 2009). O'Donoghue (2009) monitored the progress of 86 H1 and 56 H2 female players born in 1985 or after who had competed in at least one Grand Slam singles tournament between 2006 and 2009. In 2006 the H1 players competed in 1.33 of the 4 Grand Slam singles tournaments which was greater than the 1.16 tournaments for the H2 players. However, in 2009, the 2.50 Grand Slam singles tournaments that the H2 players competed in was significantly greater than the 1.99 tournaments that the H1 players competed in.

Most research into relative age effect in sport has reported on the birth month distribution of participants (Dudink, 1991; Musch and Hay, 1999; Helsen, *et al.*, 2000; Simmons and Paull, 2001; Edgar and O'Donoghue, 2005). This typically involves reducing data from each player to two categorical variables; whether they are still competing in the sport and their month of birth. Some studies have included other variables such as junior age group (Joll and O'Donoghue, 2009) and place of birth (Côté *et al.*, 2006). However, these studies have not provided any detailed knowledge of the experiences of player born in

different parts of the junior competition. An interview study has provided some insight into the experiences of international netball players born in different halves of the academic year (Edwards and O'Donoghue, 2014). This found that player born later in the academic year experienced performance attrition motives and social attrition motives to a greater extent than player born in the first half of the academic year. However, there are still other research methods that have not been applied to the study of relative age effect. A general aim of the current investigation was to introduce sports performance analysis into the study of relative age in tennis. Junior players with a relative age advantage (or disadvantage) over their peers may apply tactics that are influenced by their physical size. The players may continue to use such tactics, which were developed when they were juniors, during their senior careers even though they no longer have a relative age advantage (or disadvantage) as a fully mature senior player. Sports performance analysis is an area of sports science used to investigate many aspects of actual sports performance including tactics and strategy (Hughes, 1998). There are various indicators of strategy in tennis including shot placement (Hughes and Clarke, 1995), service placement (Unierzyski and Wieczorek, 2004) and going to the net (O'Donoghue and Ingram, 2001). The percentage of points where players go to the net is an indicator of strategy that might be influenced by relative age. This is because taller players are more successful at the net than shorter players (USTA, 1995: 121) and so H1 junior players may go to the net more than H2 junior players. Therefore, the purpose of the current investigation is to compare the percentage of points where players go to the net in senior Grand Slam singles events between H1 and H2 players. This is an original approach to the study of relative age that can improve understanding of mechanisms leading to uneven birth month distributions of senior professional players.

2. Methods

2.1. Data sources

The current investigation used data from the US Open from 2011 to 2013 and the Australian Open from 2012 to 2014 which are played on similar surfaces. This was done to avoid surface effects on strategy having an impact on the percentage of net points played by any players who competed in more matches at the French Open or Wimbledon than at the other Grand Slam tournaments. The criteria for matches to be included in the study were that the match had to be from the first round to the final, the match had to be completed and the number of net points played had to be included in the match statistics provided on the official tournament internet sites (www.usopen.org; www.ausopen.org). There were 506 women's matches involving 182 players as well as 509 men's singles matches involving 199 players that satisfied these criteria. This meant that there were point frequency data for 1012 women's singles performances and 1018 men's singles performances because there were two player performances per match.

2.2. Variables

The percentage of net points

The number of net points played by a player during a match was expressed as a percentage of the total number of points in the match. A player was deemed to have played a net point if they entered either service box while the point was still live according to the rules of tennis.

Height
Height needed to be controlled for because taller players may go to the net more (USTA, 1995: 121).

Half year of birth
Half year of birth is a dichotomous variable grouping players into two groups; H1 if they were born between 1st January and 30th June and H2 if they were born between 1st July and 31st December.

