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Quarterly Percentual Change in Height, Weight, Body Fat and Muscle Mass in Young Football Players of Different Categories

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Featured Application: Between the ages of 13–15 it is important to modulate the training load bearing in mind that physical improvements can vary significantly between individuals, depending on factors such as genetics, diet, sleep and the specific type and intensity of training. Monitoring of these variables must be done with care, keeping the health of the players as a top priority. In addition, coaches and trainers should encourage a balanced view of these metrics, encouraging players to focus on skill development and enjoyment of the sport rather than solely on physical changes.

Abstract: The purpose of this study was to compare the change of Body Composition (BC) (height, weight, body fat percentage and muscle mass) as a function of the trimester and category in a sample of young soccer players. Data collection was performed in five consecutive seasons (2016–2021). The sample consisted of 741 young male football players of different categories (Under 14 year old (U14), U15, U16, U17 and U18) belonging to a high-performance football academy. Considering the trimestral change of all the raw anthropometrics variables a set of new variables called the trimestral change in percentage (TC) of each raw variable was computed. Two-way repeated measures ANOVA (including the raw anthropometric variables as dependent and trimester and the age-category as independent) revealed differences for the anthropometric variables (p value < 0.001 in all cases), concluding that the effect of trimester reaches conventional levels of statistical significance. The trimester by age in contrast was significant ($p < 0.05$) in all raw variables except for the height. Considering the TC variables, the variable height-TC showed an increase (p value < 0.05) while the variable muscle mass-TC was near the significative value ($p = 0.09$). In this case the interaction trimester by age category was not significative ($p > 0.05$ in all cases). It seems that height suffers more changes in the first trimester but the weight, body fat percentage and muscle mass changes more in the second and third trimester. It is important to modulate the training load according to the trimester-specific response, although these improvements may vary according to factors such as genetics, diet, sleep and the specific training.

Keywords: young soccer players; changes; anthropometric measurements

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1. Introduction

Football and all the parameters that affect performance (conditional, technical, tactical, age, gender, etc.), have evolved over the years towards a more specific and individual work from the area of professional performance and areas of training and talent detection [1]. However, few studies focus on the body composition (BC) variables for the direct assessment of performance in football and the adaptations produced by the different training trimesters during the season [2]. Although it is a relatively recent assessment method, there are studies that attempt to define the individual characteristics of players in terms of BC measured with electrical impedance [3,4]. BC with impedance assessment is commonly used to track the improvement of elite football players throughout the regular season [5]. However, the BC and anthropometric characteristics of young players are little considered in the selection of young football players, as the focus is often placed on the skills that each individual has in their respective specialty [6] or much more time is devoted to increase the physical aptitudes of athletes without taking into account the evaluation of their BC and nutritional status [7], even though we know that there are currently differences in terms of physiological demands according to the position of the player and with respect to their weight, height and body mass index (BMI) [8].

If we refer to the study of BC in football and its relationship with health and injuries, BMI is commonly referred to instead of Body Fat Percentage (BFP), however, it has been determined that abdominal fat and circumference, as well as overweight indicated in BFP are better discriminators of injury risk and health status than BMI [9,10]. BMI does not distinguish between fat-free mass, where we include muscle mass (MM) or bone, and body fat, nor does it distinguish between fat distribution, knowing that abdominal fat, especially intra-abdominal fat, and fat in the gluteal-femoral region may even have a greater impact on health [11,12]. High body weight and an increase in BFP, with a greater impact on locomotor actions typical of football such as running or jumping, create a mechanical stress on the joint system and the axial skeleton, increasing the risk of injury [9,13]. Other authors who have related BC to injuries suffered by football players have shown that the ratio of fat mass to bone mass of a body segment correlates inversely with the risk of injury [9,14]. In this sense, it can be suggested that low fat-free mass values are associated with low levels of strength, which leads to sports injuries [15]. Similarly, there is a relationship between increased BMI and low BFP values with an increased risk of injury for young football players [16]. Finally, body fat levels might also impact on talent identification and talent progression to professional level [17].

BC is usually measured at the beginning of the pre-season period and then monitored at regular intervals during the season, usually every 1-2-3 months [18]. The assessment of BC is a fundamental aspect of the functional assessment of the human body in health, clinical and physical performance [19]. The methods and frequency of BC assessment are numerous and of varying complexity depending on the level of analysis, methods, number of compartments estimated or quantified resources available to the team, as well as their preferences. Currently, BC analysis methods are divided into three groups: direct, indirect, and doubly indirect. The direct method involves cadaveric dissection and although it has excellent reliability, its application and usefulness are very limited [20]. These methods are validated based on the direct method or densitometry and make it possible to measure/estimate body tissues [21]. Despite their high reliability, indirect methods are not very accessible, limited, and costly [22]. Double indirect methods have been validated based on indirect methods and therefore have a higher margin of error when compared to indirect methods [23]. However, in view of the high costs of indirect methods and methodological sophistication, dual indirect methods such as anthropometry and Bioimpedance Analysis (BIA) are gaining importance due to their simplicity, safety, ease of interpretation and low cultural constraints [24]. BIA involves passing a low-level electrical current through the body and measuring the impedance to the flow of this current. Using BIA, it is possible to consider raw parameters, such as resistance, reactance, and phase angle, to estimate body mass components using predictive equations [25]. On the other hand, BIA is a widely used method to estimate BC and offers a method to non-invasively assess fluid distribution and BC of soccer players [1,26].

