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Contextual factors in understanding the jumping performance of young football goalkeepers

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Abstract The aim of this study was to examine the effect of various contextual factors, such as relative age, biological maturation, or competitive level, on the jumping performance of young football goalkeepers. Vertical jump performance was evaluated in a selection of goalkeepers ($n = 110$) from U-14 and U-16 category teams. The sample was categorized by relative age, biological maturation, and competitive level. The results revealed a trend in the overall sample towards an overrepresentation of goalkeepers born in the early months of the year. Maturity status influenced the most in jumping performance of young goalkeepers (SJ: $F = 11.27$, $p < .001$, $\eta p^2 = 0.187$; CMJ: $F = 8.72$, $p < .001$, $\eta p^2 = 0.162$; AJ: $F = 8.37$, $p < .001$, $\eta p^2 = 0.146$), while the birth quartile had no effect on the jumping performance in the sample. Statistical differences were significant for SJ and CMJ between competitive level groups in the U-14 group only. ($F = 5.37$, $p = .008$, $\eta p^2 = 0.186$) and CMJ ($F = 4.54$, $p = .016$, $\eta p^2 = 0.159$). This study showed a greater association between maturation and jumping performance in young football goalkeepers rather than with relative age, which could influence the selection process in this field position at early ages.

Introduction

One of the main aims of youth football clubs is to identify and select players at early ages who have the potential to succeed, in order to enrolled them into a specialized development program.[1,2] Football is a multifaceted sport and a high performance in technical, tactical, physical/physiological and mental/psychological attributes are needed to succeed. However, clubs have traditionally focused on anthropometrical attributes and physical performance on this talent identification process.[3] These physical characteristics are related to the young player's growth and development, which may influence the selection of players.[4] Football categories are generally organized based on player's chronological age, and players are grouped into 1- or 2-year cohorts accordingly.[5] The term relative age (RA) refers to the player's age regarding the cohort age and it has been observed that young football players with higher RA are more likely to be selected for elite teams or football development programs.[6] This phenomenon is known as the relative age effect (RAE) and it has been observed in throughout

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different national and international teams and competitions, different competitive levels and at different age categories, suggesting that it is a real bias in talent identification and selection processes.[7]

Eventually, RAE has been explained as an advantage in anthropometric and physical performance for those older players.[8] Despite of this former assumption, recent research has shown diverse results when comparing physical performance between early-born and late-born players.[8–10] It appears that simply being born a few months earlier or later during the selection year does not imply a higher sports performance, when the effect of maturation is controlled.[4,11] Considering this, it could be hypothesised that the maturity status might have a greater influence on young players' physical performance, as it refers to the structural and functional changes in the body.[10,11] Maturation refers to the developmental process by which individuals transition into their adult state, while the concept of maturity status pertains to a distinct point within the progression of an individual's maturation. Players with an advanced maturity status (i.e. who have past their peak height velocity [PHV]) are generally taller and heavier throughout all age groups.[12] Additionally, they also tend to exceed in physical capacities their less mature peers.[4,13,14]

Specific anthropometric and physiological attributes may be needed for each playing position, hence advanced-maturity players regularly have an advantage to be selected for specific outfield positions as they use to be larger in body size, faster and stronger.[15] In particular, the goalkeeper is the player with the most specific position of the team. These players are the only players allowed to play the ball with the upper limbs in his own area. In particular, goalkeepers' main objective is to avoid the ball entering the goal. To achieve this aim, goalkeepers needs specific technical abilities (to make a save by either catching the ball or deflecting it to prevent it from entering the goal)[16] and a deep tactical understanding of the game. Physically, goalkeepers tend to exhibit superior anthropometrics characteristics been the highest and the heaviest players.[17] To fulfill their objective of preventing the ball from entering the goal, they must perform explosive jumps, high-velocity kicking, throws and explosive runs.[18] The most crucial movement involved in goalkeeping is the diving action (moving quickly or suddenly through the air, especially in a downward direction), which is performed up to 17 times per match.[19]

Whereas this position-related variation in the selection process and physical performance it's been previously examined,[20] to the best of our knowledge, no previous studies have analysed it exclusively within the position of the goalkeepers, even though the specific requirements of this position. Therefore, the purpose of this research was to test the possible existence of RAE in the selected sample and to examine the influence of contextual factors, such as RA, biological maturation, or competitive level, on the jumping performance of young football goalkeepers. This aims to underpin the impact of these variables on the talent identification process and provide relevant information to advance toward a fairer development of future generations.