Generation
Surface grading and the use of Type 1, 2, and 3 balls were introduced in professional tennis in 2002. The Type 2 ball is used at the Australian and US Open's. The Type 1 ball is faster and is used at the French Open while the Type 3 ball is 13% larger than the Type 2 ball and slows down more as it travels (Miller, 2006). This may have reduced differences in the nature of tennis between the four Grand Slam tournaments. Surface grading and using different balls may have caused tennis players to prepare differently for Grand Slam tournaments than players did prior to 2002. Therefore, players who were born on 1st January 1985 or after were considered differently to players born before this date. Players born on 1st January 1985 or after were aged 17 years or younger when surface grading was introduced in 2002 and are less likely to have played in senior Grand Slam tournaments prior to the introduction of surface grading than older players. The style of play, particularly at Wimbledon has changed due to the introduction of the Type 3 ball with fewer serve volley players (such as Goran Ivanisevic, Richard Krajicek, Cedric Pioline and Greg Rusedski) today than in the mid-1990s. While the scope of the current study is restricted to the Australian and US Open tournaments, the style of play used by successful players at Wimbledon prior to the introduction of the Type 3 ball might have impacted on the style those players used at other tournaments. Therefore, generation is used as a dichotomous factor in the current investigation; players are classified as being born before 1st January 1985 or on or after this date.

Gender
Given the different changes in percentage of H1 players between junior to senior ranks between female and male players (Edgar and O'Donoghue, 2005; O'Donoghue, 2009), it was decided to analyse female and male players separately. Thus the null hypothesis for the current investigation is that the percentage of net points is not influenced by generation, half year of birth or their interaction for female or male tennis players in the Australian and US Open tournaments.

2.3. Reliability

The official websites of the Grand Slam tennis tournaments (www.usopen.org; www.ausopen.org) provide a wealth of match statistics that can be analysed within performance analysis studies without the researcher needing to watch the matches.

However, it is necessary to ensure that the data provided on these websites are valid and reliable. The validity of the data is justified by their wide use in media coverage of Grand Slam tennis. The percentage of net points has been used as an indicator of strategy in other tennis studies (O'Donoghue and Ingram, 2001; O'Donoghue, 2003). A quasi-estimation of reliability was undertaken by comparing the percentage of net points played according to the official tournament internet sites with the percentage of net points recorded by the author during video observation. The author watched 40 sets from 9 women's singles matches and 48 sets from 9 men's singles matches from the Australian and US Open tournaments counting the number of points played and the number of points where each player went to the net. A player was deemed to have gone to the net when they enter either service box before the point has ended according to the rules of tennis. The point ends when a ball strikes the net, lands out or bounces twice without being retrieved by a player. Table 1 shows the reliability results using change in the mean, typical error (TE), standardised TE and intra-class correlation coefficient. The standardised TEs are interpreted as small disagreements between the internet data and the author's observation (Smith and Hopkins, 2011) while the intra-class correlation coefficients showed high levels of relative reliability.

Table 1. Reliability results.

Event	n	Video Observation (mean±SD)	Internet (mean±SD)	Change in the mean ± TE	Standardised TE	ICC
Women's singles	40	7.6±3.6	7.1±3.7	+0.5±1.0	0.27	0.931
Men's singles	48	11.5±5.1	11.8±5.6	-0.3±1.5	0.28	0.926

2.4. Players included

Sports performance data is unstable with performance indicators being influenced by many factors especially the style (Loffing, 2012; Tirp *et al*., 2014) and quality of the opponent (McGarry and Franks, 1994). Therefore, a player's performance is better understood if a performance indicator's value is derived from multiple matches rather than a single match (Hughes *et al*., 2001). It was necessary to decide on how many matches would be required for a player to be included in the study. Table 2 shows the number of players for whom different numbers of performances were included; the highest values were 37 for one of the male players and 36 for one of the female players. Setting the minimum number of matches for each player too low would result in data that were unrepresentative of players' typical performances. Setting the minimum number of matches for each player too high would reduce the number of players that could be included in the study. An exploratory analysis was done to determine how quickly a player's percentage of net points stabilised as performances were included. This was done for the 47 players who had played 12 or more matches. This combined with the data in Table 2 suggested that 6 matches per player would be an optimal number allowing 60 female and 56 male players to be included in the study and each player's data to be more representative of their typical value for the percentage of net points than if fewer matches were used. Each player's date of birth was recorded from the player profiles on the official tournament websites and the heights of female and male players were recorded from the official WTA (Women's Tennis Association) and ATP (Association of Tennis Professionals) websites respectively (www.atpworldtour.com; www.wtatennis.com).

Table 2. Number of players for whom different numbers of performances were recorded.

