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Effect of body composition on fitness performance in young male football players

Muhammed Mustafa ATAKAN, Evrim UNVER, Necip DEMIRCI, Alpan CINEMRE, Suleyman BULUT, Huseyin Husrev TURNAGOL

Faculty of Sport Sciences, Hacettepe University, Ankara, Turkey.
Address correspondence to M. M. Atakan, e-mail: muhammed.atakan@hacettepe.edu.tr

Abstract

The purpose of this study was to investigate the relationship between anthropometric measurements and athletic performance in young football players. Total seventeen male football players (age: 17.0 years; height: 180.9±5.99 cm and weight; 71.36±6.30 kg) agreed to participate to this study, on voluntary basis. Body composition measurements including body mass, fat mass, bone mineral content, lean mass were made by using Dual-energy X-ray absorptiometry (DXA). In order for the participant to be evaluated athletic performance, countermovement jump (CMJTT), squat jump (SJTT), T-agility test, 30m sprint test and 6 x 40m repeated sprint test were performed respectively. Pearson correlation coefficient (r) was used to relationship between body composition and athletic performance parameters. As a result, negatively significant correlation was found between sprint times and body mass ($p<0.05$). There was also negative correlation between repeated sprint performance (measured in time) and lean Mass (LM), lean mass index (LMI), appendicular LM and appendicular LMI ($p<0.05$). There were also negatively significant correlation among T-agility test, body mass and LM was ($p<0.05$). Non-significant correlation was seen among CMJT, SJT and body mass index and other anthropometric variables. In conclusion, for football players, changes in body composition are of great importance in athletic performance, especially sprint and agility.

Keywords: Agility, body composition, football, sprint.

INTRODUCTION

One of the fundamental component of sport science in soccer is to accurately measure body composition (13). In professional soccer, assessments are used alongside fitness measurements to determine physical preparedness for competition and to monitor the effects of training and dietary interventions on body composition status (22). Dual-energy X-ray absorptiometry (DEXA) is the most accurate means of determining body composition, and it is generally considered the current gold standard for this purpose. DEXA output provides the differences in lean and fat mass between the left and right sides. This is particularly important for athletes who wish to develop symmetrical bodies or who need to produce the same muscular power in each leg or in each arm (2).

Soccer is a team sport played in an outdoor field and requires a high standard of preparation through the development of physical performance skills, as well as tactical and technical expertise, in order to complete 90 minutes of competitive play (15). The association between anthropometrical profile of the players and measure of match-related performance has been shown (1). Elite soccer players have a low endomorphy rating that is equal to fat percent approximately 7-19%. This anthropometric percent value is thought (highly muscular with low adiposity) to increase the performance in soccer. The players who have higher lean with low adiposity mass are supposed to go on higher intensity than do the others with lower lean mass with higher adiposity (17). Soccer consists of intermittent activity involving sudden variations in movement and intensity (20). Changes in body composition such as an increase in lean mas or an decrease in fat mass therefore are expected to have effects on these movements.

Physical fitness in football is may be the most important factor to be successful with technical and tactical skills (16). Speed, power, strength and the ability of change of direction are some of key factors to reach success in modern football as well as body composition (4,27). The purpose of this study were (1) to examine measurement of body composition by DXA and (2) the analysis of body composition and some anthrometric physical performances variables in football players aged under 18.

MATERIAL & METHODS

Participants

Seventeen male football players aged at 17 (height; 180.9±5.99 cm and weight; 71.36±6.30 kg) were participated in this study. Participants were all active football players who are competing in U18 football league. Participants were told not to take any drugs, coffee or alcohol and not to be physically active at least 24 hr. before test day. All measurements were performed in the same day. The Ethics committee of Hacettepe University approved this study. All participants were informed about all measurements before study and gave informed consent.