Methods

Participants

One hundred and ten young football goalkeepers from Spain, from different U-14 ($n = 58$) and U-16 ($n = 52$) category teams (age [years]: 14.16 ± 1.12; PHV [years]: 0.22 ± 1.22; mass [kg]: 60.84 ± 12.34; height [cm]: 167.80 ± 8.97) were included in this study. The inclusion criteria were[1] having an active goalkeeper license,[2] having at least 3 years of experience as a goalkeeper, and[3] being free from injury or illness at the time of evaluation and in the preceding months or weeks, respectively. The competitive level (CL) of the goalkeepers were registered from CL1 (lowest CL in the country) to CL4 (highest national CL in the country). This research was approved by the Ethical Committee of the hosting institution (DCD.IPG.01.21). Each participant and their parents/guardians signed an informed consent according to the Declaration of Helsinki (2013).

Anthropometrics

Body height and sitting height were measured with a fixed stadiometer (± 0.1 cm; SECA LTD, Hamburg, Germany). Leg length was obtained from body height − sitting height, and body mass was measured with a digital scale (± 0.1 kg; Tanita BC-601, Tokio, Japan).

Relative age

The relative age was measured asking for the player's birth date. According to this data, the player was categorized in an age group and in a birth quartile (Q) within its group. The categorization by birth quartiles was carried out as follows: Players born in the months of January to March were categorized as Q1; players born between April and June as Q2, those born between July and September as Q3; and those born between October and December of the selection year were categorized as Q4.

Maturity status

Players' maturity status was estimated by the years from/to the peak height velocity (PHV)[21] which uses the players' body weight, height, sitting height, leg-length and their decimal age:

$$
\begin{aligned}
& \mathit{Years from/to the PHV for boys} \\
&= -9.236 \\
&\quad + (0.0002708 * (\mathrm{Leg length} * \mathrm{Sitting height})) \\
&\quad + (0.001663 * (\mathrm{Chronological age} * \mathrm{Leg length})) \\
&\quad + (0.007216 * (\mathrm{Chronological age} * \mathrm{Sitting height})) \\
&\quad + (0.02292 * (\mathrm{Weight}/\mathrm{Height} * 100))
\end{aligned}
$$

The estimation of the years from/to the PHV is the most commonly used indicator of the somatic maturation in the sports field.[22] The PHV represents a theoretical point of maximum growth in length during the individual's adolescence which usually happens at the age of 14 in boys and 12 in girls.[22−24] According to the years from/to the PHV, players were matched in three maturity groups: PrePHV (players before their PHV [$<$ −0.5 years to their PHV]; n = 32), MidPHV (players currently in their PHV [from −0.5 years to their PHV to 0.5 years from their PHV]; n = 29) and PostPHV (players after their PHV [$>$ 0.5 years from their PHV]; n = 49).

Test procedure

Player's anthropometrical parameters were obtained before the jump assessment. Before the jumping performance tests, players carried out a standardized warm-up that consisted in 5 min of low-intensity running, 3−5 min of dynamic stretching and 3−5 min of high-intensity actions, such as short accelerations and decelerations, changes of direction and jumps. To finish the warm-up and to ensure the players performed squat technique properly, the players performed squatting movements (2 × 8 repetitions) and 3 submaximal jumps. 2−3 min after the warm up, the jumping ability of the young goalkeepers was assessed using three tests of vertical jump: the Squat Jump test (SJ), which refers to the muscles contractile capability; the Countermovement Jump test (CMJ), which includes the plyometric capability in the jump and the Abalakov Jump test (AJ), which includes coordinative components to the jump ability.[25,26] The players executed the SJ from a starting position with a knee flexion angle of 90°. Throughout the jump, they were required to maintain their hands on their hips, and performing a prior countermovement was prohibited.[27] In the case of the CMJ, players initiated the jump from a standing position. They were instructed to execute a countermovement involving knee and hip flexion before the jump. Additionally, players were instructed to maintain their hands on their hips throughout the entire movement.[27] The AJ followed the same protocol as the CMJ, with the inclusion of a player's arm swing.[26] In all three jump protocols, goalkeepers were encouraged to maximize their jumping performance. They were specifically instructed to land with ankle dorsiflexion and knee extension to avoid an increase of the fly time.

