Acta Kinesiologica 17 (2023) Issue.2
DOI. 10.51371/issn.1840-2976.2023.17.2.1

Original Investigation

Analysis of the effects of the transitional period on performance parameters in young soccer players

Óscar Villanueva-Guerrero[a*], Elena Mainer-Pardos[a*], Hadi Nobari[b,c], Demetrio Lozano[a], José L. Arjol-Serrano[a], Alberto Roso-Moliner[a]
[a]Health Sciences Faculty, Universidad San Jorge.
[b]Faculty of Sport Sciences, University of Extremadura, 10003 Cáceres, Spain.
[c]Department of Exercise Physiology, Faculty of Educational Sciences and Psychology, University of Mohaghegh Ardabili, Ardabil, Iran.

Purpose: The transitional period has been shown to produce detraining effects in soccer players and could increase the risk of injury. The primary purpose of this study was to analyse the impact of the transitional period (4-6 weeks) on lower body power levels by vertical and horizontal jumping in young players and compare them with the first part of the regular season, using the peak height velocity (PHV) as a covariate.
Methods: Eighteen elite youth players (15.73 ± .25 years) belonging to a professional soccer club that competes in national U-16 categories were evaluated before starting the transitional period (M1: end of the season) and at the end of it (M2: end of transitional period), as well as in the middle of the regular season (M3). The variables analyzed in the study were the vertical jump (e.g., CMJ) and horizontal jump.
Results: Improvements were observed in all the variables during the transitional period. They were also like those of the first part of the season. When analysing responders and non-responders to the PHV between M1, M2 and M3, all the vertical jump variables show significant differences ($P < .05$). In contrast, no significant differences were found in the horizontal jump ($P > .05$).
Conclusions: It is shown that the transitional period (7 weeks) does not have detraining effects on young players because they are in a moment of muscular development. In addition, the responder players have higher values in power levels and have produced more tremendous changes during study time than the non-responder players.

Keywords: Transitional period; power; adolescent players; soccer; peak height velocity.

Introduction

Soccer is a team sport in which 11 against 11 players face each other, and the objective is to score more goals in the opponent's goal than the opponent [1]. It is an intermittent sport where most of the playing time is performed at low intensity, although the decisive actions are performed at high intensity [2]. In the conditional section, this sport evolves towards a highly physical component, where power plays a fundamental role [3]. The ability of soccer players to generate power, the efficiency of the muscular system and movement patterns are the factors that most affect performance in actions such as sprints, changes of direction or jumps [4].
A full season in soccer consists of a pre-season period and a competitive period. During the pre-season, the load intensifies to try to reach, once again, the appropriate values to compete at the required level [5]. In the competitive period, in general, there is a progressive decrease in the physical load in training, mainly in the training volume. The transitional period is the phase between the end of a season and the start of the following pre-season [6]. Generally, the transitional period in professional soccer lasts approximately 4 weeks [5]. A systematic review and meta-analysis[5] suggests this off-season as a window of opportunity to improve performance and prevent future injuries. It is a stage that allows the athlete to recover both physically and mentally from the load of the season and work on specific aspects or needs of each player, such as imbalances or asymmetries in the lower limbs[5]. According to Bishop et al., more than 10% asymmetry between limbs increases the risk of injury [7]. A study by Gonzalo-Skok showed that unilateral exercises favours the reduction of asymmetries between limbs and improve power in those actions that require a unilateral application of power [8]. The transitional period would generally entail detraining effects on the athlete in terms of both explosive and endurance intensive efforts [9], so individualised training protocols should be created to mitigate the deterioration of performance variables [10]. A program with 2 weeks of rest and 4 weeks of training resulted in players maintaining their functional performance in high-intensity activities, whereas aerobic capacity and body composition worsened during this period [11].
The development of physical fitness in young athletes leads to improvements and opportunities to reach professional sport, so maximizing skills development during the growth age can be a critical factor, as the ratio of young players reaching the professional soccer is minimal [12]. Physical and physiological abilities undergo the greatest change during adolescence [13], with pubertal age being the critical time for performance development in young players [14]. According to Lloyd et al.,[15] the optimal period for improving physical, technical and physiological abilities is between the ages of 12 and 16. This change does not

occur in all adolescents at the same time, favouring players who mature earlier [16]. The peak height velocity (PHV) is the moment when the maximum height velocity occurs and is an indication of the maturational age [15]. The work methodology at this stage must take into account the maturational development, as early maturation can anticipate performance, just as many athletes could be discarded due to their physique without taking into account the height peak [17]. On the other hand, the "Relative Age Effect" shows how being born in the first months of the year has significant implications for future success, because these are athletes who have greater physical and physiological maturity in the training stages than those born in the final months [18,19]. In this study, it is advisable to carry out an analysis of responders and non-responders [20], which will help us to identify if the player is responding to the process. This analysis differentiates the effects produced in the intervention between the most developed and less developed players in reference to the PHV. Making this comparison between responders and non-responders to the PHV can provide additional information to understand the evolution of athletes.

