International Journal of EXERCISE SCIENCE

Original Research

Centesimal Age and Relative Age Effect in Elite Futsal Players

DAYSE D. S. CARRACO†1, LARISSA R. GALATTI‡2, MARCELO MASSA‡3, IRINEU LOTURCO‡4, and CESAR C. C. ABAD‡1,4

[1]Singularidades Institute (iS), São Paulo, BR; [2]School of Applied Sciences, University of Campinas (UNICAMP), Limeira, BR; [3]School of Arts, Sciences and Humanities (EACH), University of São Paulo (USP), São Paulo, BR; [4]Nucleus of High Performance in Sport (NAR-SP), São Paulo, BR

†Denotes graduate student author, ‡Denotes professional author

ABSTRACT

International Journal of Exercise Science 13(6): 329-341, 2020. To investigate centesimal age (CA) and relative age effect (RAE) in elite male futsal players their date of birth and court-position were accessed through the official FIFA website. The absolute and relative frequency distributions of player births were quantified by quartiles and semesters. The two-way ANOVA and the Chi-Square analysis were applied to check for possible differences. The results showed a mean CA of 27.76 ± 4.11 years with no differences for both playing positions and competitions. In addition, no significant differences were found between quartiles or between semesters. The results suggest that elite male futsal athletes reach optimal competitive performance close to 27 years. Neither playing position nor geographical location may affect RAE, which seems to not affect the competitive performance (ranking) of elite male futsal players. These findings may help practitioners to understand the RAE phenomenon in futsal. In conclusion, being born in the early months of the year appears not to be important to successful performances in futsal. Overall, futsal athletes take about two decades to achieve their best performance. Coaches and researchers should consider the implementation of long-term training strategies (≈ 20 years) to progressively and effectively develop young futsal players.

KEY WORDS: Sport, performance, high performance, team sports

INTRODUCTION

Futsal started in South America in the 1930s and subsequently became popular around the World (17, 21). Officially recognized by the *Fédération Internationale de Football Association* (FIFA), futsal was originally adapted from the soccer field to a small court. Futsal is played by two teams composed of four court players and one goalkeeper. An official match consists of two halves of 20-min, with a fixed interval of 10-m between them, which is played on a 20 x 40m court (14).

Since 1989, FIFA has organized the most important futsal tournament worldwide. The "FIFA Futsal World Cup" (FFWC) takes place every 4 years and includes the best futsal players in the world. Although FFWC is considered a tight championship, there is a scarcity of data on the factors that could affect performance during these competitions. Undoubtedly, a stronger

understanding of these factors may help managers, coaches and researchers to develop more effective training programs and make more assertive decisions.

In this regard, the age that athletes achieve their peak performance could provide relevant information about the time needed to prepare a high-performance futsal athlete. For example, Allen and Hopkins (1) revealed that the age at which the best international athletes achieve their best performances varies from 20 to 27 years in strength-power sports and from 20 to 39 years in endurance sports. Although the authors reported important information about the ages that these athletes achieve their optimal performances, they found insufficient evidence regarding team sports. Thus, the age at which male futsal elite players achieve their best performances remains unknown. Accordingly, the centesimal age (CA) may be more appropriate than nearly age to explain the chronological effects related to successful performances, as this refers to every single day of the athletes' life. For instance, if an athlete was born in January 1st and another in December 31st of the same year, despite of the same (year) age, the first one would be eleven months and thirty days older than the second one. Therefore, they probably present some physical and technical characteristics able to impact performance at different extents. As such, CA seems to be more adequate than the "total age" to discriminate between athletes grouped in similar age-categories.