Jump height during the jump was recorded using the smartphone app *My Jump 2* for iOS (Apple Inc., Cupertino, CA, USA). The performance of *My Jump 2* has been validated in the literature against laboratory gold-standard criteria and tested in many kinds of populations.[28,29] An iPhone 13 unit (Apple Inc., Cupertino, CA, USA) was used to record and process high-speed videos (240 fps, 720p) of jump executions.[30] The participants performed three attempts of each type of jump, with a one-minute rest between them, randomizing the order of the jumps. The best attempt of each jump type was used for subsequent analysis.

Statistical analysis

Data is presented as mean ± standard deviation. A chi-square test was used to test the statistical difference between the observed and expected birth distribution, assuming that the expected birth distribution is a 25 % of births per quartile. Three one-way analyses of variance (ANOVAs) with post-hoc (Bonferroni) tests were performed[1] to compare the jumping ability according to the players' Q in each age category;[2] to compare the jumping ability according to the players' maturity group; and[3] to compare the jumping ability between players from different CL. Due to the low sample size in CL3 and 4 groups, they were combined into a single group for statistical analyses. To calculate the effect size for each ANOVA the "partial eta squared" (ηp^2) was used and interpreted as follows: $\eta p^2 = 0.01$ indicates a small effect. $\eta p^2 = 0.06$ indicates a medium effect. $\eta p^2 = 0.14$ indicates a large effect. All calculations were performed using Microsoft Excel (Microsoft, Seattle, Washington, USA) and JASP software (JASP Team, Version 0.17.3) and the level of significance was set at $p < .05$.

Results

The distribution of birth quartiles in the analyzed sample is shown in Fig. 1. The chi-square analysis did not reveal statistical differences between groups, but it was observed a trend in the overall sample (as in each age group) towards an overrepresentation of goalkeepers born in the early months of the year compared to those born in the last quartile of the year (Fig. 1).

The birth quartile did not influence the players' jumping performance (U-14: $F = 0.58$ to 1.30, $p < .05$, $\eta p^2 = 0.036$ to 0.078; U-16: $F = 0.68$ to 1.28, $p < .05$, $\eta p^2 = 0.042$ to 0.094) (Table 1).

The jumping performance of the assessed goalkeepers was influenced by their maturity status (SJ: $F = 11.27$, $p < .001$, $\eta p^2 = 0.187$; CMJ: $F = 8.72$, $p < .001$, $\eta p^2 = 0.162$; AJ: $F = 8.37$, $p < .001$, $\eta p^2 = 0.146$). The pairwise comparison revealed that for SJ, CMJ and AJ the statistical differences were mainly between Pre- and PostPHV (Table 2).

Finally, it was observed a trend towards a higher vertical jump performance of goalkeepers competing in higher CLs. However, this observation was statistically significant for SJ ($F = 5.37$, $p = .008$, $\eta p^2 = 0.186$) and CMJ ($F = 4.54$, $p = .016$, $\eta p^2 = 0.159$) in the U-14 group only (Table 3).

Discussion

To the authors' knowledge, this is the first study that aimed to analyze the existence of relative age effect and the possible influence of contextual factors as the relative age, biological maturation and the competitive level of players in the jumping performance of young football goalkeepers. The main results of this study show that an advanced maturity status was associated with statistically better values in jump performance, whereas no association was found for young goalkeepers with different RA regarding jumping performance. These findings are in accordance with the recent states which affirm that advance maturity, but not older RA, is associated with better physical performance in young football players.

The birth quartile distribution follows an unbalanced path in favor of those players born in the early month of the year. These results, which are specific for the goalkeeper field position, are consonant with previous research analyzing RAE in young football players for all playing positions.[4,6,31] There is no certain explanation about the causes of RAE in football. Previous investigations have hypothesized about the influence of physical performance in