Gender	Number of matches per player										
	1	2	3	4	5	6	7	8	9	10+	Total
Women's singles	39	38	23	13	9	9	9	7	5	30	182
Men's singles	62	34	12	20	15	14	6	1	5	30	199
All	101	72	35	33	24	23	15	8	10	60	381

2.5. Statistical analysis

The z_{Skew} value was determined for each player's values for percentage of net points using the equation specified by Vincent (1999: pp.83). There were 8 of the players whose data were positively skewed ($z_{Skew} > +1.96$) to a greater extent than is considered tolerable (Vincent, 1999: 83) with the remaining players' values being within a tolerable range of skewness ($-1.96 \leq z_{Skew} \leq +1.96$). The typical value for a player's percentage of net points was set to the median of their values for the 8 players whose data were positively skewed with mean values being used for the remaining players. The net strategy of each of the 116 players was represented by their average (median or mean) value for percentage of net points.

There was no correlation between height and the average percentage of net points for female players ($r = -0.022$). However, there was a small positive correlation between height and the average percentage of net points for male players ($r = +0.317$). It was, therefore, decided to apply a two-way ANOVA to the female data but a two-way ANCOVA to the male data. Both tests including generation and half year of birth as between subjects effects with the ANCOVA applied to the male data also including height as a covariate.

A Kolmogorov Smirnov test revealed that the average percentage of net points played by female players was sufficiently normally distributed ($p = 0.062$). Levene's test revealed that there were no significant differences between the variances of female players of different generations or half years of birth ($p = 0.316$). The height adjusted average percentage of net points played by male players mildly violated the assumption of normality ($p = 0.030$) but the values that were not height adjusted severely violated the assumption ($p < 0.001$). There were similar variances between gender and half year of birth groups for the height adjusted values of average percentage of points players went to the net ($p = 0.793$). Given that height adjusted values were being analysed for the male players and the need to analyse the interaction of generation and half year of birth, the use of the ANCOVA test was justified.

3. Results

Table 3 shows the average percentage of net points. The mixed ANOVA revealed that the average percentage of net points for female players was not significantly influenced by generation ($F(1,56) = 2.8$, $p = 0.102$, partial $\eta^2 = 0.047$), half year of birth ($F(1,56) =$

0.2, p = 0.864, partial η^2 = 0.001) or their interaction (F(1,56) = 1.1, p = 0.308, partial η^2 = 0.019). The mixed ANCOVA revealed that the average percentage of net points for male players was significantly influenced by generation (F(1,51) = 4.4, p = 0.041, partial η^2 = 0.080) and the interaction of generation and half year of birth (F(1,51) = 4.4, p = 0.040, partial η^2 = 0.080). However, half year of birth had no significantly influence on the average percentage of net points for male players (F(1,51) = 0.3, p = 0.603, partial η^2 = 0.005).

Table 3. Percentage of points where players go to the net (mean±SD).

Generation	Half Year of birth		
	H1	H2	All
Women's singles			
Born before 1st Jan 1985	10.9±3.1 (n=10)	9.8±1.1 (n=5)	10.5±2.8 (n=15)
Born 1st Jan 1985 or after	8.5±2.8 (n=28)	9.3±2.6 (n=17)	8.8±2.7 (n=45)
All	9.2±3.1 (n=38)	9.4±2.4 (n=22)	9.2±2.8 (n=60)
Men's singles			
Born before 1st Jan 1985	11.7±5.2 (n=11)	13.1±2.9 (n=12)	12.4±4.1 (n=23)
Born 1st Jan 1985 or after	12.1±2.5 (n=17)	10.4±2.8 (n=16)	11.3±2.8 (n=33)
All	11.9±3.7 (n=28)	11.6±3.1 (n=28)	11.8±3.4 (n=56)

4. Discussion

This study included 60 female players and 56 male players who had completed 6 or more singles matches on courts where net statistics were recorded on the official tournament web sites at the Australian and US Open tournaments over a 3 year period. These players can, therefore, be considered to be successful professional tennis players. The study has found some evidence supporting previous findings that there is a greater attrition of H2 players than H1 players (Edgar and O'Donoghue, 2005). However, this only applied to the female players included in the current investigation. Female players may drop out of professional tennis before gaining the necessary Grand Slam experience to be included in a study such as the current one which requires multiple match data for each player. Relative age effect could be more psychological for female players than physical (Dudink, 1994).