Besides CA, birthdate frequency distribution can also affect futsal performance. The relative age effect (RAE), for example, is a current phenomenon observed in several team sport athletes such as ice hockey, basketball, and American football (4, 5, 37). Conceptually, RAE is related to the inequality found across birthdate distributions when players have similar chronological ages and, despite having distinct biological ages, are grouped in the same age-category. Hence, athletes who are born in the first quartiles of a given year will probably mature faster and, as a consequence, will be more prone to perform better in their specific sport-tasks than players born in the last two quarters of the year (7, 23). Indeed, previous studies have shown that many successful male team sport athletes concentrate their birth dates in the first months of the age-year (in contrast to female team sports athletes) (2). Despite RAE is usually reported in RAE lower age-category athletes (41), several authors suggest that RAE remains in adult-elite professional players (20, 27, 28).

Such as several sports organizations, FIFA also uses a window of 2-years (24 months) to separate athletes into age-categories. Although this strategy is well-intentioned to equalize the competitive level and reduce differences between opponents, at the same time, it brings some disadvantages for those born at the end of the year. For instance, as athletes who were born at the beginning of the selection year (e.g., January) may be relatively older (up to 720 days) and probably mature firstly (3, 35), it is expected that they also present greater body size (e.g., muscle mass) and better physical fitness than their peers who were born later, at the end of the year (e.g., December) (7, 40). As a result, these athletes normally receive more attention, play longer, compete against better opponents, are involved in competitions with higher demands, increase their motivation, and are more likely to be selected by coaches (40).

Based on the importance and scarcity of CA and RAE values in elite male futsal-athletes the purpose of the study was to investigate the CA and birth month frequency distribution of elite male futsal players. We hypothesized that RAE would exist in elite male futsal players, varying according to playing position, geographical location and final ranking position.

METHODS

Participants

This work is a retrospective and descriptive study with a cross-sectional design. This research was carried out fully in accordance to the ethical standards of the International Journal of Exercise Science (31). Since there are no data about women futsal athletes on the FIFA website, the present study was performed only with male futsal players who participated of the last three FIFA Futsal World Cups (2008, 2012 and 2016) and were registered in the official website of FIFA. No inclusion or exclusion criteria were adopted.

Protocol

The personal IDs of the players were replaced with a code to ensure anonymity and confidentiality. Data were evaluated blindly by two independent pairs of experienced observers. In case of discrepancy between the two analyses, the data were reviewed by an experienced third-party appraiser. The countries, game positions, final rankings, continental federations, and birth dates of the athletes who competed in the last three FIFA Futsal World Cups (2008, 2012 and 2016) were collected from open access websites:

1. http://www.fifa.com/mm/document/tournament/competition/87/58/94/ffwc_2008_squadlists.pdf
2. http://www.fifadata.com/document/ffwc/2012/pdf/ffwc_2012_squadlists.pdf
3. http://www.fifadata.com/document/ffwc/2016/pdf/ffwc_2016_squadlists.pdf

The month and year of birth of each player were recorded. The CA were obtained by subtracting the date of birth and the starting day of the respective FFWC.

To obtain the CA, the following equations were used:

$$E1 = [(DDFFWC - 1) + 30.3 * (MMCMFF - 1)] \div 365 \quad (1)$$

$$E2 = [(DDDB - 1) + 30.3 * (MMDB - 1)] \div 365 \quad (2)$$

Then, if E1> E2, the CA was calculated by the following equation:

$$CA = E1 - E2 + YYYYFFWC + YYYYDB \quad (3)$$

Otherwise, if E1 <E2, the following equation was used:

$$CA = 1- E2 + E1+ YYYYFFWC + YYYYDB - 1 \quad (4)$$

E1 = equation 1; E2 = equation 2; DD = day, MM = month, YYYY = year; FFWC = date of beginning of the FIFA Futsal World Cup; DB = date of birth of the athletes; CA = centesimal age (16).

Statistical Analysis

The distributions of the date of birth were accounted by month (January to December), quartiles [Q1, Q2, Q3 and Q4], and semesters (S1 and S2). Subsequently, the distributions of absolute (N) and relative (%) birth dates were described. Two-way ANOVA was applied to test differences between CA by court-positions (e.g., goalkeeper, defender, forward, midfielder, wing and pivot) and competition year (e.g., 2008, 2012, and 2016). A Tukey's post-hoc test was applied when necessary. To compare the distributions of the birth date by month, quarter, and semester, the Chi-square analysis was used. A significance level of 5% was adopted for all analyses (p <0.05).