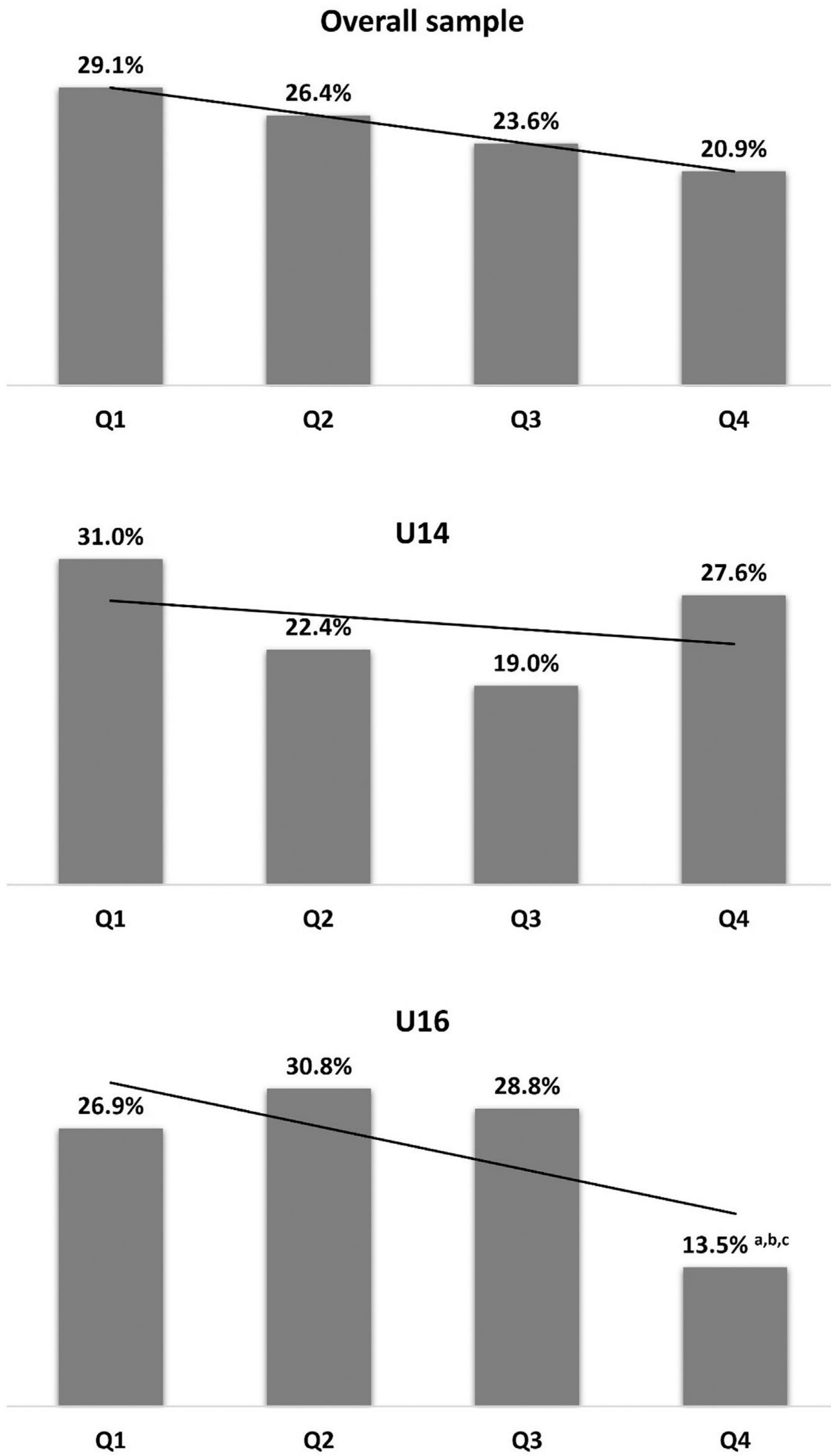

Fig. 1 Birth quartile distribution in percentage (with a trend line) for the overall sample, U14 and U16 categories.

RAE.[8] In this study, it was evaluated this possible impact of RA in goalkeepers' physical performance, and the results showed that the birth quartile did not influence the players' jumping performance, so the hypothesis of an advantage of early-born players due to a better physical performance seemed to be diffuse in order to explain the RAE, as late studies are also dismissing this statement.[10]

Moreover, different results are obtained when controlling the maturity status as a covariable. Players with an advanced maturity status are more likely to perform better on physical tasks as a result of adaptations related to maturation like an increase in androgen concentrations, fiber-type differentiation, resting adenosine triphosphate, creatine phosphate levels, and the architectural development of

Table 1 Jumping performance (SJ, CMJ and AJ) according to player's birth quartile (Q) for U-14 and U-16 categories.