Anthropometric Measurements

Height and weight were measured at the beginning of measurement. Height was measured to the nearest 0.5 cm using a stadiometer (Holtain Ltd. UK). During this measurements participants were dressed standard sport clothes with only shorts and t-shirts with bare foot. Body weight was measured to the nearest 0.100 gr via Tanita (Tanita TBF 401 A Japan) and body mass index (BMI) was calculated as weight/height^2 (kg/m)^2. Body composition measurements were made using DXA (Lunar Prodigy) which provides a reliable estimate of whole body composition. Before DEXA measures, participants were instructed to remove any metal objects that would interfere with testing. A technician assisted the participants in the proper positioning to obtain the most accurate measurement based on the manufacturer's guidelines. All measurements were conducted by personnel trained by the manufacturer for accuracy of measurement. The DEXA equipment was calibrated daily according to procedures prescribed by the manufacturer. The reliability and validity of DEXA to determine body composition have been established (Svendsen, Haarbo, Hassager, & C'hristiansen, 1993). Subjects lay supine on the DXA table with arms adequately separated from the trunk and were instructed to remain still throughout the scanning procedure. Height-adjusted indexes were calculated as follows: BMI [weight (kg)/height^2 (m)], FMI [FM (kg)/height^2 (m)], and LMI [LM (kg)/height^2 (m)], appendicular LMI [LM (arms and legs) (kg)/height^2 (m)]. Bone mass measures included in this study were whole body BMC (g) and BMD (g·cm^2).

Vertical Jump Measurements

CMJTT consisted of three maximal vertical jumps performed on Fusion Sports Smart Jump platform (Australia). Participants were allowed to start jumping when their hands were on waist and legs were shoulder width during both jumps. Before squat jump, participants were told to start jumping when their knee angle is approximately at 90°. During jumping participants were asked to jump as high as they can. During Countermovement jump participants were told to crouch down and jump as fast as they can. They were told to crouch until their knee angle is approximately 90°. During jumping participants were asked to jump at their highest. Jumps were made twice in both tests and the highest jump scores were recorded.

Sprint Tests

30m straight sprint test was made and measured by using Fusion Smart speed (Australia) Gates and wireless computer. Participants were asked to start on feet and run as fast as they can. The test was repeated 5 minutes rest apart and the best sprint times were recorded to evaluate.

T- Agility Test

T Agility Test was performed in this study. T Agility Test is applied to measure direction changes in four directions. 3 cones were placed 5.47 m apart in a straight line and a fourth cone was placed 9.14 m apart from middle cone which was the start and finish point), forming a T shape (25). The test were performed in four direction which were 9. 14m straight sprint and shuffles to left and right cone and 9.14m backwards run from the middle cone. The test times were measured by using Fusion Smart Speed (Australia). The test was performed twice with 5 minutes rest and the best times were recorded as test scores.

6 x 40m Repeated Sprint Test (RST)

RST was performed 1 hour after other tests were completed. Participants warmed again by using a warming protocol which was 5 minutes jog and 10 minutes stretching exercices. After warm up participants were told to start run each 40m and turn back to start point by jogging in 30 seconds. All 40m sprint times were recorded. After test total sprint time, fastest sprint time and mean sprint time was determined to calculate the % decrement of sprint times.

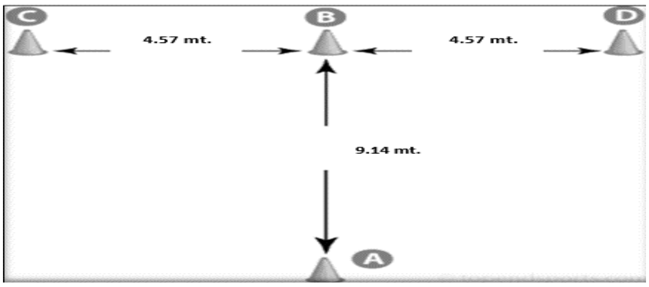

Figure 2. T test of agility.

Statistical Analysis

Statistical analysis was made by using SPSS 21 statistical analysis software. The normality test was made for all variables. Shapiro-Wilk normality test was used to test of normality. All variables were distributed normally (p > 0.05). After normality test, the descriptive of tests were determined and showed (Table 1 and Table 2). The correlations of performance tests between body composition scores were determined by using Pearson correlation coefficient. For all analyses, the criterion for significance was set at an alpha level of p< 0.05.

RESULTS

The descriptive statistics of physical and body composition parameters are presented in Table 1. The mean score with standard deviations of performance tests is also presented in table 2.