The relationship between strength and speed allows us to identify the mechanical capabilities of the musculoskeletal system to produce strength, power, and speed [21]. Jump height is a good predictor of muscle power, and therefore several types of vertical jumps have been used as standardized tests of athletic performance [22]. The bilateral Counter Movement Jump (CMJ) is one of the most reliable tests for the estimation of explosive power in soccer players [23]. The horizontal jump is related to sprint speed [24] and is also used as a test of lower body explosive power, as it has been shown to have good reproducibility and validity compared with different other vertical jump tests [25].

So far, different research has been carried out in adult populations on the transitional period showing detraining effects between the end of one season and the beginning of the next one [5,6]. The study of variations in physical fitness in young soccer players is frequent in research [13,14 15]. However, there is a lack of research on what effect this transitional period may have on growing players and how the PHV may affect these changes.

The main objectives of this study were to observe the possible effects of the transition period in young soccer players on power levels assessed by vertical and horizontal jump, to analyze the possible relationship between the effects of the transition period and PHV, to compare the values at the beginning of the season with those obtained after the first training phase at mid-season, correlating them with PHV, and to compare the effect on the variables according to responders and non-responders. It was hypothesized that the power values obtained with the tests performed on soccer players in the youth stage after the transitional period will decrease with respect to the same tests performed at the end of the previous season. This decrease will be smaller in those soccer players who are closer to their PHV, so they may have less of a detraining effect.

Methods

Participants

Participants were 18 elite male youth soccer players (Mean 15.73 ± .25, PHV 13.84 ± .59) belonging to a professional soccer club. Inclusion criteria were as follows: (i) Players between 15 and 16 years of age belonging to the club in the 2020-2021 and 2021-2022 seasons, (ii) Players without previous injury during the month prior to any assessment. The exclusion criteria were as follows: (i) Failure to complete any assessment test, (ii) Players who at the time of testing may have been affected by any type of injury or illness that could impair their abilities, (iii) Players who for any reason were unable to complete at least 80% of the sessions scheduled in their training program for the transitional period and in the subsequent training period. The final sample was reduced from 24 to 18 players for not meeting these criteria.

Experimental Design

The study design was a quasi-experimental longitudinal cohort prospective pre-test post-test of a single group. In addition, another post-test was conducted to compare the effects of the transitional period with those of the first phase of the regular season. Prior to data collection, written informed consent was obtained from both the players and their parents. The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Ethics Committee of the Ethics Committee of the San Jorge University (REPORT No. 26/2/21-22).

In this study the assessments were conducted at three points in time: moment 1 (M1: end of the 2020-2021 season), moment 2 (M2: start of the 2021-2022 season) and moment 3 (midseason 2021-2022) . This study started in June 2021 and ended in December 2021. The time between moments was as follows: (i) Between M1 and M2, the transitional period, 7 weeks elapse; (ii) Between M2 and M3, the first part of the regular season, 16 weeks elapse.

The intervention lasted 7 weeks, from the end of one season until the start of the following season. During this period, the players were given a specific training program with two objectives, on the one hand, to favour recovery from muscle fatigue and mental recovery from the wear and tear of the previous season and, on the other hand, to maintain or increase basic strength for the following season. During the first 4 weeks of the transitional period, the training program followed a series of recommendations for the players to stay active with different proposals complementary to soccer, favouring rest, healthy lifestyle habits and maintaining the level of physical activity, with a weekly body weight control. In the last 3 weeks, the main objective was to reach the level of physical condition necessary for pre-season. The players performed two aerobic training sessions and two power training sessions (plyometrics and self-loading) per week, with a progressive increase in volume and intensity. The researcher controlled the load of the training sessions of his players with a weekly recording of the sessions taking into account the duration of the session and the perception of subjective effort.

The training program during the first part of the regular season was based on 4 training sessions per week with a game duration of 90 minutes, as well as including power sessions once a week. The competition in which the players in the study participate is the top national U-16 category. The competition format is a regular league played one day per week, during the weekend.

Methodology

The variables analyzed in the study were the vertical jump (e.g., CMJ) and horizontal jump.. Both tests were performed in a bilateral and unilateral manner. The following terminology was used to record the variables: (i) CMJ for bilateral vertical jump (ii) CMJR for vertical jump with right. CMJL for vertical jump with left. (iv) HJ for the bilateral horizontal jump. (v) HJR for horizontal jump with right. (vi) HJL for horizontal jump with left leg. These assessment tests are the primary method for assessing muscle function and imbalances in athletes.