		Q1	Q2	Q3	Q4	F	p	ηp^2
U-14	SJ (cm)	24.46 ± 4.29	24.57 ± 4.35	21.33 ± 4.88	24.13 ± 4.33	1.30	.287	0.078
	CMJ (cm)	27.80 ± 4.32	28.79 ± 5.60	25.54 ± 5.39	27.80 ± 5.33	0.77	.517	0.047
	AJ (cm)	31.57 ± 4.43	34.62 ± 8.15	31.63 ± 5.88	32.87 ± 7.18	0.58	.631	0.036
U-16	SJ (cm)	31.22 ± 8.54	27.70 ± 5.56	29.80 ± 8.20	27.73 ± 5.37	0.68	.570	0.042
	CMJ (cm)	36.33 ± 9.37	30.87 ± 4.84	34.37 ± 11.05	30.05 ± 5.21	1.28	.296	0.094
	AJ (cm)	41.28 ± 8.91	37.04 ± 5.76	37.29 ± 9.64	35.97 ± 4.79	1.00	.401	0.063

U-14: Under 14 category; U-16: Under 16 category; SJ: Squat jump; CMJ: Countermovement jump; AJ: Abalakov jump; Q1: Birth quartile 1; Q2: Birth quartile 2; Q3: Birth quartile 3; Q4: Birth quartile 4; ηp^2: Partial eta squared.

Table 2 Jumping capability (SJ, CMJ and AJ) according to player's maturity status.

	PrePHV	MidPHV	PostPHV	F	p	ηp^2
SJ (cm)	22.53 ± 4.48	25.55 ± 3.85	29.23 ± 7.37[a,b]	11.27	$<.001$	0.187
CMJ (cm)	26.63 ± 5.33	29.49 ± 4.42	33.24 ± 8.38[a]	8.72	$<.001$	0.162
AJ (cm)	31.26 ± 5.75	35.06 ± 7.04	38.03 ± 7.89[a]	8.37	$<.001$	0.146

U-14: Under 14 category; U-16: Under 16 category; SJ: Squat jump; CMJ: Countermovement jump; AJ: Abalakov jump; PrePHV: Previous to the peak height velocity; MidPHV: Around the peak height velocity; PostPHV: Past the peak height velocity.
[a] : statistically different ($p < .05$) from PrePHV.
[b] : statistically different ($p < .05$) from MidPHV.

muscle-tendon units.[32] The results of the current study are in line with this statement showing statistical differences in jumping capabilities between maturity groups. The PostPHV goalkeepers of this study obtained statistically better values in SJ, CMJ and AJ than the PrePHV goalkeepers' group. These results did not differ from those investigations carried out in outfield young players in which maturation had a substantial influence on physical performance, as players advanced in maturation performed better in field tests (i.e. linear sprint) and presented greater match running performances, than their less mature teammates.[10,13] Therefore, in line with the most recent publications, the results of this study underpin the statement of maturity having a greater association than RA with physical performance in young football players regardless the position.[9] The advantage of PostPHV players in jump tests against their less mature peers, may be truly consider in talent identification processes as given the physical advantages associated with early maturation (e.g., higher muscle mass, different fiber-type composition or higher recruitment of motor units).[33]

In order to compete at early stages, coaches and scouts usually select goalkeepers at early ages with higher anthropometrical parameters such as body heigh or wingspan. In the attempt to select young goalkeepers for short-term performance, coaches and scouts in youth football academies often choose goalkeepers with a more advanced maturation status. This results in the exclusion of goalkeepers with a delayed maturation status due to a temporary anthropometric and physical disadvantage.[34] Later matures, thus, may likely perform in disadvantageous conditions, making it challenging for clubs to identify attributes in these players that indicate they have the potential to perform at an elite level. Nevertheless, athletes with delayed maturational states can not only perform as well as their peers with a more advanced maturational state in the future but can also achieve higher anthropometric and performance levels, as they have more time for the application of appropriate training stimuli for conditional improvement.