The control and evaluation of BC can be a key factor in football, as it can be used to determine the degree of preparation of young players to assimilate training loads, to evaluate their training capacity, as well as to evaluate the effectiveness of training programmes [27]. The principal objective of the study was to compare the percentual changes for anthropometrics variables (height, weight, body fat percentage and muscle mass) as a function of the trimester in a sample of adolescent football players. Secondary the study aims to compare the percentages of trimestral changes as a function of the variables analyzed (height, weight, body fat percentage and muscle mass).

2. Materials and Methods

This longitudinal study was carried out in 5 seasons. The first season was 2016/2017 and the last in 2020/2021. The Under14 (U14), U15, U16, U17 and U18 categories were controlled. The season was from September to June. As a marker of the anthropometric status of the players, a monthly control of BC was carried out. The nomenclature used to name the training sessions considers the days prior to the game. That is, Match Day (MD), MD + 1 (1 Day after the match), MD−4 (4 days before the match), MD−3 (3 days before the match), MD−2 (2 days before the match), and MD−1 (1 day before match) [27].

BC evaluation was carried out always once time per month (MD−3) in the second week of each month (Figure 1) [27]. The assessment session was conducted in the same well-ventilated room with controlled temperature and humidity following the standard food and fluid protocol so that they were presented in a rested state, fasted overnight, and hydrated before the test. They were also asked to arrive with an empty bladder and bowel [28]. Subjects wore only shorts during testing and removed any metal and jewellery prior to testing. They were asked to avoid strenuous exercise, alcohol, and any stimulants for 24 h prior to testing [29]. All control of this evaluation was supervised longitudinally by the same people responsible. This profile was a PhD in sports sciences, master's in physical Preparation and more than 10 years of practical experience.

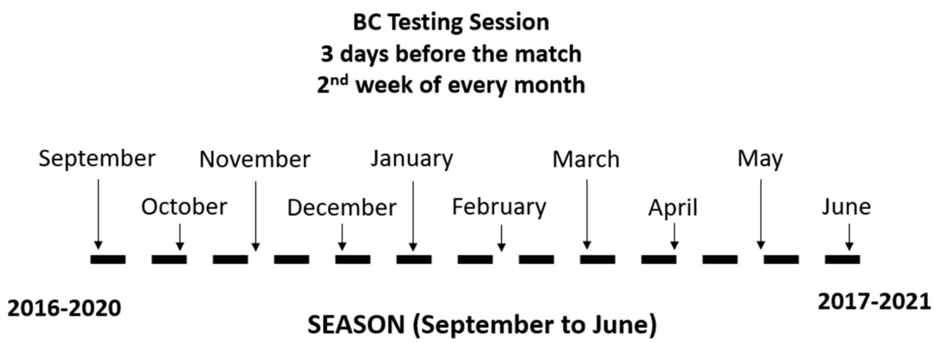

Figure 1. Visual representation of the test procedure timeline for the 2016 to 2021 seasons. Each season started measuring in September and ended in June.

2.1. Participants

The sample consisted of 741 young male football players of different categories belonging to a high-performance football academy, with more than 5 years in the sport of football and who spent one full year at the academy (See Table 1). All players, parents and/or guardians, together with the academy managers, were notified of the research design and its requirements, as well as the potential benefits and risks prior to the start of the study, by providing and signing the informed consent form for under-aged and adults' players. At the beginning of the season, parents and players were given the protocol of the procedures carried out in the sports science department and an example of reporting information on the players. In addition, it was explained collectively in a group meeting and through audiovisual tools. All of them voluntarily agreed to participate in this study. The study protocol adhered to the principles of the Declaration of Helsinki and was approved by the institutional ethics committee. Regarding the general dynamics of training, you can see Tables 2 and 3. The rest periods in the microcycle coincide with the academic calendar. For this reason, they have days off from training. The duration of the strength training was 1 h, and the technical-tactical training was 1 h 15 min. The strength work in the U13, U14 and U15 groups was arranged in a circuit and using their own body weight. In the U16, U17 and U18 groups, they were also performed in a circuit and using body weight plus overloads [27]. All participants played in an official competition, governed by the Catalan Football Federation. The duration matches lasted 90 min.

Table 1. Longitudinal descriptive analysis. Average and Standard Deviation (SD).