Trained staff followed the International Standard for Anthropometric Assessment standards (ISAK) to conduct anthropometric measurements (weight, height, sitting height and leg length) of the participants. In addition, other measurements (date of birth) were taken to determine the maturational peak as a grouping variable. Players were divided into two groups according to average scores on the M1 assessments: (i) responders, who were above average, and (ii) non-responders, who were below average on the covariate peak height velocity.

The procedure at all three assessment time points was the same. The assessment tests were conducted between 16:00 and 18:00. The anthropometric measurements for the PHV were measured in the M1 before the beginning of the physical performance tests. An aerobic warm-up on a stationary bike was performed for 10' with a subsequent 5' muscle activation. Participants were asked to avoid high-intensity exercise for at least 48 hours prior to the performance assessment tests [26]. The order of the tests was according to the order they appear in the manuscript, always starting with bilateral, then right leg and finally left leg.

Vertical Jump

The vertical jump tests were analysed using an iPhone 12 electronic device with the "MyJump2" APP, where we know the jump height indirectly through the flight time [27]. The assessment protocol for each test (bilateral, right and left) was performed 3 times with 45 seconds of recovery and the best jump was recorded [28]. To certify correct technical execution of the vertical jumps, the instructors observed the subjects, checking that the flight phase was performed without leg flexion and that the arms remained tight to the hips throughout the execution of the jump. The variables used for subsequent analyses were bilateral (CMJ), right with one leg (CMJR), left with one leg (CMJL).

Horizontal Jump

Horizontal jump (HJ) performance (i.e., distance achieved) was assessed with a tape measure [29]. The assessment protocol for each test (bilateral, right and left) was performed 3 times with 45 seconds of recovery, and the best jump was recorded [28]. To certify correct technical execution of the horizontal jumps, the instructor observed the subjects, controlling the landing phase, so that the subjects maintained their balance at the moment of landing for 2 seconds and kept their hands clasped behind their backs. The variables used for subsequent analyses were bilateral (SH), right with one leg (HJR), left with one leg (HJL).

Peak Height Velocity.

The anthropometric tests were carried out in the M1 with the aim of determining the PHV of the subjects who participated in the study. To determine the PHV, anthropometric measurements of weight, height, sitting height and leg length were taken. Height (standing, sitting and leg length) and weight measurements were taken respectively with a Ferbixo stadiometer accurate to 0.1 cm and a Scale 100 glass scale accurate to 0.1 kg. Mirwald's formula was used to establish the offset of subjects' maturity and age in the PHV [30].

$$PHV = (-9.236 + (.0002708 \, x \, Leg\ Length \, x \, Seated\ Height) + (-.001663 \, x \, Age \, x \, Leg\ Length) + (.7216 \, x \, Age \, x \, Seated\ Height + ((.02292 \, x \, Weight/height) \, x \, 100))$$

Statistical analysis

Statistical analyses were performed using SPSS (version 25.0, IBM SPSS Inc., Chicago, IL, USA). The significance level was set at $P < .05$. Data are presented as mean and standard deviation (SD). The normality of the data was checked with the Shapiro-Wilk test, all variables met the assumptions of normality ($P > .05$), and parametric tests were performed. The data (i.e., vertical, and horizontal jump variables) were analysed by repeated measures ANOVA using PHV as a covariate (PHV age = 13.84 years). Subsequently, all variables were analysed with the LSD post hoc test. Effect size was calculated using Hedges' g and interpreted according to the following criteria [31,32]: trivial < .2; small = .2- .6; moderate = .6-1.2; large = 1.2-2.0; very large = 2.0-4.0; and extremely large 4.0. Finally, the independent Student's t-test divided the sample into responders and non-responders by taking the mean of the M1 variables as the cut-off value and then comparing M1 with M2 and M3.

Results

The repeated measures ANOVA showed the following results. The CMJ (F= 4.413; P = .020) showed time effects, however when PHV (F= .406; P = .533) was entered as a covariate, there were no significant differences between time points (Table 1).

Table 1. Differences between repeated measures at three different points in time.

Variable (cm)	Moment 1 M ± SD	Moment 2 M ± SD	Moment 3 M ± SD	Main effect of the time		PHV x Time effect	
				F	*P*	F	*P*
CMJ	32.3 ± 5.78	32.9 ± 5.48	33.4 ± 5.56	4.413	.020	.406	.533
CMJR	18.4 ± 4.55	18.9 ± 4.60	19.3 ± 4.08	1.553	.226	1.005	.331
CMJL	18.5 ± 4.64	19.1 ± 4.67	19.5 ± 4.33	2.651	.085	.598	.451
HJ	176.2 ± 10.4	181.5 ± 10.1	178.7 ± 8.30	4.484	.190	.650	.432
HJR	170.9 ± 11.1	175.8 ± 11.4	174.8 ± 10.5	2.245	.121	.567	.462
HJL	170.4 ± 11.8	177.7 ± 11.9	174.9 ± 10.8	5.084	.120	.244	.628

CMJ: Vertical jump; HJ: Horizontal jump; PHV: peak heigh velocity; M1: Moment 1; M2: Moment 2; M3: Moment 3; SD: Standard Deviation.