According to statistical analysis, there is a negatively significant correlation between sprint times and body mass. There is positive correlation among FM, FMI and sprint performance time. But this relationship was not statistically significant (p>0.05). Correlations among LM, LMI, appendicular LM, appendicular LMI and total sprint time are negatively significant but moderate (p<0.05). There are no significant correlations among BMC, BMD, BMD z-score and sprint performance (p>0.05) (Table 3). Correlations of countermovement jump heights and squat jump heights with all body composition parameters are non-significant (p>0.05). T agility test times are correlated negatively significantly with body mass, LM, appendicular LM and appendicular LMI (r =-0.49 to -0.65) (p<0.05). Correlations of t agility test with other parameters are non-significant (p>0.05).

Table 1. Body composition and bone mass measurements (n = 17).

Variable	Mean	SD
Age (years)	17.35	0.47
Height (cm)	180.91	5.99
Weight (kg)	71.36	6.31
BMI (kg/m2)	21.85	2.19
Sitting height (cm)	93.94	93.93
DXA body mass (kg)	72.42	6.20
FM (kg)	11,63	2.47
FMI (kg/m^2)	3.59	0.88
FM percentage (%)	16.03	2.84
LM (kg)	57.54	5.06
LMI (kg/m^2)	17.68	1.67
Appendicular LM (kg)	26.68	2.66
Appendicular LMI (kg/m^2)	12.95	1.26
Total body BMC (g)	3.22	0.22
Total body BMD (g/cm^2)	1.35	.11
Total body BMD z-score	1.86	0.94

Standard deviation SD, BMI body mass index, FM fat mass, FMI fat mass index, LM lean mass, LMI lean mass index, BMC bone mineral content, BMD bone mineral content.

Table 2. The result of performance tests (n= 17).

Performance Tests	Mean	SD
1_40m (sn)	5.56	0.22
2_40m (sn)	5.61	0.28
3_40m (sn)	5.72	0.28
4_40m (sn)	5.79	0.27
5_40m (sn)	5.92	0.38
6_40m (sn)	5.87	0.28
TSTM (sn)	34.49	1.48
BST	5.51	0.19
Decrement Percent	4.19	1.19
30m (sn)	4.28	0.15
t-agility test (sn)	9.56	0.42
Counter movement jump (cm)	37.57	4.16
Squat Jump (cm)	37.52	3.94

TSTM total sprint time mean, BST best sprint time

Table 3. Pearson correlation (r) analysis of sprint times during RST and anthropometric measurements.

Variables	TSTM	BST	Dec. Perc
DXA body mass (kg)	-.24	-.16	-.08
FM (kg)	.25	20	.29
FMI (kg/m^2)	.21	.15	.38
FM percentage (%)	.42	.33	.39
LM (kg)	-.42	-.31	-.23
LMI (kg/m^2)	-.38	-.46	-.37
Appendicular LM (kg)	-.44	-.24	-.14
Appendicular LMI (kg/m^2)	-.51*	-.31	-.23
Total body BMC (g)	.11	.02	.16
Total body BMD (g/cm^2)	.30	.17	.45
Total body BMD z score	-.0	.06	-.03

TSTM total sprint time mean, BST best sprint time, FM fat mass, FMI fat mass index, LM lean mass, LMI lean mass index, BMC bone mineral content, BMD bone mineral content, Dec. Perc decrement percent. * $p < 0.05$, ** $p < 0.01$

Table 4. Pearson correlation (r) analysis of performance tests and anthropometric measurements.

Variable	CMJT	SJT	30 m	t test
DXA body mass (kg)	-.11	-.07	-.12	-.65**
FM (kg)	-.38	-.27	-.18	-.36
FMI (kg/m^2)	-.43	-.31	.17	.26
FM percentage (%)	-.42	-.29	.28	-.18
LM (kg)	.05	.04	-.25	-.60**
LMI (kg/m^2)	-.20	-.18	-.16	-.46
Appendicular LM (kg)	.12	.12	-.26	-.53*
Appendicular LMI (kg/m^2)	-.03	-.01	-.31	-.49*
Total body BMC (g)	-.15	-.13	.07	-.29
Total body BMD (g/cm^2)	-.47	-.44	.18	-.20
Total body BMD z score	-.42	-.39	.09	-.16

CMJT counter movement jump, SJT squat jump FM fat mass, FMI fat mass index, LM lean mass, LMI lean mass index, BMC bone mineral content, BMD bone mineral content. * $p < 0.05$, ** $p < 0.01$

DISCUSSION

The purpose of the present study was (1) to examine the measurement of body composition by DXA and (2) the analysis of body composition and some anthropometric physical performances variables in football players aged under 18. The results of this study revealed the relationship between body composition and physical performance.