Football specific physical performance tests are widely used as an objective and reliable method to evaluate young football players current level or future success.[35] Whereas sprint, change of direction or dribbling speed test are commonly used to test outfield players' physical performance, goalkeepers' evaluation may be analyzed in line with their

Table 3 Jumping capability (SJ, CMJ and AJ) according to player's competitive level (CL) for U-14 and U-16 categories.

		CL1	CL2	CL3–4	F	p	ηp^2
U-14	SJ (cm)	22.24 ± 4.29	24.59 ± 3.85	28.05 ± 4.16[a]	5.37	.008	0.186
	CMJ (cm)	25.83 ± 5.35	29.01 ± 3.86	31.69 ± 4.47[a]	4.54	.016	0.159
	AJ (cm)	30.85 ± 6.53	34.07 ± 6.30	34.86 ± 5.69	1.94	.155	0.075
U-16	SJ (cm)	26.86 ± 5.82	28.79 ± 7.33	31.89 ± 7.71	2.30	.111	0.089
	CMJ (cm)	30.42 ± 6.18	33.36 ± 6.18	35.89 ± 9.21	1.57	.220	0.077
	AJ (cm)	35.48 ± 5.70	37.63 ± 8.95	40.97 ± 8.17	2.11	.132	0.084

U-14: Under 14 category; U-16: Under 16 category; SJ: Squat jump; CMJ: Countermovement jump; AJ: Abalakov jump; CL1: Competitive level 1; CL2: Competitive level 2; CL3–4: Competitive levels 3 and 4.
[a] : statistically different ($p < .05$) from PrePHV.

match demands. Goalkeepers' match performance analysis show up that diving action may be the most crucial action made by a goalkeeper, as it may be performed to intercept goal shots. The diving save is characterized by large forces exerted at push off generated in a very short period of time.[36] Consequently, good vertical jump capacity may be determinant for goalkeepers, as they are required to perform high vertical jumps to catch or deflect the ball as well as the mentioned diving actions.[37] It has been observed that goalkeepers tend to exhibit the highest jump values among all the positions.[38,39] In addition, Arnason et al., (2004)[40] show up that during selection processes the finally selected players had better jump values than the nonelected ones. This argument may be reflected in the positive trend between vertical jump and competitive level observed in this sample, goalkeepers competing in a higher CL tend to obtain higher vertical jump values than the goalkeepers competing in minor CLs. Furthermore, these differences were statistically significant for SJ and CMJ in the U-14 group. These results are comparable to Rebelo et al., (2013)[41] in which elite players perform higher vertical jumps than nonelite one. However, the results of this section should be taken with caution, as the sample size of some CLs was not sufficient to carry out statistical analysis independently (the authors combined CL3 and 4), which represents a limitation in this study.

This study provides an isolated assessment of the abilities that should be considered in the process of identifying and selecting young goalkeeping talents, so the results obtained should be approached with caution, understanding that there are other conditional variables, as well as technical, tactical, and psychological variables that may be influencing the selection process of young goalkeepers and have not been analyzed in this study. In future research, it would be interesting to globally analyze the effect of relative age and maturation in the selection of young goalkeepers, considering physical, technical, and tactical parameters that provide the reader with a broader perspective on the impact of these variables on the overall performance of the athlete.

As a conclusion, this study supports a better understanding of contextual factors as the influence of relative age, biological maturation and the level of competition in the young football goalkeepers' jumping performance. It was identified a trend towards an overrepresentation of goalkeepers born in the early months of the year. As well as results supporting the statement of maturation having a greater association than relative age with physical performance in young football goalkeepers. For all this, football professionals should assess and control biological maturation in young football goalkeepers, as maturity status may have an important role in the whole talent identification process to avoid an unfair selection process based on actual performance rather than identifying the goalkeepers with the potential to become elite players.

Conflicts of interest

The authors report there are no competing interests to declare.