The post hoc analysis test showed that there were differences between M2 and M3 (P = .040) and introduced the variable PHV (P = .045). The total effect size was trivial (g= .17) (Table 2).

Table 2. Pairwise differences and effect size between moments.

Variable (cm)	Moment	Dif. in averages	95% CI for D		LSD	PHV	Hedge's g
			Lower	Higher	*P*	*P*	Value
CMJ	M1-M2	-.632	-1.340	.077	.077	.087	.10 (-.3;.6) T
	M2-M3	-1.057	-2.061	-.052	.040	.045	.17 (-.3;.6) T
	M1-M3	-.425	-.872	.022	.061	.056	.07 (-.5;.4) T
CMJR	M1-M2	-.542	-1.814	.792	.381	.378	.09 (-.4;.5) T
	M2-M3	-.917	-2.165	.382	.139	.139	.18 (-.3;.6) S
	M1-M3	-.376	-1.079	.327	.275	.289	.08 (-.4;.5) T
CMJL	M1-M2	-.663	-1.826	.499	.245	.253	.13 (-.3;.6) T
	M2-M3	-1.015	-2.051	.021	.054	.060	.21 (-.2;.7) S
	M1-M3	-.352	-.853	.150	.157	.170	.07 (-.4;.5) T
HJ	M1-M2	-5.278	-9.589	-.967	.019	.022	.48 (0;1) S
	M2-M3	-2.444	-5.784	.895	.141	.149	.24 (-.2;.7) S
	M1-M3	2.833	-.605	6.271	1.100	.096	-.29 (-.8;.2) S
HJR	M1-M2	-7.278	-11.572	-2.984	.002	.003	.40 (-.1;.9) S
	M2-M3	-4.500	-9.511	.551	.075	.081	.34 (-.1;.8) S
	M1-M3	2.778	-2.448	8.003	.278	.289	.08 (-.5;.4) T
HJL	M1-M2	-4.889	-10.760	.982	.097	.102	.58 (0;1) M
	M2-M3	-3.889	-8.362	.585	.084	.083	.37 (-.1;.8) S
	M1-M3	1.000	-3.987	5.987	.678	.687	.23 (-.7;.2) S

CMJ: Vertical jump; HJ: Horizontal jump.M1: Moment 1; M2: Moment 2; M3: Moment 3; Effect size: Trivial <.2; Small = .2-.6; Moderate = .6 – 1.2; Large = 1.2-2.0; Very large = 2.0-4.0; Extremely large > 4.0.

In addition, the HJ showed (F= 4.484; *P* = .190) time effects, however, when PHV (F= .650; *P* = .432) was introduced as a covariate, there were no significant differences between the time points. The post hoc test showed that there were differences between M1 and M2 *P* = .002) and when introducing the PHV variable (*P* = .003). The overall effect size was small (*g*= .40) (Table 3). Finally, HJR (F= 4.325; *P* = .020) showed effects over time and when PHV was introduced as a covariate these significant differences remained (F= 2.245; *P* = .121) (Table 1). The post hoc test showed that there were differences between M1 and M2 (*P* = .019) and when introducing the variable PHV (*P* = .022). The overall effect size was small (g= .48) (Table 2).

Table 3. Differences and effect size between responders and not responders.

Variable (cm)	Moment	Responders	Non responders	Average diff.	95% CI	*P*	Hedge's g
	M1-M2	37.7 ± 4.82	29.1 ± 1.58	8.55	(5.12; 11.9)	<.001*	2.4 (-3.6;-1.1)VL
CMJ	M1-M3	37.7 ± 5.54	29.8 ± 1.95	7.90	(3.93; 11.8)	.001*	1.9 (-3;-.7) L
	M2-M3	38.8 ± 4.94	29.1 ± 1.58	8.55	(5.53; 12.4)	<.001*	2.51 (1.2;3.7) L
	M1-M2	23.5 ± 1.96	16.1 ± 3.05	7.55	(4.79; 10.3)	<.001*	2.66 (1.3;3.9)VL
CMJR	M1-M3	23.1 ± 1.67	16.9 ± 3.18	6.21	(3.42; 9.00)	<.001*	2.17 (.9;3.3) L