			2016/2017		
	U14	U15	U16	U17	U18
N	33	25	22	23	10
Age	13.84 ± 0.61	15 ± 0.08	15.89 ± 0.18	17 ± 0.80	18.21 ± 0.75
Height (cm)	162 ± 15.23	165 ± 8.85	171.83 ± 4.08	174.86 ± 11.12	176.90 ± 10.12
Weight (Kg)	50.19 ± 4.72	61.86 ± 2.55	64.48 ± 3.25	67.83 ± 2.25	70.18 ± 2.55
BF (%)	10.79 ± 3.21	13.73 ± 4.12	12.21 ± 1.58	13.33 ± 0.87	13.07 ± 1.28
Muscle Mass (%)	41.77 ± 5.61	52.59 ± 1.83	56.47 ± 2.02	58.67 ± 3.15	60.92 ± 2.05
			2017/2018		
	U14	U15	U16	U17	U18
N	47	21	32	23	24
Age	13.59 ± 0.69	14.84 ± 0.7	15.81 ± 0.64	16.84 ± 1.32	18 ± 0.2
Height (cm)	156 ± 50.07	157 ± 49.53	157.18 ± 54.72	176.05 ± 18.50	177.15 ± 7.62
Weight (Kg)	60.21 ± 8.01	60.27 ± 7.9	67.32 ± 11.19	68 ± 9.33	70.66 ± 8.01
BF (%)	13.94 ± 4.63	13.92 ± 4.57	13.49 ± 2.84	13.52 ± 3.23	12.43 ± 4.21
Muscle Mass (%)	37.78 ± 23.55	42.32 ± 17.56	44.95 ± 25.96	45.35 ± 26.14	52.29 ± 22.04
			2018/2019		
	U14	U15	U16	U17	U18
N	22	49	38	42	18
Age	13.86 ± 0.35	15 ± 0.8	16 ± 0.12	17.21 ± 0.25	18 ± 0.1
Height (cm)	162.60 ± 48.20	163.18 ± 40.70	166 ± 32.04	174.34 ± 6.33	174.33 ± 8.66
Weight (Kg)	60.39 ± 20.46	61.71 ± 13.90	66.53 ± 6.01	68.15 ± 6.52	69.64 ± 10.16
BF (%)	13.43 ± 4.35	14.20 ± 4.55	14.56 ± 3.62	12.91 ± 3.74	14.95 ± 3.74
Muscle Mass (%)	36.34 ± 26.1	35.51 ± 26.68	36.92 ± 27.72	42.59 ± 27.07	57.40 ± 6.15
			2019/2020		
	U14	U15	U16	U17	U18
N	49	22	30	51	29
Age	13.81 ± 0.39	14.90 ± 0.29	14.90 ± 0.29	16.96 ± 0.19	17.96 ± 0.42
Height (cm)	167.45 ± 12.04	170.06 ± 5.77	174.54 ± 4.59	175.36 ± 6.43	176.22 ± 8.29
Weight (Kg)	60.11 ± 11.11	62.14 ± 8.79	66.77 ± 5.60	66.66 ± 8.07	67.26 ± 10.18
BF (%)	14.58 ± 2.69	15.35 ± 4.05	12.77 ± 2.50	13.17 ± 3.03	12.48 ± 2.79
Muscle Mass (%)	34.34 ± 22.3	38.24 ± 25.1	40.69 ± 27.26	43.23 ± 26.14	42.51 ± 27.53
			2020/2021		
	U14	U15	U16	U17	U18
N	21	22	27	43	18
Age	13.62 ± 0.5	14.94 ± 0.22	15.96 ± 0.33	16.96 ± 0.28	18 ± 0.48
Height (cm)	167.54 ± 5.28	168.29 ± 7.65	173.19 ± 7.40	173.07 ± 6.52	178.18 ± 4.16
Weight (Kg)	60.99 ± 6.08	59.85 ± 8.12	63.47 ± 9.33	66.55 ± 8.30	74.63 ± 9.92
BF (%)	15.96 ± 2.12	13.24 ± 3.27	14.01 ± 4.14	12.52 ± 2.54	14.44 ± 5.20
Muscle Mass (%)	35.32 ± 24.67	36.82 ± 23.18	48.87 ± 18.62	50.58 ± 19.52	55.97 ± 21.29

cm: centimeters; Kg: Kilogram; BF (%): Body Fat Percentage; U: Under.

Table 2. Typical week for group U13-U14-U15.

Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday/Sunday
7:45–8:45	Rest	Rest	Strength Training	Technical-Tactical Training	Strength Training	Match
15:30–16:45	Recovery Training	Rest	Technical-Tactical Training	Technical-Tactical Training	Technical-Tactical Training	

Table 3. Typical week for group U16-U17-U18.

Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday/Sunday
7:45–8:45	Rest	Strength Training	Rest	Strength Training	Technical-Tactical Training	Match
16:45–18:00	Recovery Training	Technical-Tactical Training	Rest	Technical-Tactical Training	Technical-Tactical Training	

2.2. Material

A SECA® wall stadiometer (model 206, Hamburg, Germany) with an accuracy of 0.5 cm was used to monitor height. For the control of BC variables (weight, % fat and muscle mass), a Tanita® (model MC-980MA PLUS, Arlington Heights, IL, USA) was used for BIA. Before the BIA measurement, the hands and feet of the participants were wiped with an electrolyte wipe [27].

Data collection was performed monthly at the same time (7:45 am). First, the height was checked (without shoes) and then the height, age and sex data were entered into the Tanita®, where the players were taken barefoot, fasting and without any metallic material [1,27]. The BC was performed with the players standing with their feet in contact with the electrodes in the foot area of the scale and their hands on the handles, placing their fingers in the standard locations [28].

2.3. Statistics Analysis

Statistical analysis was performed with OriginPro version 2019b software. (OriginLab. Northampton USA). The significant *p*-value was set at $p = 0.05$. Means and standard deviations for each of the variables were used to describe the data collected. Outliers were eliminated using the range between the 10th and 90th percentiles for each of the primary variables (height, weight, body fat percentage [BF%] and muscle mass).

Based on the primary variables without outliers, the percentages of change between months were calculated (Formulas (1) and (2)). Subsequently, the means of the two percentage changes (MPC) produced in a trimester were calculated, and a variable called trimestral percentage change (TC) was obtained (Formula (3), which was subsequently used in the statistical analyses.

$$\text{1st monthly percentual change (MPC1) (\%)} = \text{(Month 2 value-Month 1 value)}/\text{(Month 1 value)} \times 100 \quad (1)$$

$$\text{2nd monthly percentual change (MPC2) (\%)} = \text{(Month 3 value-Month 2 value)}/\text{(Month 2 value)} \times 100 \quad (2)$$

$$\text{Trimestral percentual change (TC) (\%)} = \text{(MPC1 + MPC2)}/2 \quad (3)$$

Once this was done different Two-Way Repeated Measures ANOVA were performed, including the raw variables (height, weight, body fat percentage and muscle mass) or the TC of each raw variable (height-TC, weight-TC, body fat percentage-TC and muscle mass-TC) as dependent variables. Age category (13, 14, 15, 16, 17 and 18 years) and trimester (1st, 2nd and 3rd), were the between and within- independent variables.

Two-Way Repeated Measures ANOVA analysis was also performed including as dependent variable the averaged trimestral change per variable in percentage and as independent variables the age category variable (between groups: 13, 14, 15, 16, 17 and

18 years) and the anthropometric trimestral change variables (withing groups: height-TC, weight-TC, BF%-TC and MM-TC).

For all Two-ways ANOVAs, Mauchly's test of sphericity was performed. If the assumption of sphericity was not met ($p < 0.05$) and if the Epsilon value was greater than 0.75, the Huynh-Feldt correction was applied. If the normality assumption was not met and the Epsilon value was less than 0.75, the Greenhouse-Heisser correction was applied. Post-hoc analyses were also performed, applying the Bonferroni correction.

3. Results

For height, trimester have significant effect ($p < 0.01$; df = 1.37; F = 5.85), and the post-hoc test did not show any significative differences. The interaction between trimester and category of age do not have significant effect ($p = 0.39$; df = 6.87; F = 1.06). Also, there are differences in height between the different categories of age ($p = 0.02$; df = 5; F = 5.15). The post-hoc test showed statistical differences between the category U14 and the rest of categories of age ($p < 0.05$) (Table 4). For weight, trimester have significant effect ($p < 0.001$; df = 1.54; F = 144.25), and there was an interaction between the trimester and the category of age ($p = 0.05$; df = 7.68; F = 1.98) and differences between the categories of age ($p < 0.001$; df = 5; F = 8.14). The older age groups showed the highest weight values (Table 4). In the case of fat percentage there were differences between trimesters ($p < 0.001$; df = 1.80; F = 37.26). In this case there was a significant trimester-age category interaction ($p < 0.02$; df = 2.09; F = 8.99) and no differences between age categories ($p = 0.13$; df = 5; F = 2.30). Post-hoc analyses showed significant differences between the first and second trimester (being higher in the second trimester; $p = 0.04$) and between the U14 category, with U16, U17 and U18 ($p < 0.001$) (Table 4). Finally, in the case of muscle mass there were significant differences between trimesters ($p < 0.001$; df = 1.57; F = 150.66); a significant trimester-age category interaction ($p < 0.001$; df = 7.87; F = 3.56) and significant differences between the different age categories. Post-hoc analyses showed differences between trimester 1 and trimester 3 ($p < 0.05$) and between almost all age categories ($p < 0.05$) (Table 4).