References

1. Gil SM, Zabala-Lili J, Bidaurrazaga-Letona I, Aduna B, Lekue JA, Santos-Concejero J, et al. Talent identification and selection process of outfield players and goalkeepers in a professional soccer club. J Sports Sci. 2014;32(20):1931–9.
2. Williams AM, Ford PR, Drust B. Talent identification and development in soccer since the millennium. J Sports Sci. 2020;38 (11–12):1199–210.
3. Carling C, Le Gall F, Reilly T, Williams AM. Do anthropometric and fitness characteristics vary according to birth date distribution in elite youth academy soccer players? Scand J Med Sci Sports. 2009;19(1):3–9.
4. Peña-González I, Fernández-Fernández J, Moya-Ramón M, Cervelló E. Relative age effect, biological maturation, and coaches' efficacy expectations in young male soccer players. Res Q Exerc Sport. 2018;89(3):373–9.
5. Cobley S, Baker J, Wattie N, McKenna J. Annual age-grouping and athlete development: a meta-analytical review of relative age effects in sport. Sports Medicine. 2009;39(3):235–56.
6. Helsen WF, Van Winckel J, Williams AM. The relative age effect in youth soccer across Europe. J Sports Sci. 2005;23(6):629–36.
7. Yagüe JM, de la Rubia A, Sánchez-Molina J, Maroto-Izquierdo S, Molinero O. The relative age effect in the 10 best leagues of male professional football of the union of european football associations (UEFA). J Sports Sci Med. 2018;17(3):409–16.
8. Bliss A, Brickley G. Effects of relative age on physical and physiological performance characteristics in youth soccer. J Sports Med Phys Fitness. 2011;51(4):571–5.
9. Peña-González I, Javaloyes A, Cervelló E, Moya-Ramón M. The maturity status but not the relative age influences elite young football players' physical performance. Sci Med Football. 2022;6(3):309–16.
10. Radnor JM, Staines J, Bevan J, Cumming SP, Kelly AL, Lloyd RS, et al. Maturity has a greater association than relative age with physical performance in english male academy soccer players. Sports. 2021;9(12):1–13.
11. Deprez D, Coutts AJ, Fransen J, Deconinck F, Lenoir M, Vaeyens R, et al. Relative age, biological maturation and anaerobic characteristics in elite youth soccer players. Int J Sports Med. 2013;34(10):897–903.
12. Malina RM, Eisenmann JC, Cumming SP, Ribeiro B, Aroso J. Maturity-associated variation in the growth and functional capacities of youth football (soccer) players 13-15 years. Eur J Appl Physiol. 2004;91(5–6):555–62.
13. Buchheit M, Mendez-Villanueva A. Effects of age, maturity and body dimensions on match running performance in highly trained under-15 soccer players. J Sports Sci. 2014;32 (13):1271–8.
14. Buchheit M, Samozino P, Glynn JA, Michael BS, Al Haddad H, Mendez-Villanueva A, et al. Mechanical determinants of acceleration and maximal sprinting speed in highly trained young soccer players. J Sports Sci. 2014;32(20):1906–13.
15. Susana Gil, Gil J, Ruiz F, Irazusta A, Irazusta J. Physiological and anthropometric characteristics of young soccer players according to their playing position: relevance for the selection process. J Strength Cond Res. 2007;21(2):438–45.
16. Tienza-Valverde A, Hernández-Beltrán V, Espada MC, Bravo-Sánchez A, Santos FJ, Gamonales JM. Analysis of individual performance indicators of football goalkeeper. Apunts Sports Medicine. 2023;58(219).
17. Towlson C, Cobley S, Midgley AW, Garrett A, Parkin G, Lovell R. Relative age, maturation and physical biases on position allocation in elite-youth soccer. Int J Sports Med. 2017;38 (3):201–9.
18. Perez-Arroniz M, Calleja-González J, Zabala-Lili J, Zubillaga A. The soccer goalkeeper profile: bibliographic review. Phys Sportsmedicine. 2023;51(3):193–202.