RESULTS

The average CA of the 950 players in the last three editions of the FIFA Futsal World Cup was 27.76 ± 4.11 years. The CA of futsal players grouped by game position in each championship is described in Table 1. No differences were found between game positions (e.g., goalkeeper, defender, forward, midfielder, wing and pivot) or between the different editions of the competitions (e.g., 2008, 2012 and 2016).

The monthly, quarterly, and semesterly distributions are described in Tables 2, 3, and 4, respectively. There were no significant differences in the frequency distribution of the birth month of athletes. The quarterly and semesterly distributions of the athletes´ birthdates grouped by continents (i.e. Continental Federation) are described in Table 5 and 6, respectively), whereas the quarterly and semesterly distributions grouped by ranking are described in Table 7 and 8, respectively). Overall, the results suggest that neither geographical location nor final ranking affect RAE of elite male international futsal players.

Table 2. The monthly distributions of the date of birth of the FIFA Futsal players.

	2008				2012				2016				TOTAL			
	N	Mean		SD	N	Mean		SD	N	Mean		SD	N	Mean		SD
Gk	51	28.84	±	4.93	61	29.26	±	4.27	58	30.36	±	4.49	170	29.49	±	4.56
Df	71	26.90	±	3.81	81	27.90	±	4.50	87	29.00	±	3.76	239	27.93	±	4.02
Fw	89	26.74	±	4.30	113	27.31	±	4.26	61	27.85	±	3.72	263	27.30	±	4.09
Mf	68	27.10	±	4.56	80	26.46	±	4.01	31	26.16	±	3.89	179	26.57	±	4.15
W	0	--	±	--	0	--	±	--	63	27.67	±	3.72	63	27.67	±	3.72
P	0	--	±	--	0	--	±	--	36	27.62	±	4.10	36	27.62	±	4.10
T	279	27.39	±	4.40	335	27.73	±	4.26	336	28.11	±	3.95	950	27.76	±	4.11

Note. Data presented as mean ± standard deviation (SD); Gk = Goalkeeper; Df = Defender; Fw = Forward; Mf = Midfielder; W = Wing; P = Pivot; T = TOTAL

Table 2. The monthly distributions of the date of birth of the FIFA Futsal players.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	X^2	*p*
2008	N	30	23	22	18	31	21	19	26	18	26	18	27	10.42	0.49
	%	10.75	8.24	7.89	6.45	11.11	7.53	6.81	9.32	6.45	9.32	6.45	9.68		
2012	N	20	27	26	26	29	36	28	24	24	29	30	36	8.56	0.66
	%	5.97	8.06	7.76	7.76	8.66	10.75	8.36	7.16	7.16	8.66	8.96	10.75		
2016	N	23	27	31	31	29	23	28	36	21	26	34	27	8.00	0.71
	%	6.85	8.04	9.23	9.23	8.63	6.85	8.33	10.71	6.25	7.74	10.12	8.04		
TOTAL	N	73	77	79	75	89	80	75	86	63	81	82	90	7.73	0.74
	%	7.68	8.11	8.32	7.89	9.37	8.42	7.89	9.05	6.63	8.53	8.63	9.47		

Table 3. The distributions of date of birth by quartiles of FIFA Futsal players.

		Q1	Q2	Q3	Q4	X^2	*p*
2008	N	75	70	63	71	1.07	0.78
	%	26.88	25.09	22.58	25.45		
2012	N	73	91	76	95	4.24	0.24
	%	21.79	27.16	22.69	28.36		
2016	N	81	83	85	87	0.24	0.97
	%	24.11	24.70	25.30	25.89		
TOTAL	N	229	244	224	253	2.26	0.52
	%	24.11	25.68	23.58	26.63		

Table 4. The distributions of the date of birth per semester of the year of FIFA Futsal players.