Table 4. Raw anthropometric variables depending on category of age (Mean ± Standard Error).

Age Category	Variable	Trimester 1	Trimester 2	Trimester 3
U14	Height (cm)	167.9 + 1.5	168.5 + 1.5	169.4 + 1.5
	Weight (kg)	62.3 + 1.6	64.4 + 1.6	64.7 + 1.6
	BF (%)	14.8 + 0.6	15.7 + 0.6	14.8 + 0.6
	Muscle mass (%)	51.7 + 1.2	52.9 + 1.2	53.7 + 1.2
U15	Height (cm)	172.6 + 1	173.1 + 1	173.9 + 1
	Weight (kg)	61.6 + 1.2	63 + 1.2	63.9 + 1.2
	BF (%)	13.5 + 0.5	14.3 + 0.5	14.1 + 0.5
	Muscle mass (%)	53.1 + 0.8	53.8 + 0.8	54.8 + 0.8
U16	Height (cm)	170.9 + 1	171.7 + 1	172.6 + 1
	Weight (kg)	60 + 1.1	61.4 + 1.1	62.5 + 1.1
	BF (%)	12.8 + 0.4	13.4 + 0.4	13 + 0.4
	Muscle mass (%)	52 + 0.8	53.1 + 0.8	54.3 + 0.8
U17	Height (cm)	173.4 + 0.8	173.8 + 0.8	173.3 + 0.8
	Weight (kg)	64.5 + 0.9	65.8 + 0.9	66.4 + 0.9
	BF (%)	12.9 + 0.3	13.5 + 0.3	13.3 + 0.3
	Muscle mass (%)	56 + 0.7	56.7 + 0.7	57.4 + 0.7
U18	Height (cm)	175.1 + 0.7	175.4 + 0.7	175.8 + 0.7
	Weight (kg)	66.3 + 0.8	67.6 + 0.8	68.2 + 0.8
	BF (%)	12.7 + 0.3	13.3 + 0.3	13.4 + 0.3
	Muscle mass (%)	57.7 + 0.6	58.5 + 0.6	58.9 + 0.6
U19	Height (cm)	173.3 + 1.4	175.4 + 1.4	174 + 1.4
	Weight (kg)	70.8 + 1.5	71.2 + 1.5	71.8 + 1.5
	BF (%)	13.7 + 0.5	14 + 0.5	14.1 + 0.5
	Muscle mass (%)	60 + 1.1	60 + 1.1	60.7 + 1.1

BF: Body Fat Percentage.

Considering the TCs, trimester showed significant effects in relation to height-TC (Table 5). In relation to age category or the interaction trimester by age category there were no significant differences in any of the cases (Table 5). Regarding post-hoc analyses there were significant differences or an approximation to significant *p*-value between first and second trimester for height-CT ($p = 0.03$) and between 1st–3rd trimester for height-TC ($p = 0.07$) (Figure 2); between the 1st–2nd and 2nd–3rd trimester for weight-TC ($p < 0.001$) (Figure 3), between trimester 2nd–3rd for BFP-TC ($p < 0.01$) (Figure 4) and between trimester 2nd–3rd for muscle mass ($p < 0.05$) (Figure 5).

Table 5. Two-way repeated measures ANOVA for trimestral changes (TC) of each anthropometric variable.

Variable	Effect of Trimester				Effect of Age Category				Effect of Trimester by Age Category			
	DF	MS	F	*p*	DF	MS	F	*p*	DF	MS	F	*p*
Height TC (%)	1.95	0.24	3.68	0.03	5	0.11	1.96	0.16	9.77	0.11	1.73	0.07
Weight TC (%)	1.83	23.9	39.03	5.55	5	0.29	0.52	0.47	9.13	0.29	0.47	0.9
BF TC (%)	1.67	194.02	10.65	1.04	5	6.62	0.39	0.54	8.33	10.39	0.57	0.81
Muscle Mass TC (%)	1.51	30.67	2.6	0.09	5	10	1.38	0.24	7.53	11.02	0.94	0.48

F: Degrees of freedom; MS: Mean Square; BF TC: Body Fat Percentage, trimestral change.