	M2-M3	23.1 ± 1.79	15.6 ± 1.15	7.41	(5.90; 8.92)	<.001*	4.80 (2.9;6.6) EL
	M1-M2	22.5 ± 3.95	15.8 ± 2.39	6.67	(3.40; 9.93)	.001*	1.93 (-3;-.8) L
CMJL	M1-M3	22.6 ± 3.56	16.3 ± 2.20	6.30	(3.35; 9.26)	<.001*	2.02 (.8;3.1) L
	M2-M3	23.3 ± 2.39	15.7 ± 1.18	7.63	(5.74;9.52)	<.001*	3.83 (2.2;5.3) EL
	M1-M2	187.8 ± 9.72	177.5 ± 8.27	10.31	(1.12; 19.38)	.280	1.1 (-2.1;0) M
HJ	M1-M3	185.2 ± 7.54	174.5 ± 5.80	10.74	(4.06; 17.14)	.040*	1.56 (.4;2.6) M
	M2-M3	182.8 ± 9.64	175.4 ± 5.50	7.47	(.16;15.14)	.050*	0.93 (0;1.9) M
	M1-M2	182.8 ± 13.5	172.5 ± 7.60	10.33	(.64; 21.31)	.063	.89 (-1.8;0) M
HJR	M1-M3	179.4 ± 7.90	170.4 ± 11.9	9.00	(1.12; 19.12)	.078	.84 (-1.8;0) M
	M2-M3	178.5 ± 9.74	170.3 ± 10.32	9.22	(.84; 19.29)	.070	.77 (.1;1.7) M
	M1-M2	181.3 ± 12.8	171.4 ± 8.39	9.97	(.68; 20.63)	.650	.90 (-1.8;0) M
HJL	M1-M2	181.38 ± 12.89	171.40 ± 8.39	9.97	(.68; 20.63)	.650	.90 (-1.8;0) M
	M1-M3	180.1 ± 9.04	170.6 ± 9.76	9.52	(0.13; 19.18)	.530	.95 (1.9-0) M
	M2-M3	178.8± 10.3	171.6 ± 9.98	7.27	(2.92; 17.47)	.150	.68 (.2;1.6) M

CMJ: Vertical jump; HJ: Horizontal jump. M1: Moment 1; M2: Moment 2; M3: Moment 3; Effect size: Trivial <.2; Small = .2-.6; Moderate = .6 – 1.2; Large = 1.2-2.0; Very large = 2.0-4.0; Extremely large > 4.0.

Table 3 presents the differences in performance between responders and non-responders. Responders are those above the mean PHV and non-responders are those below the mean PHV, i.e., responders are those who have matured later than the mean (+13.84 years) and non-responders are those who have matured earlier than the mean (-13.84 years). Between M1, M2 and M3 all vertical jump variables show significant differences ($P < .05$; g= 1.90 to 4.80) between responders and non-responders. While between M1/M2 and M3 there were also significant differences ($P < .05$; g= .93 to 1.56) in HJ be-tween responders and non-responders.

Discussion

The main purpose of this study was to analyse the effects of the transitional period in young soccer players on power levels, assessed through vertical and horizontal jump and to compare these effects with those occurring during the regular season. Finally, carrying out the study with growing players, the covariate of peak growth velocity was used to observe the relationship with lower body power levels. The main evidence from the study revealed that the maturational peak is highly correlated with training effects. When analysing between PHV responders and non-responders, significant differences between groups were experienced in all vertical jump tests.

The values obtained in the lower body power levels at the beginning and end of the transitional period studied were similar, and a small improvement can even be observed in each variable analysed. In comparison with the current studies, according to Clemente et al. [5] significant detrimental effects of the cessation of training were observed ($p < .05$), as well as negative detrimental effects of off-season training programmes for the vertical jump in professional male soccer players. A study by Melchiorri et al. [33] in which U-16 players experienced a transitional period without physical activity showed a high magnitude of significant decreases in physiological variables. These results may be related to the growth phase of the players, which will be discussed in the subsequent analysis of peak growth velocity.

When analysing the results over the time of the study, the CMJ showed significant improvements over the total time of the study ($P = .020$). When comparing the effects of the transitional period with those of the first part of the season, separating them into M1-M2 and M2-M3, it could be observed that it was in the first part of the season where these significant improvements were found when performing the post hoc analysis (P =.04). How-ever, in the horizontal jump performance, greater effects were observed in the transitional period SH ($P = .010$) and HJR ($P = .019$) with respect to the first part of the season. These analyses are without considering the PHV. It seems that there is an improvement in lower body power in our athletes due to the fact that they have improved throughout the study in all the variables analysed and the tests performed are related to determine lower body power indirectly [22, 25]. According to Lloyd et al. [34], detrained youngsters obtain improvements in jump height regardless of the type of training or maturity stage, so that in relation to this study, the tendency to improve in growing age is always upward, whether it is a specific training program of the transitional period or the training load of the regular season.