		S1	S2	X^2	*p*
2008	N	145	134	0.43	0.51
	%	51.97	48.03		
2012	N	164	171	0.15	0.70
	%	48.96	51.04		
2016	N	164	172	0.19	0.66
	%	48.81	51.19		
TOTAL	N	473	477	0.02	0.90
	%	49.79	50.21		

Table 5. The distributions of the date of birth by quartiles of FIFA Futsal players grouped by Continental Federation.

		Q1	Q2	Q3	Q4	X^2	*p*
AFC	N	60	66	47	64	3.69	0.30
	%	25.32	27.85	19.83	27.00		
CAF	N	25	28	25	33	1.54	0.67
	%	22.52	25.23	22.52	29.73		
CONCACAF	N	41	29	33	37	2.29	0.52
	%	29.29	20.71	23.57	26.43		
CONMEBOL	N	39	44	31	53	6.10	0.11
	%	23.35	26.35	18.56	31.74		
UEFA	N	64	76	88	66	4.94	0.18
	%	21.77	25.85	29.93	22.45		
TOTAL	N	229	243	224	253	2.22	0.53
	%	24.13	25.61	23.60	26.66		

Note. AFC = Asian Footbal Confederation; CAF = Confederation of African Football; CONCACAF = Confederation of North, Central American and Caribbean Association Football; CONMEBOL = South American Football Confederation; UEFA = Union of European Football Associations

Table 6. The distributions of the date of birth by semester of FIFA Futsal players grouped by Continental Federation.

		S1	S2	X^2	*p*
AFC	N	126	111	0.95	0.33
	%	53.16	46.84		
CAF	N	53	58	0.23	0.64
	%	47.75	52.25		
CONCACAF	N	70	70	0.00	1.00
	%	50.00	50.00		
CONMEBOL	N	83	84	0.01	0.94
	%	49.70	50.30		
UEFA	N	140	154	0.67	0.41
	%	47.62	52.38		
TOTAL	N	472	477	0.03	0.87
	%	49.74	50.26		

Note. AFC = Asian Footbal Confederation; CAF = Confederation of African Football; CONCACAF = Confederation of North, Central American and Caribbean Association Football; CONMEBOL = South American Football Confederation; UEFA = Union of European Football Associations

Table 7. The distributions of the date of birth by quartiles of FIFA Futsal players grouped by final ranking.

		Q1	Q2	Q3	Q4	X^2	*p*
1st-4th	N	34	41	50	43	3.10	0.38
	%	20.24	24.40	29.76	25.60		
5th -8th	N	44	42	43	39	0.33	0.95
	%	26.19	25.00	25.60	23.21		
9th -12th	N	35	46	41	46	1.95	0.58
	%	20.83	27.38	24.40	27.38		
13th-16th	N	37	47	31	50	5.64	0.13
	%	22.42	28.48	18.79	30.30		
17 th-20th	N	47	46	29	46	5.38	0.15
	%	27.98	27.38	17.26	27.38		
21st-24th	N	32	22	28	29	1.90	0.59
	%	28.83	19.82	25.23	26.13		
TOTAL	N	229	244	222	253	2.51	0.47
	%	24.16	25.74	23.42	26.69		

Table 8. The distributions of the date of birth by semester of FIFA Futsal players grouped by final ranking.

		S1	S2	X^2	*p*
1st-4th	N	75	93	1.93	0.16
	%	44.64	55.36		
5th -8th	N	86	82	0.10	0.76
	%	51.19	48.81		
9th -12th	N	81	87	0.21	0.64
	%	48.21	51.79		
13th-16th	N	84	81	0.05	0.82
	%	50.91	49.09		
17 th-20th	N	93	75	1.93	0.16
	%	55.36	44.64		
21st-24th	N	54	57	0.08	0.78
	%	48.65	51.35		
TOTAL	N	473	475	3.52	0.06
	%	49.89	50.11		

DISCUSSION

The present study investigated only the CA and RAE of elite male futsal players who competed in the FIFA Futsal World Cup (FFWC). The last three editions of the FFWC were considered for accounting. To the best of our knowledge, there are no studies about the optimal age and relative age effect in international-level futsal athletes. Therefore, this is the first study on this topic. The most important finding is that, contrary to our hypothesis, there were no significant differences in the average age of the players of different game positions or in the frequency distribution of

the players' months of birth. In addition, neither geographical location nor final ranking affected RAE of elite male international futsal players.