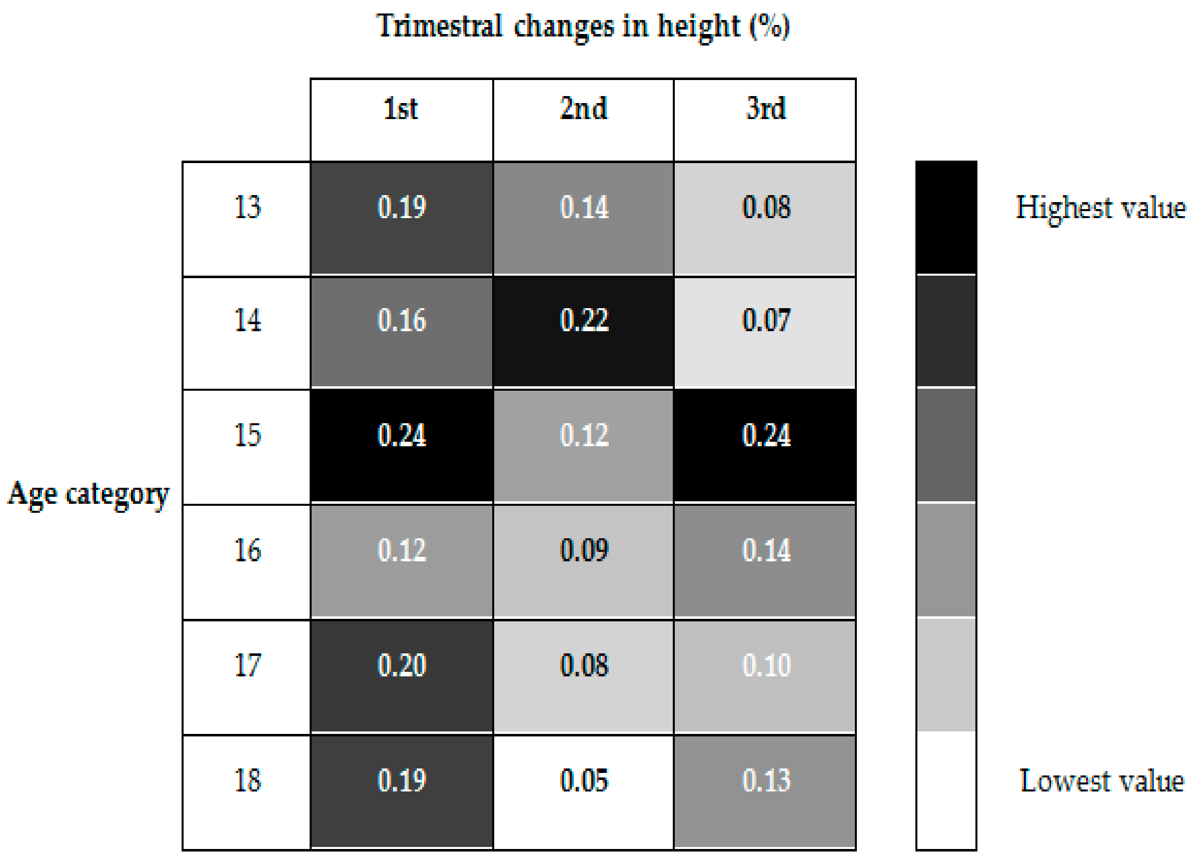

Figure 2. Changes in Height (%) in each trimester according to participants age category.

Trimestral changes in weight (%)

Age category	1st	2nd	3rd
13	0.03	0.93	0.47
14	0.14	0.73	0.58
15	0.14	1.00	0.56
16	0.10	0.78	0.61
17	0.06	0.78	0.40
18	0.07	0.67	0.69

Highest value
Lowest value

Figure 3. Changes in Weight (%) in each trimester according to participants age category.

Trimestral changes in BF (%)

Age category	1st	2nd	3rd
13	0.51	1.72	1.99
14	0.59	2.68	0.67
15	0.34	3.28	0.69
16	0.41	2.54	1.21
17	0.44	1.86	0.43
18	0.52	1.84	1.54

Highest value
Lowest value

Figure 4. Changes in BF (%) in each trimester according to participants age category.