By introducing PHV as a covariate in the present study, changes in the results were observed after data analysis. In the repeated measures ANOVA when PHV was introduced as a covariate, there were no significant differences between the evaluation times. In the post hoc analysis with PHV as a covariate, significant differences were found in CMJ between M2 and M3, and in HJ and HJR between M1 and M2. These variables analysed seem to be influenced by PHV, because changes were observed when it was included as a covariate. The current literature on this topic shows that physical performance in the training stage is closely related to the maturation of the players [35]. In the growing age, the interaction of genes, hormones, nutrients and environmental factors trigger physical and functional alterations in young players [36]. The age of the study subjects is a key time for skill acquisition and performance development in young elite soccer players [14]. The results of this study seem to be related to current research on maturational age players, as most of the mentioned articles include PHV.

After analysing between responders and non-responders to the PHV, significant differences between groups were experienced in all vertical jump tests. The term responder has been used to describe individuals who showed a better response and non-responder those who showed a worse response than the mean of all subjects who participated in the intervention [37]. Responders are those who are above the mean PHV, and non-responders are those who are below the mean PHV, i.e., non-responders are those who have matured later than the mean (-13.84 years). Responders have improved more in the vertical jump than in the horizontal jump. Between M1, M2 and M3 all vertical jump variables show significant differences ($P < .05$; g= 1.90 to 4.80) between responders and non-responders. While between M1, M2 and M3 there were also significant differences ($P < .05$; g= .93 to 1.56) in SH between responders and non-responders. Furthermore, when looking at the difference in means at each time point between one group and the other, differences were found between 7.90 cm and 8.55 cm in the bilateral vertical jump test (CMJ) and 7.47 cm to 10.74 cm difference in the bilateral horizontal jump. This data demonstrates how players above the mean 13.84 years of PHV obtain higher values than players below the mean. In relation to current research, the scientific literature highlights that players who have matured earlier have an advantage over those who mature later [12]. These results reinforce the importance of paying attention to the maturational peak and not only to the chronological age, as many athletes are discarded because of their physique without taking into account the height peak [13].

The research conducted has several limitations. The first limitation is the small sample size, which means that research with a larger number of subjects is needed to improve the present study. Another limitation we found in the study is the monitoring of the work during the transitional period, as it is a training program that is not controlled in per-son, and more so in young players, which means that the reliability of the correct execution of the program is not the maximum. Also, the comparison between the different moments of the study (M1, M2 and M3), is different in terms of time, since during M1 and M2 7 weeks elapse, while between M2 and M3 18 weeks (4 months) elapse, so there is a time difference for external factors to influence the results of the research.

One limitation of our current study is the use of covariation to detect responders and non-responders. Since we had only one group of participants, covariation may not have been necessary and could have introduced unnecessary complexity to the analysis. While we aimed to account for the potential influence of maturational age (PHV) on the performance outcomes, it could be argued that this could have been addressed more straightforwardly through a pilot-restricted group study. Therefore, to address the limitation mentioned above, we recommend that future studies consider incorporating a pilot restricted group study as a complementary part of the main investigation protocol. This approach would allow for a more direct comparison between responders and non-responders without the need for covariates and provide clearer and more straightforward results.

Practical Applications

As future practical applications, it is proposed to perform an analysis of the players' lower body asymmetries.. An asymmetry greater than 10% means that the player is at greater risk of injury, as well as a negative relationship with sprint time [38]. The transitional period can be an opportunity to reduce asymmetries between lower limbs. To reduce asymmetries, Gonzalo-Stock et al. [39], propose starting the power work with the leg that performs worst in the tests carried out, and it also seems that on occasions it could be interesting to carry out a greater volume of work with this leg.

Conclusions

The results of the present study show that training during the transitional period is necessary for the improvement of performance in young soccer players, because the transitional period is the optimal time to improve physical, technical, and physiological capabilities. In addition, calculating or assessing the maturational age of growing soccer players allows training to be individualized, adapting the program by applying stimuli that are more appropriate to the maturational moment, thus achieving the player's development potential.

Acknowledgments

The authors would like to thank the team’s coaches and players for their cooperation during all data collection procedures.

Ethical Committee approval

The research was granted by Ethics Committee of the San Jorge University (REPORT No. 26/2/21-22).

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Topic

Sport Science.

Conflicts of interest

The authors have no conflicts of interest to declare.

Funding

This study received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Declaration if used ChatGPT

We don't used ChatGPT.

Author-s contribution

Conceptualization, O.V.-G., E.P.-M. and J.-L.A..; methodology, O.V.-G., E.P.-M., H.N., D.L., A.R.-M. and J.-L. A.; formal analysis, O.V.-G., E.P.-M. and H.N.; investigation, O.V.-G., E.P.-M., D.L., A.R.-M. and J.-L. A.; writing—original draft preparation, , O.V.-G., E.P.-M. and J.-L.A. ; writing—review and editing, O.V.-G., E.P.-M., H.N., D.L., A.R.-M. and J.-L. A.. All authors have read and agreed to the published version of the manuscript.