The overall reduction in net points between generations agrees with observations of Grand Slam tennis performance before and after surface grading and the introduction of the Type 1 and Type 3 balls. Prior to surface grading, female and male players went to the net on 12.0% and 17.4% of points respectively (O'Donoghue and Ingram, 2001). Brown and O'Donoghue (2008) repeated O'Donoghue and Ingram's study using matches from the 2007 Grand Slam tournaments after the introduction of surface grading and the introduction of Type 1 and 3 balls. They found that the number of net points played by female and male players had reduced to 7.8% and 9.0% of points respectively. Generation did not have a significant influence on the percentage of net points played by female players because only 15 female players born before 1st January 1985 met the criteria for inclusion in the investigation. This reduced the observed power of the test of generation effect to 0.373.

There was no significant relative age effect on the percentage of points where female players went to net. This may be explained by female players not being as strong as their male counterparts which is evidenced by the greater ability of male players to win points on serve (Furlong, 1995; Verlinden *et al*., 2004; Brown and O'Donoghue, 2008).

The significant interaction between generation and half year of birth in men's singles tennis is the finding of the current investigation that has the greatest impact. Uneven birth month patterns have been observed in sport, but until now there has only been speculation about how relative age might influence performance. Prior to surface grading and the introduction of the Type 1 and 3 balls, it was beneficial for male players to go to the net at Wimbledon. Therefore, all players aspiring to progress to the later rounds of Wimbledon needed to be able to approach the net and play effectively there. These serve and volley players would have also competed at other Grand Slam tournaments resulting in the relative high number of net points played at all tournaments in the mid-1990s (O'Donoghue and Ingram, 2001). Since the introduction of surface grading and the Type 1 and 3 balls, there has been a reduction in net points played at Grand Slam tournaments (Brown and O'Donoghue, 2008) suggesting that players have more of a choice about whether to or not to adopt a strategy of approaching the net. It is the H1 players of the generation born on 1st January 1985 or after who go to the net noticeably more than H2 players of the same generation. The different strategies of the H1 and H2 players may have developed when they were juniors. The relative age advantage of the H1 players would have included physical advantages such as being taller. This could have encouraged the H1 players to go to the net more than the H2 players (USTA, 1995: 121). Despite being fully mature senior players during the matches analysed in the current investigation, these alternative strategies of the H1 and H2 players have persisted. This may be because the style of play used by a player is developed during junior years and the player habituates to using this style as a senior player. It should be noted that the interaction effect is small, accounting for 8% of the variance in the data. However, there are many factors that influence style of play, such as coaching philosophy, surfaces that players train and play on, participation in doubles, serving ability, volleying ability and the ability to play effective approach shots. Therefore, the small interactive effect between generation and half year of birth provides important evidence that relative age does influence style of play. Relative age is recognised as a secondary mechanism explaining achievement in sport (Wattie *et al*, 2007) and, therefore, it may be unrealistic to expect anything greater than a small effect.

In conclusion, the current investigation has shown that relative age in combination with generation has a small but significant effect on the percentage of net points played by male players. This is important initial evidence of relative age effect going beyond birth month distributions of players. However, because the investigation has focussed on senior player performance, longitudinal research is needed to investigate relative age effects on playing style of junior players and whether any such effects influence the style they adopt later as senior players. Further research should also consider other performance variables where physical maturity is relevant such as indicators related to serving. There are other sports where relative age effects have been found where sports performance analysis can allow a more detailed look at how relative age influences tactical and technical aspects of performance. Future research of this kind will benefit our understanding of relative age effect in sport.

5. Acknowledgement

The author would like to thank Zsófia Csomor who collected the web data used in the current investigation.

6. References

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

Brown, E. and O'Donoghue, P.G. (2008), Gender and Surface effect on elite tennis strategy, **Coaching and Sports Science Review**, Valencia: ITF, Issue 46, December 2008, pp. 9-11.

Cobley, S., Baker, J., Wattie, N. and McKenna, J. (2009). Annual age-grouping and athlete development: a meta-analytical review of relative age effects in sport. **Sports Medicine**, 39(3), 235-256.

Côté, J., Macdonald, D.J., Baker, J. and Abernethy, B. (2006). When "where" is more important than "when": Birthplace and birthdate effects on the achievement of sporting expertise. **Journal of Sports Sciences**, 24, 1065-1073.