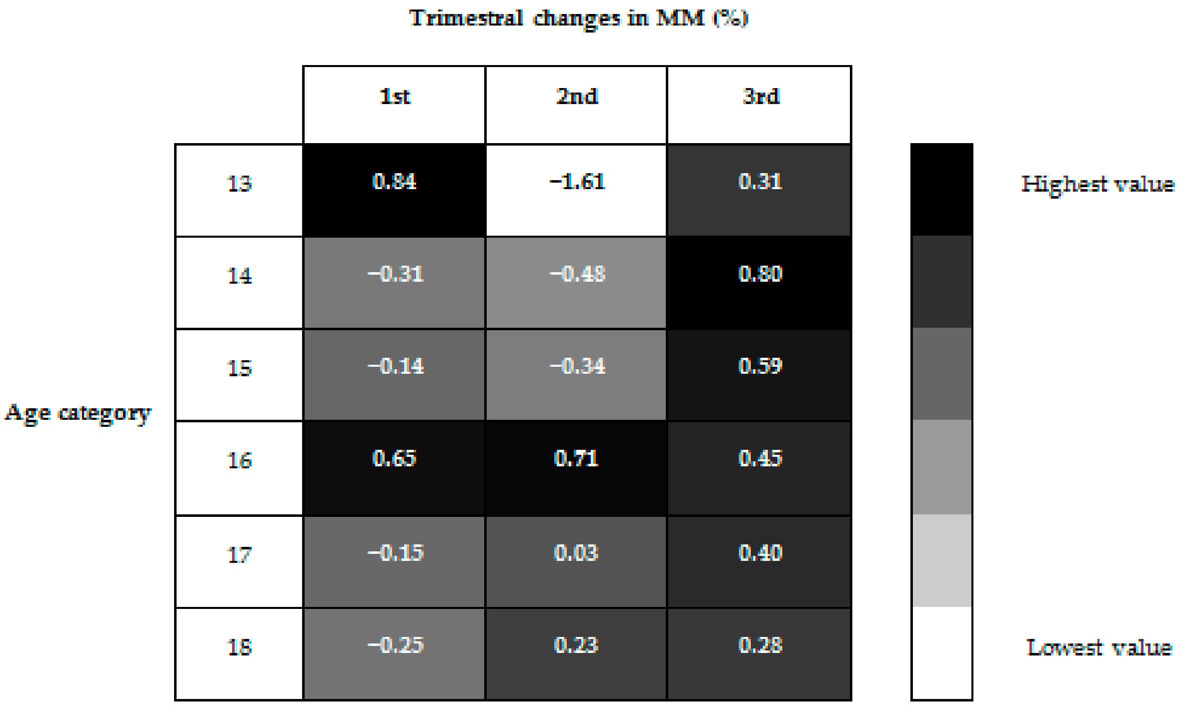

Figure 5. Changes in Muscle Mass (%) in each trimester according to participants age category.

Regarding the comparisons of the percentages of change of each of the anthropometric variables according to age category, the Two-way repeated measures ANOVA showed differences between variables (df = 1.46; mean square = 314.29; F = 46.62; $p < 0.001$), but not between age categories (df = 5.00; mean square = 6.87; F = 2.07; $p = 0.15$). There was also no interaction between the two variables (df = 7.30; mean square = 7.28; F = 1.08; $p < 0.37$). Post-hoc comparisons for anthropometric variables showed differences in all cases ($p < 0.05$), except for the comparison height-TC and muscle mass-TC. The percentual changes per variable and age category are summarized in Figure 6.

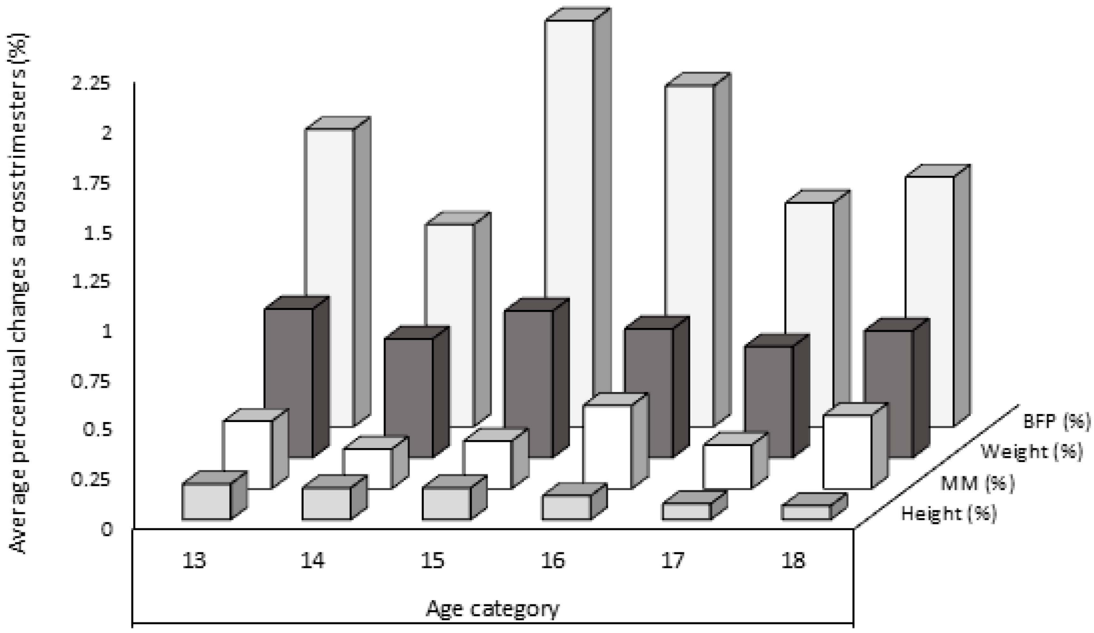

Figure 6. Percental change per variable.

4. Discussion

The purpose of this study was two-fold, to compare the trimestral change percentages for each of the variables analyzed (height, weight, body fat percentage, and muscle mass) as a function of the trimester in a sample of adolescent soccer players and to compare the trimestral change percentages as a function of the variables analyzed. Several studies have reported seasonal variations in the physical fitness and anthropometrical variables of young soccer players [29,30]. This study revealed a significant increase in all the anthropometrical indicators analyzed from the start to the end of the season. However, it must be recognized that maturity state is a variable that can influence such changes [29].