References

1. Stølen T, Chamari K, Castagna C, Wisløff U. Physiology of soccer: an update. *Sports Med.* 2005;35:501-536. doi: 10.2165/00007256-200535060-00004.
2. Orendurff MS, Walker JD, Jovanovic M, et al. Intensity and duration of intermittent exercise and recovery during a soccer match. *J Strenght Cond Res*. 2010;24(10):2683-2692. doi: 10.1519/JSC.0b013e3181bac463.
3. Sarmento H, Anguera MT, Pereira A, Araújo D. Talent identification and development in male football: A systematic review. *Sports Med*. 2018;48:907-931. doi: 10.1007/s40279-017-0851-7.
4. Arregui-Martin MA, Garcia-Tabar I, Gorostiaga EM. Half soccer season induced physical conditioning adaptations in elite youth players. *Int J Sports Med*. 2020;41(02):106-112. doi: 10.1055/a-1014-2809.
5. Clemente FM, Ramirez-Campillo R, Sarmento H. Detrimental effects of the off-season in soccer players: a systematic review and meta-analysis. *Sports Med.* 2021;51:795-814. doi: 10.1007/s40279-020-01407-4.
6. Silva JR, Brito J, Akenhead R, Nassis GP. The transition period in soccer: a window of opportunity. *Sports Med*. 2016;46:305-313. doi: 10.1007/s40279-015-0419-3.
7. Bishop C, McAuley W, Read P, et al. Acute effect of repeated sprints on interlimb asymmetries during unilateral jumping. *J Strenght Cond Res*. 2021;35(8):2127-2132. doi: 10.1519/JSC.0000000000003109
8. Gonzalo-Skok O, Tous-Fajardo J, Suarez-Arrones L, Arjol-Serrano JL, Casajús JA, Mendez-Villanueva A. Single-leg power output and between-limbs imbalances in team-sport players: Unilateral versus bilateral combined resistance training. *Int J Sports Physiol Perform.* 2017;12(1):106-114. doi: 10.1123/ijspp.2015-0743.
9. Chamari K, Padulo J. 'Aerobic' and 'Anaerobic' terms used in exercise physiology: a critical terminology reflection. *Sports Med Open*. Dec 2015;1(1):9. doi:10.1186/s40798-015-0012-1
10. Parpa K, Michaelides MA. The effect of transition period on performance parameters in elite female soccer players. *Int J Sports Med*. 2020;41(08):528-532. doi: 10.1055/a-1103-2038
11. Requena B, García I, Suárez-Arrones L, et al. Off-season effects on functional performance, body composition, and blood parameters in top-level professional soccer players. *J Strenght Cond Res.* 2017;31(4):939-946. doi: 10.1519/JSC.0000000000001568.
12. Teixeira AS, da Silva JF, Carminatti LJ, et al. Reliability and validity of the Carminatti's test for aerobic fitness in youth soccer players. *J Strenght Cond Res.* 2014;28(11):3264-3273. doi: 10.1519/JSC.0000000000000534.
13. Pearson D, Naughton GA, Torode MJ. Predictability of physiological testing and the role of maturation in talent identification for adolescent team sports. *J Sci Med Sport.* 2006;9(4):277-287. doi: 10.1016/j.jsams.2006.05.020
14. Rommers N, Mostaert M, Goossens L, et al. Age and maturity related differences in motor coordination among male elite youth soccer players. *J Sports Sci.* 2019;37(2):196-203. doi: 10.1080/02640414.2018.1488454
15. Lloyd RS, Oliver J. The youth physical development model: A new approach to long-term athletic development. *J Strenght Cond Res.* 2012;34(3):61-72. doi: 10.1519/SSC.0b013e31825760ea
16. 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*. 2010;5(4):571-592. doi: 10.1260/1747-9541.5.4.571
17. Holienka M, Babic M, Doležajová L, Šelinger P, Musilová E. Motor performance of young soccer players based on their biological age. *J Physical Education*. 2017;17(4):2508-2512. doi: 10.7752/jpes.2017.04282
18. 18. 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.
19. Deprez D, Vaeyens R, Coutts A, Lenoir M, Philippaerts R. Relative age effect and Yo-Yo IR1 in youth soccer. *Int J Sports Med*. 2012;33(12):987-993. doi: 10.1055/s-0032-1311654
20. Atkinson G, Williamson P, Batterham AM. Issues in the determination of 'responders' and 'non-responders' in physiological research. *Exp Physiol.* 2019;104(8):1215-1225. doi: 10.1113/EP087712.
21. Jiménez-Reyes P, Samozino P, Brughelli M, Morin J-B. Effectiveness of an individualized training based on force-velocity profiling during jumping. *Front Physiol*. 2017;7:677. doi: 10.3389/fphys.2016.00677
22. Jiménez-Reyes P, Cuadrado-Peñafiel V, González-Badillo J. Analysis of variables measured in vertical jump related to athletic performance and its application to training. *Cultura Ciencia y Deporte*. 2011;6(17):113-9.
23. Rodríguez-Rosell D, Mora-Custodio R, Franco-Márquez F, Yáñez-García JM, González-Badillo J. 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 Strenght Cond Res*. . 2017;31(1):196-206. doi: 10.1519/JSC.0000000000001476.
24. Jiménez-Reyes P, González-Badillo J. Monitoring training load through the CMJ in sprints and jump events for optimizing performance in athletics. *Cultura, Ciencia y Deporte*. 2011;7(18):207-217.
25. Maćkała K, Fostiak M, Kowalski K. Selected determinants of acceleration in the 100m sprint. *J Hum Kinet.* 2015;45(1):135-148. doi: 10.1515/hukin-2015-0014
26. Paul DJ, Nassis GP, Research C. Testing strength and power in soccer players: the application of conventional and traditional methods of assessment. *J Strenght Cond Res*. 2015;29(6):1748-1758. oi: 10.1519/JSC.0000000000000807.
27. 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):1574-1579. doi: 10.1080/02640414.2014.996184