Dudink, A. (1994). Birth date and sporting success. **Nature**, 368, 592.

Edgar, S., & O'Donoghue, P.G. (2005). Season of birth distribution of elite tennis players. **Journal of Sports Sciences**, 23, 1013-1020.

Edwards, L. and O'Donoghue, P.G. (2014), Relative age effect in netball: a qualitative investigation, **International Journal of Coaching Science**, 8(1), 47-68.

Furlong, J. (1995), 'The service in lawn tennis: How important is it?'. In Reilly, T., Hughes, M. and Lees, A. (eds.) **Science and Racket Sports**, (pp.266-271), E and EN Spon.

Helsen, W.F., Hodges, N.J., Van Winckel, J. and Starkes, J.L. (2000), The roles of talent, physical precocity and practice in the development of soccer expertise, **Journal of Sports Sciences**, 18, 727-736.

Hughes, M. (1998), The application of notational analysis to racket sports, In Lees, A., Maynard, I., Hughes, M. and Reilly, T. (eds), **Science and Racket Sports 2** (pp. 211-20), London: E and FN Spon.

Hughes, M. and Clarke, S. (1995), Surface effect on elite tennis strategy, In Reilly, T., Hughes, M. and Lees, A. (eds.) **Science and Racket Sports** (pp. 272-277), E and FN Spon.

Hughes, M., Evans, S. and Wells, J. (2001). Establishing normative profiles in performance analysis, **International Journal of Performance Analysis of Sport**, 1, 4-27.

Joll, A. and O'Donoghue, P.G. (2007). Relative age distribution of Welsh netball players. **International Journal of Coaching Science**, 1, 3-30.

Loffing, F. (2012). Hand dominance in tennis: Why left-handed performers may have an edge over their competitors, **Journal of Medicine and Science in Tennis**, 17, 50-54.

McGarry, T., Khan, M.A. and Franks, I.M. (1999), On the presence and absence of behavioural traits in sport: an example from championship squash match-play, **Journal of Sports Sciences**, 17, 297-311.

Miller, S. (2006), Modern Tennis rackets, balls and surfaces. **British Journal of Sports Medicine**, 40, 401-405.

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

O'Donoghue, P.G. (2003), The effect of scoreline on elite tennis strategy: a cluster analysis, **Journal of Sports Sciences**, 21, 284-285.

O'Donoghue, P.G. (2009), Relative age in tennis, **Studies in Physical Culture and Tourism**, 16(4), 379-388.

O'Donoghue, P. and Ingram, B. (2001), A notational analysis of elite tennis strategy, **Journal of Sports Sciences**, 19, 107-115.

Simmons, C. and Paull, G.C. (2001), Season-of-birth bias in association football, **Journal of Sports Sciences**, 19, 677-686.

Smith, T.B., and Hopkins, W.G. (2011), Variability and predictability of finals times of elite rowers, **Medicine Science Sports Exercise**, 43, 2155-60.

Tirp, J., Baker, J., Weigelt, M. and Schorer, J. (2014), Combat stance in judo – Laterality differences between and within competition levels, **International Journal of Performance Analysis in Sport**, 14, 217-224.

Unierzyski, P. and Wieczorek, A. (2004), Comparison of tactical solutions and game patterns in the finals of two grand slam tournaments in tennis, In Lees, A., Kahn, J. and Maynard, I. (eds.), **Science and Racket Sports 3**, (pp. 169-174) Oxon: Routledge.

USTA (United States Tennis Association) (1995), **Coaching tennis successfully**, Champaign, Il: Human Kinetics.

Verlinden, M., Ruyskensvelde, J., van Gorp, B., De Decker, S., Goossens, R. and Clarijs, J. (2004), Effect of gender and tennis court surface properties upon strategy in elite singles, In Lees, A., Kahn, J. and Maynard, I. (eds.), **Science and Racket Sports 3** (pp. 163-168), Oxon: Routledge.

Vincent, W.J. (1999), **Statistics in Kinesiology, 2nd edn**., Champaign, Il: Human Kinetcs.

Wattie, N., Baker, J., Cobley, S. and Montelpare, W.J. (2007), A historical examination of relative age effects in Canadian hockey players, **International Journal of Sport Psychology**, 38, 178-186.