It is important to highlight that, contrary to other sports (e.g. soccer and handball), unfortunately, at least until now, futsal has not been widely played by women. Of note, on the official FIFA website, there are no data regarding the organization or promotion of women futsal championships.

The lack of significant differences between the average age of futsal players suggests an ideal age at which they achieve optimal performance, regardless of the playing position. This age varied between 25 and 27 years of age and corroborates findings from previous studies (13). In other modalities, such as football, for example, there are commonly differences between game positions. Goalkeepers, for example, are frequently older than field players (8). Our findings suggest that the dynamics of futsal matches differ from other sports such as European handball and seem to require similar physical conditioning regardless of the position on the court. The results of Vicente-Vila and Lago-Peñas (39) reinforce our findings, as they identified greater ball possession efficiency, longer ball possession, and less defensive pressure when the goalkeeper participated as a regular field player during official matches.

The differences described in physical performance between U-20s and high-level futsal adults (30) also suggest that middle-aged futsal players (≈27 years old) are better than their younger counterparts. Therefore, as the futsal World Cup occurs every four years, it is possible that futsal players close to 18 years old are still very young and, thus, do not yet have the experience, physical ability, or cognitive behavior required to make better decisions during official matches (33). However, in the long term, the calling of young players needs to be considered, since greater experience in previous competitions could be an important factor for success in international-level competitions (22). Therefore, coaches must consider mixing older and younger athletes in the team. Furthermore, coaches should also consider the younger athletes within the team as potential "developmental players" (i.e., non-starters or athletes to participate in friendly matches and less important tournaments). Nonetheless, whereas this question remains opened, future studies are required to compare RAE among different ages and levels of competitions.

In this study, our findings contradict previous results describing RAE in young and adult Brazilian futsal players at regional and national levels (27). In fact, RAE can be expected in futsal because, normally, high-level futsal players present higher physiological performance (e.g., higher ventilatory threshold velocities and maximal oxygen uptake, shorter sprint time, and better intermittent running ability) than low-level players (25, 34). Moreover, since some skills depend on maturational factors (9, 19), RAE could benefit early matured players more than later maturing individuals (24). Thus, it is reasonable to suppose that RAE could remain in elite adult futsal players. In contrast, as the FIFA Futsal rules (https://www.fifa.com) allow unlimited changes of players during the match, perhaps the physical advantages of more mature players could be suppressed by technical and tactical skills. Therefore, the belief that younger athletes will have more advantages compared to their peers may not be true. Likewise, the hypothesis

that advantages during puberty could be maintained in adulthood also does not appear in elite male futsal players. It is important to notice in this study that a cross-sectional design was adopted, and the same players were not always considered in different editions of the FFWC. Thus, longitudinal studies with chronic follow-up may contribute to verifying whether RAE in young futsal players is maintained until adulthood.

As RAE relies on several physical, cognitive, emotional, geographic, and sociocultural factors (11, 37) understanding why RAE was not found in athletes who played in the FFWC is a difficult task. Nonetheless, some empirical hypotheses may explain the absence of RAE. Firstly, it is important to note that data on RAE of high-level futsal athletes from other European and American National Leagues are scarce. Thus, regarding this limitation, comparisons with studies that investigated RAE in athletes of other sports could help to understand the absence of RAE found in the present study. For example, sports such as field hockey, table tennis, dance, gymnastics, and volleyball also do not seem to be affected by RAE (32, 38). The authors explain the absence of RAE by the greater requirement of specific technical-motor proficiency of these modalities and less attention of the trainers to anthropometric and maturational factors to teach and train young athletes (32, 38). It is also important to note that some of the studies mentioned above were carried out in the Netherlands, which traditionally maintains sporting talent programs emphasizing technical quality and sport-specific motor skills more than physical abilities (38). Therefore, under these conditions, it seems that management of the Dutch modalities minimizes the chances of RAE. In this context, it is possible to suggest that the RAE phenomenon seems to be affected by sociocultural aspects and the sporting and political organization of each country.