28. Emmonds S, Sawczuk T, Scantlebury S, Till K, Jones B. Seasonal changes in the physical performance of elite youth female soccer players. *J Strenght Cond Res*. 2020;34(9):2636-2643. doi: 10.1519/JSC.0000000000002943
29. Pardos-Mainer E, Casajús JA, Gonzalo-Skok O. Reliability and sensitivity of jumping, linear sprinting and change of direction ability tests in adolescent female football players. *Science and Medicine in Football*. 2019;3(3):183-190. doi: 10.1080/24733938.2018.1554257
30. Mirwald RL, Baxter-Jones AD, Bailey DA, Beunen GP. An assessment of maturity from anthropometric measurements.*Med Sci Sports Exerc.* 2002;34(4):689-694. doi: 10.1097/00005768-200204000-00020.
31. Batterham AM, Hopkins WG. Making meaningful inferences about magnitudes. JIjosp, performance. *Int J Sports Physiol Perform.* 2006;1(1):50-57.
32. Hopkins W, Marshall S, Batterham A, Hanin J. Progressive statistics for studies in sports medicine and exercise science. *Med Sci Sports Exerc*. 2009;41(1):3. doi: 10.1249/MSS.0b013e31818cb278
33. Melchiorri G, Ronconi M, Triossi T, et al. Detraining in young soccer players. *J Sports Med Phys Fitness*. 2014;54(1):27-33.
34. Lloyd RS, Radnor JM, Croix MBDS, Cronin JB, Oliver JL. Research C. Changes in sprint and jump performances after traditional, plyometric, and combined resistance training in male youth pre-and post-peak height velocity. *J Strenght Cond Res*.. 2016;30(5):1239-1247. doi: 10.1519/JSC.0000000000001216.
35. Borges PH, Cumming S, Ronque ER, et al. Relationship between tactical performance, somatic maturity and functional capabilities in young soccer players. *J Hum Kinet.* 2018;64(1):160-169. doi: 10.1515/hukin-2017-0190
36. Vandendriessche JB, Vaeyens R, Vandorpe B, Lenoir M, Lefevre J, Philippaerts RM. Biological maturation, morphology, fitness, and motor coordination as part of a selection strategy in the search for international youth soccer players (age 15–16 years). *J Sports Sci*. 2012;30(15):1695-1703. doi: 10.1080/02640414.2011.652654
37. Rampinini E, Coutts AJ, Castagna C, Sassi R, Impellizzeri F. Variation in top level soccer match performance. *Int J Sports Med*. 2007;28(12):1018-1024. doi: 10.1055/s-2007-965158
38. Bishop C, Read P, McCubbine J, Turner A. Vertical and horizontal asymmetries are related to slower sprinting and jump performance in elite youth female soccer players. *J Strength Cond Res*. 2021;35(1):56-63. doi: 10.1519/JSC.0000000000002544.
39. Gonzalo-Skok O, Moreno-Azze A, Arjol-Serrano JL, Tous-Fajardo J, Bishop C. A comparison of 3 different unilateral strength training strategies to enhance jumping performance and decrease interlimb asymmetries in soccer players. *Int J Sports Physiol Perform.* 2019;14(9):1256-1264. doi: 10.1123/ijspp.2018-0920

Corresponding information:

Received: 06.05.2023.
Accepted: 20.08.2023.
Correspondence to: Villanueva-Guerrero, Oscar and Mainer-Pardos, Elena
University: : Health Sciences Faculty, Universidad San Jorge, Autovía A23 km 299, 50830 Villanueva de Gállego, Zaragoza, Spain
E-mail: oscarvillanuevaguerrero@gmail.com; epardos@usj.es