The mean height and body mass of the participants were similar to those reported previously for both older (3,18) and similarly aged players (12). Body percent fat (~16.78) and the mean BMD and BMC measured in this study were also similar to those previously reported (5,26). To our knowledge, we examined the first determining the relationship between body composition parameters consisting of LMI, appendicular LM, appendicular

LMI, FMI which were measured by DXA and physical performance tests including repeated sprint, 30 m sprint, agility and jumping tests. Body composition and bone measurements were done using DXA which provides a reliable estimate of whole body composition. The main results we obtained in this study demonstrated that body composition is paramount for physical performance and fitness. There was a negative relationship between body mass and repeated sprint time and 30 m sprint time. That is an increase in body mass will negatively affect sprint performance. This is in agreement with a previous report demonstrating negative significant relationships between body mass and sprint performance (8,10,11).But increase in body mass in soccer player after training period can be attributed to gaining in lean tissue as well. The study conducted by Silvestre and others showed that 60% of the increase in body mass could be explained by a gain in lean tissue. Increase in muscle tissue during training can be contributed to gain in lean tissue and this will eventually increase body mass (18). In this study, FM, percent fat and FMI were correlated negatively with a decrease in sprint performance time ($p<0.05$). The obtained results showed that an increase in fat mass is detrimental to speed. This finding confirms other existing studies on the same topic (18-20). As expected, a negative correlation was found between repeated sprint performance (measured in time) and LM, LMI, appendicular LM and appendicular LMI ($p<0.05$), whilst sprint performance has a moderate positive relationship with FM, FMI and percent fat ($p<0.05$). We also found a negative correlation between TSTM and appendicular LMI ($p<0.05$). It can be concluded from these results that increase in LM will substantially improve sprint performance. Gomez et al. suggested that gaining muscle mass will increase sprint performance (14) as muscle mass is a major determinant of maximal force. Another important factor for sprint performance is also the ability to maintain proper sprint mechanics and subsequently a high percentage of maximum velocity at the end of the run (6). Speed is conferred predominantly by an enhanced ability to generate and transmit muscular force to the ground. Therefore, having faster sprint performances must be the results of having frequent strides (24). These studies had obtained similar results when compared with those obtained in this study (7,19). No statistically significant relationship was found between sprinting performance and BMC, BMD z-score ($p>0.05$). Another correlation we applied was between jumping test and body composition. These results indicated that jumping tests have a non-significant negative correlation between and body mass, FM, FMI and percent fat, but positive correlation between jumping tests and LM and appendicular LM ($p>0.05$). In order to jump higher, an athlete has to apply a substantial amount of force against the ground and against his/her own BM (9). The increase in body mass or fat mass, therefore, will influence unfavorably jumping capacity. An increased muscle mass was confirmed to improve vertical jump performance. Additionally, it can be assumed that if an increase in muscle mass or fat-free mass improves vertical jumping performance, then this may also influence improved acceleration in a sprint performance due to the relationships that these two components have one another. Another physical parameter measured in this study was agility that we examined its relationship with body composition. After correlation analysis, we found a strong relationship between agility and body mass ($p<0.01$). These results show that increase in body mass is detrimental to agility performance in competition, especially in soccer. Football players, therefore, need to maintain their body weight within the specified ranges. As expected, an increase in agility test time, which was associated with LM ($p<0.01$), appendicular LM and appendicular LMI, ensued. That is gaining in lean mass would result in increasing agility performance. When we look from different perspectives, it can readily be seen that fat-free mass or lean mass has a significant influence on agility performance. Very little research has attempted to correlate anthropometric variables and agility. Theoretically, factors such as body fat and body segment lengths may contribute to agility performance. In our study, neither FM, percent fat nor BMD, BMC, z-score had not statistically significant effects on agility ($p>0.05$). But the exact relationship between these variables is unclear. Further research is warranted.

As a conclusion, body composition is an important factor for physical performance. The major results of this study show that while LM, LMI, appendicular LMI positively affects physical fitness tests; body mass, percent fat, FM, FMI and appendicular FMI affects negatively. Therefore, not only increase in LM but also decrease in FM will contribute to increasing in performance. Our findings also support the role of fat mass and fat percentage as the primary markers of poorer physical performance.

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