19. Rebelo-Gonçalves R, Figueiredo AJ, Coelho-e-Silva MJ, Tessitore A. Assessment of technical skills in young soccer goalkeepers: reliability and validity of two goalkeeper-specific tests. J Sports Sci Med. 2016;15(3):516–23.
20. Peña-González I, Javaloyes A, Sarabia JM, Moya-Ramón M. Relative age-related differences between different competitive levels and field positions in young soccer players. Res Sports Med. 2021;29(3):254–64.
21. Mirwald RL, Baxter-Jones ADG, Bailey DA, Beunen GP. An assessment of maturity from anthropometric measurements. Med Sci Sports Exerc. 2002;34(4):689–94.
22. Kozieł SM, Malina RM. Modified maturity offset prediction equations: validation in independent longitudinal samples of boys and girls. Sports Med. 2018;48(1):221–36. Jan.
23. Bradley PS, Mohr M, Bendiksen M, Randers MB, Flindt M, Barnes C, et al. Sub-maximal and maximal Yo-Yo intermittent endurance test level 2: heart rate response, reproducibility and application to elite soccer. Eur J Appl Physiol. 2011;111 (6):969–78.
24. Pitlovic V, Saric G, Pitlovic H, Jovanovic S, Jurisic D, P V, et al. A correlation of peak height velocity and olecranon apophysis ossification assessed by ultrasound. Coll Antropol. 2013;37 (4):1285–9.
25. Bosco C, Pekka L, Komi P V. A simple method for measurement of mechanical power in jumping. Appl Physiol, Nutrit Metabol. 1983;50:273–82.
26. Rodríguez-Rosell D, Mora-Custodio R, Franco-Márquez F, Yáñez-García JM, González-Badillo JJ. Traditional vs. Sport-specific vertical jump tests: reliability, validity, and relationship with the legs strength and sprint performance in adult and teen soccer and basketball players. J Strength Cond Res. 2017;31(1):196–206.
27. Markovic G, Dizdar D, Jukic I, Cardinale M. Reliability and factorial validity of squat and countermovement jump tests. J Strength Cond Res. 2004;18(3):551–5.
28. Balsalobre-Fernández C, Glaister M, Lockey RA. The validity and reliability of an iPhone app for measuring vertical jump performance. J Sports Sci. 2015;33(15).
29. Bogataj Š, Pajek M, Hadžić V, Andrašić S, Padulo J, Trajković N. Validity, reliability, and usefulness of my jump 2 app for measuring vertical jump in primary school children. Int J Environ Res Public Health. 2020;17(10).
30. Pueo A.B., Hopkins W.G., Penichet-Tomas A., Jimenez-Olmedo J.M. Jump height Accuracy of flight time and countermovement-jump height estimated from videos at different frame rates with MyJump. 2023;595–601.
31. Mujika I, Vaeyens R, Matthys SPJ, Santisteban J, Goiriena J, Philippaerts R. The relative age effect in a professional football club setting. J Sports Sci. 2009;27(11):1153–8.
32. Lloyd RS, Oliver JL. The youth physical development model: a new approach to long-term athletic development. Strength Cond J. 2012;34(3):61–72.
33. Radnor JM, Oliver JL, Waugh CM, Myer GD, Moore IS, Lloyd RS. The influence of growth and maturation on stretch-shortening cycle function in youth. Sports Medicine. 2018;48(1):57–71.
34. Meylan C, Cronin J, Oliver J, Hughes M. Talent identification in soccer: the role of maturity status on physical, physiological and technical characteristics. Int J Sports Sci Coach. 2010;5 (4):571–92. [cited 2020 Oct 8]Available from http://journals.sagepub.com/doi/10.1260/1747-9541.5.4.571.
35. Reilly T, Williams AM, Nevill A, Franks A. A multidisciplinary approach to talent identification in soccer. J Sports Sci. 2000;18 (9):695–702.
36. Ibrahim R, Kingma I, de Boode VA, Faber GS, van Dieën JH. Kinematic and kinetic analysis of the goalkeeper's diving save in football. J Sports Sci. 2019;37(3):313–21.
37. Ziv G, Lidor R. Physical characteristics, physiological attributes, and on-field performances of soccer goalkeepers. Int J Sports Physiol Perform. 2011;6(4):509–24.
38. Sporis G, Jukic I, Ostojic S, Milanovic D. Fitness profiling in soccer: physical and Physiologic chareacteristics of elite players. October. 2009;23(7):1947–53.
39. Boone J, Vaeyens R, Steyaert A, Vanden Bossche L, Bourgois J. Physical fitness of elite Belgian soccer players by player position. J Strength Cond Res. 2012;26(8):2051–7.
40. Arnason A, Sigurdsson SB, Gudmundsson A, Holme I, Engebretsen L, Bahr R. Physical fitness, injuries, and team performance in soccer. Med Sci Sports Exerc. 2004;36(2):278–85.
41. Rebelo A, Brito J, Maia J, Coelho-E-Silva MJ, Figueiredo AJ, Bangsbo J, et al. Anthropometric characteristics, physical fitness and technical performance of under-19 soccer players by competitive level and field position. Int J Sports Med. 2013;34 (4):312–7.