Morales Junior et al (2017), for example, found RAE in the Brazilian Men's National League, but in the Women's National League not. This sex differences may occur since the lack of women futsal competitions in the youth ages (below U-13) since the most Brazilian girls start to play futsal tournaments only on adolescence. Thus, they are less exposed to processes of advanced talent selection, which tends to decrease the effect of inequality between who were born in different months within the same year. In contrast, the Brazilian boys may start to play official futsal competitions from U-7´s. These data reinforce the perspective that sport organization and youth sport competitions interfere in the prevalence of RAE (10). However, even with Brazil being the most successful National team of FIFA Futsal World Cup, it is possible that this phenomenon may be different in those countries that have other futsal organization system or a higher appreciation for female futsal practices. For this reason, several pedagogical and psychosocial aspects have been associated with RAE in previous studies, as stakeholders and coaches tend to favor talented youths from early ages, reinforcing the belief that these children are able to become an athlete, providing them with better training and competition opportunities, as well as reinforcing the self-confidence of the children and their desire to continue in practice (11, 18, 27).

It should be borne in mind that a possible hypothesis for the non-appearance of RAE in the FFWC may be the early migration of talented futsal players into soccer. In fact, in several countries, children start playing soccer and futsal concomitantly. Consequently, due to the

greater popularity and better financial support for soccer, several of them give up futsal to play only soccer. Therefore, talented futsal players who were more precocious and could contribute to the existence of RAE in future adult futsal players would only appear in soccer, as already described in previous studies (12, 41). In contrast, it is possible that starting soccer players who were born in the last months of their age group (without RAE) and who received less attention, less instruction, and fewer opportunities (29, 36) or like futsal rather than soccer due to its dynamics would migrate to futsal that has less popularity with different professional prospects. Then, with less players in futsal than in soccer, they could have greater opportunities to reach success. Thus, this migration would be compatible with the distributions of birth dates of the age group, reducing the probability of RAE in adult futsal players, even in this sport, where the age of instruction can be very early (6). However, it is a speculative approach so as a qualitative study surrounding the reasons why some players choose futsal would validate these hypotheses. Then, future studies are necessary to elucidate this point.

Another aspect that affects RAE is the popularity of the sport. In fact, some authors argue that RAE may be more frequent in countries with a greater number of practitioners than in smaller countries (29). In Canada, for example, RAE was systematically observed for ice hockey, which represents the most popular activity in the country (4, 5), but no RAE has been observed for volleyball athletes (15). Similar results were found in professional sports in North America including basketball (NBA), gridiron football (NFL), baseball (MLB), and ice hockey (NHL) which are the most popular sports in the USA (37). For example, RAE has been found in young male basketball players (high popularity), but not in female players (low popularity) (2). The same can be seen in Brazil, where rugby (low popularity) has no RAE whereas soccer (higher popularity) has (26).

The main limitation of this study is its transversal design and the impossibility of marking the RAE according to the distribution of birthdates of the population of the different countries that participated in the FFWC. Thus, we suggest that longitudinal studies, with samples composed of futsal players of various ages, categories, competitive levels, and sex be conducted to better understand this phenomenon.

In conclusion, the ideal age for an elite futsal player to reach their peak performance seems to be close to 27 years, regardless of their playing position. Considering this, the pathway of a futsal male athlete to the FFWC could be around two decades, as it is not uncommon for a child to start at 5-8 years old. Furthermore, RAE did not occur in elite players who disputed the FFWC. Sports managers, coaches, and physical conditioners may consider RAE to be absent in elite futsal players, therefore they should not privilege more mature athletes in their processes of detection, selection, and promotion of talents. Being aware of this could be a multiple decade process.