According to the results found in the present study, it seems that from 13 to 15 years of age, there are greater changes per trimester in the height-TC of the players (although there were no significant differences) (Figure 2). As expected from a previous study of European youth players [31], the highest increases in height and weight occurred when players turned 14 years of age. When analyzing Muscle Mass-TC, it was noticed an interesting nuance, as it turns out that the peak gain in muscle mass occurs a year after the peak gain in body weight [30]. This is possible because fat mass decreases due to rapid growth and testosterone secretion increases while muscle mass increases. Testosterone is known to reduce triglyceride synthesis [32]. Muscle mass as a percentage of body weight improved from 3.09% at age 13 to 3.36% at age 15, which is consistent with results for the general population [31–33]. According to [29], several physical fitness variables such as limb movement speed, core strength, explosive power, running speed, agility, cardiorespiratory endurance, and anaerobic capacity all show greatest development at peak height, with weight and height gain occurring at the age of 13.8 years. Therefore, it is very relevant to prepare physical exercise programs aimed at improving these physical capacities in this age range.

Changes in height, weight, muscle mass between different years have been extensively studied. For example, it is estimated that the peak of height growth in child football players is reached at 13.8 + 0.8 years and peak weight velocity occurred, on average, at the same age as peak height velocity [33]. Knowing the maturity status is an important factor for training having into account that later maturing players had a significantly higher overuse injury incidence than their earlier maturing counterparts both in the year before peak height velocity and the year of peak height velocity [34]. Knowing the growth pattern should also be taken into account in the periodisation of training with a performance enhancement objective. For example Waldron et al. [35] demonstrate the importance of gains in lean body mass across later adolescence that support the ability to generate horizontal speed and predicted vertical power.

Despite longitudinal studies that analyse changes between different years, there are hardly any studies that deal with changes between trimesters of the same year. For example [36] conclude that in children aged 5–10 years from September to April (season) is when most height is gained, while weight does not seem to change. These changes in height could be due to variables such as the light-dark cycle, temperature, or humidity among others. The study was conducted in Houston which has a temperate climate which may facilitate engagement in outdoor physical activity throughout the school year which causes weight gains to be small [36]. In the case of our study something similar could have occurred. The greatest increases in height occurred in the first trimester, perhaps due to the inertia of height growth during the summer. On the other hand, in our study we found that the greatest increases were in height. It is possible that height is the variable of all those measured that is most dependent on genetic factors. The rest of the variables (weight, BF % or Muscle Mass) could be modified more by non-genetic factors (training, nutrition, etc.). In terms of training planning, these large percentage changes in height can cause changes in the centre of gravity and instability. As mentioned above this can be especially important in the first semester, and should be taken into account in exercise planning. The changes in weight, BF (%) and Muscle Mass (%) occur in a greater proportion during the second and third trimester. When individuals start a new exercise program, especially one that includes medium and high intensity aerobic training (for instance, soccer), they often experience significant changes in anthropometric variables such as Body Mass, BF % and Muscle Mass after a few months (second trimester) [37,38]. This is because the body has adapted to the new level of physical demand and requires more advanced or intensive training to continue progressing [39]. Additionally, diet and genetics can play a significant role in how these variables change over time [40]. It's also crucial to remember that everyone's body responds differently to exercise, and individual results can vary.

This study had some limitations. First, BIA devices have high reliability, however, it is necessary to improve the validity of these devices and their estimation equations. On the other hand, this study only incorporates anthropometric variables and does not refer to their influence on the physical or sports performance of young players. Therefore, it would be important to research into these correlations to better understand the changes produced and their influence on physical development. Another important limitation is that there was no follow-up of nutritional control on the players. This could have substantially influenced the results, especially for muscle mass and % body fat. Finally, it would be important to know what type of training the players perform at each age to discern whether the changes produced in each of the anthropometric variables can be influenced by it.

5. Conclusion

In young football players height suffers more changes in the first trimester but the weight, body fat percentage and muscle mass changes more in the second and third trimester. On the other hand, it is in the height variable that the greatest changes occur. Therefore, it seems important to modulate the training load based on the specific age response, especially in young soccer players. However, it's important to note that these improvements can vary significantly between individuals, depending on factors such as genetics, diet, sleep, and the specific type and intensity of training. Monitoring these variables should be done with care, keeping the players' health as the top priority. Also, coaches and trainers should foster a balanced view of these metrics, encouraging players to focus on skill development and enjoyment of the sport rather than solely on physical changes.

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

Data Availability Statement: The datasets generated during and analyzed during the current study are available from the corresponding author on reasonable request. Records from this study will be kept for at least 5 years.

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