REFERENCES

1. Allen SV, Hopkins WG. Age of peak competitive performance of elite athletes: A systematic review. Sport Med 45(10): 1431-1441, 2015.

2. Arrieta H, Torres-Unda J, Gil SM, Irazusta J. Relative age effect and performance in the U16, U18 and U20 European Basketball Championships. J Sports Sci 34(16): 1530-1534, 2015.

3. Baker J, Janning C, Wong H, Cobley S, Schorer J. Variations in relative age effects in individual sports: Skiing, figure skating and gymnastics. Eur J Sport Sci 14(Suppl 1): 1-8, 2012.

4. Barnsley R, Thompson G. Birthdate and success in minor hockey: The key to the NHL. Canad J Behav Sci 20(2): 167-176, 1988.

5. Barnsley R, Thompson G, Barnsley PE. Hockey success and birthdate: The relative age effect. CAHPER J Dance 51(1): 23-28, 1985.

6. Bettega OB, Prestes MF, Lopes CR, Galatti LR. Pedagogia do esporte: O jogo como balizador na iniciação ao futsal. Pensar Prát(Impr) 18(2): 487-501, 2015.

7. Bliss A, Brickley G. Effects of relative age on physical and physiological performance characteristics in youth soccer. J Sports Med Phys Fitness 51(4): 571-575, 2011.

8. Bloomfield J, Polman R, O'Donoghue P. Physical demands of different positions in FA Premier League soccer. J Sport Sci Med 6(1): 63-70, 2007.

9. Carvalho HM, Coelho-e-Silva MJ, Eisenmann JC, Malina RM. Aerobic fitness, maturation, and training experience in youth basketball. Int J Sports Physiol Perform 8(4): 428-434, 2013.

10. Cobley S, Abraham C, Baker J. Relative age effects on physical education attainment and school sport representation. Phys Educ Sport Pedagogy 13(3): 267-276, 2008.

11. Côté J, Macdonald DJ, Baker J, Abernethy B. When "where" is more important than "when": Birthplace and birthdate effects on the achievement of sporting expertise. J Sport Sci 24(10): 1065-1073, 2006.

12. Del Campo DGD, Pastor Vicedo JC, Gonzalez Villora S, Contreras Jordan OR. The relative age effect in youth soccer players from Spain. J Sport Sci Med 9(2): 190-198, 2010.

13. Dendir S. When do soccer players peak? A note. J Sport Analytics 2(2): 89-105, 2016.

14. FIFA Futsal Coaching Manual. (2013). Available online: https://resources.fifa.com/image/upload/futsal-coaching-manual.pdf?cloudid=s5yvzkdqyevndrtdcke4/ (accessed Dec 11, 2019).

15. Grondin S, Deshaies P, Nault L-P. Trimestre de naissance et participation au hockey et au volleyball. La Rev Québ L'activ Physique 2(1): 97-103, 1984.

16. Guedes DP. Practical manual for evaluation in physical education/Manual prático para avaliação em educação física. Editora Manole Ltda; 2006.

17. Hamid MS, Jaafar Z, Mohd Ali AS. Incidence and characteristics of injuries during the 2010 FELDA/FAM National Futsal League in Malaysia. PLoS One 9(4): e95158, 2014.

18. Hancock DJ, Adler AL, Côté J. A proposed theoretical model to explain relative age effects in sport. Eur J Sport Sci 13(6): 630-637, 2013.

19. Harrison CB, Kinugasa T, Gill N, Kilding AE. Aerobic fitness for young athletes: Combining game-based and high-intensity interval training. Int J Sports Med 36(11): 929-934, 2015.

20. Helsen WF, Baker J, Michiels S, Schorer J, Van winckel J, Williams AM. The relative age effect in European professional soccer: Did ten years of research make any difference? J Sport Sci 30(15): 1665-1671, 2012.
21. Junge A, Dvorak J. Injury risk of playing football in futsal world cups. Br J Sports Med 44(15): 1089-1092, 2010.

22. Kobal R, Barroso R, Abad CCC, Kitamura K, Carmo ECd, Pereira L, Nakamura FY, Loturco I. Previous participation in FIFA World-Cup: The key to success? Motriz: Rev Educ Física 22(2): 73-79, 2016.

23. Lemez S, Baker J, Horton S, Wattie N, Weir P. Examining the relationship between relative age, competition level, and dropout rates in male youth ice-hockey players. Scand J Med Sci Sports 24(6): 935-942, 2014.

24. Lovell R, Towlson C, Parkin G, Portas M, Vaeyens R, Cobley S. Soccer player characteristics in English lower-league development programmes: The relationships between relative age, maturation, anthropometry and physical fitness. PLoS One 10(9): e0137238, 2015.

25. Makaje N, Ruangthai R, Arkarapanthu A, Yoopat P. Physiological demands and activity profiles during futsal match play according to competitive level. J Sports Med Phys Fitness 52(4): 366-374, 2012.

26. Massa M, Costa RA, Paciaroni R, Neiva JFO, Moreira A, Aoki MS. Efeito da idade relativa no rugby brasileiro. Rev Bras Ciência Mov 25(4): 68-74, 2017.

27. Morales Júnior VR, Alves IVG, Galatti LR, Marques RFR. The relative age effect on Brazilian elite futsal: Men and women scenarios. Motriz: Rev Educ Fis 23(3): 2017.

28. Mujika I, Vaeyens R, Matthys SPJ, Santisteban J, Goiriena J, Philippaerts R. The relative age effect in a professional football club setting. J Sport Sci 27(11): 1153-1158, 2009.

29. Musch J, Grondin S. Unequal competition as an impediment to personal development: A review of the relative age effect in sport. Develop Rev 21(2): 147-167, 2001.

30. Nakamura FY, Pereira LA, Cal Abad CC, Kobal R, Kitamura K, Roschel H, Rabelo F, Souza WA, Jr., Loturco I. Differences in physical performance between U-20 and senior top-level Brazilian futsal players. J Sports Med Phys Fitness 56(11): 1289-1297, 2016.

31. Navalta JW, Stone WJ, Lyons S. Ethical issues relating to scientific discovery in exercise science. Int J Exerc Sci 12(1): 1-8, 2019.

32. Okazaki FHA, Keller B, Fontana FE, Gallagher JD. The relative age effect among female Brazilian youth volleyball players. Res Q Exerc Sport 82(1): 135-139, 2011.

33. Olthof SB, Frencken WG, Lemmink KA. The older, the wider: On-field tactical behavior of elite-standard youth soccer players in small-sided games. Hum Mov Sci 41(1): 92-102, 2015.

34. Pedro RE, Milanez VF, Boullosa DA, Nakamura FY. Running speeds at ventilatory threshold and maximal oxygen consumption discriminate futsal competitive level. J Strength Cond Res 27(2): 514-518, 2013.

35. Romann M, Fuchslocher J. The need to consider relative age effects in women's talent development process. Percept Mot Skills 118(3): 651-662, 2014.

36. Sherar LB, Bruner MW, Munroe-Chandler KJ, Baxter-Jones AD. Relative age and fast tracking of elite major junior ice hockey players. Percept Mot Skills 104(3 Pt 1): 702-706, 2007.

37. Steingröver C, Wattie N, Baker J, Schorer J. Does relative age affect career length in North American professional sports? Sport Med Open 2(1): 18-18, 2016.

38. van Rossum JH. Relative age effect revisited: Findings from the dance domain. Percept Mot Skills 102(2): 302-308, 2006.

39. Vicente-Vila P, Lago-Penas C. The goalkeeper influence on ball possession effectiveness in futsal. J Hum Kinet 51(1): 217-224, 2016.

40. Wattie N, Schorer J, Baker J. The relative age effect in sport: A developmental systems model. Sports Med 45(1): 83-94, 2015.

41. Williams JH. Relative age effect in youth soccer: Analysis of the fifa u17 world cup competition. Scand J Med Sci Sports 20(3): 502-508, 2010.