RESEARCH ARTICLE

Analysis of the differences in body composition and physiological profiles of professional female sub-junior soccer players of Manipur: An observational study

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ABSTRACT

Background: This study aimed to analyze body composition and certain physiological profiles in professional women sub-junior soccer players of Manipur during their playing season. *Method and Materials:* Twenty-seven players from the Manipur sub-junior soccer team playing in local league games participated in this study. They were assessed using the variables body fat mass (BFM), soft lean mass (SLM), fat-free mass (FFM), intracellular water (ICW), extracellular water (ECW), total body water (TBW) through the sophisticated state of the art impedance bioanalyzer (Chorder, USA) and also cholesterol and lactate threshold. One-way ANOVA showed significant differences ($p < 0.05$) in anthropometric indicators and body composition parameters (Glycogen mass, Muscle mass, BCM, BCM/FFM%, Total Mineral Mass, TBW, ICW, ICW%, ICW/FFM%), body-fat percentage, relative $\dot{V}_{O2}$max, cholesterol and lactate levels and fat mass with respect to field positions. *Results:* There were no significant differences between playing positions in the variables of body weight, height, age, or professional experience ($p > 0.05$). However, forward-position players showed lower values of fat-free mass in relation to other playing positions, and they are lower and lighter with regard to the goalkeepers ($p < 0.05$). There are qualitative and quantitative alterations between assessed positions and the correct use of these individual differences on behalf of the team can contribute to the sportive success. Relative BCM, ECM/BCM, BCM/FFM, cholesterol, lactate threshold, and BCMI need wide-scale application in team sports. *Conclusion:* It can be concluded that size and body composition are important when analyzing soccer players according to their position, despite the appearance of only minor differences between them.

Keywords: Bio-electrical impedance, Body cell mass, Intracellular water, Physiological performances, Young sub-junior soccer players.

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Introduction

Football was once considered to be the sole realm of men. Contrary to men's football, women's football has not traditionally enjoyed a competitive advantage and has not gained as much national popularity. A total of 200,000 players have been registered in the Asian subcontinent since 2018, of which 40,000 or 20% have been women.[1] Statistics from 2011 indicated that there were 29 million registered players worldwide, which represented a 34% increase in the number of female players compared to that in 2000[2] Physiological and morphological parameters are important components of performance in many sports. The morphological and body composition (body fat, body mass, muscle mass) of athletes, physical characteristics, and technical-tactics capacity significantly affect success and performance.[3]

Over the last decades, women's participation in sports has greatly enhanced all over the globe. Even though scientific research on women soccer athletes is increasing, it is still limited. Coaches and sports-related healthcare professionals should be aware of gender-specific questions and needs for optimizing performance. Especially at an elite level, few data have been used to show anthropometric and body composition changes in women soccer players during the in-season. According to recent literary data, no studies were found if the abovementioned variables and the training load variables, such as rated perceived exertion body composition assessment, were considered simultaneously. According to a recent report, performance measured by training and/or match data and body composition assessment could help soccer coaches and their staff provide proper information for each player according to their specific playing position. Therefore, knowledge of the essential characteristics of successful women's team soccer performance is useful to coaches, physicians, nutritionists, and exercise physiologists to improve their knowledge about women's soccer athletes. This study aims to analyze the variations in anthropometric and body composition variables and their relationship with internal load in elite women soccer players across early and

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mid-competitive in-season using bioelectrical impedance analysis (BIA).

Material And Methods

Twenty-seven young female soccer players (mean age:16.52 ± 0.94 years) participated in the study. All the players belonged to various parts of Manipur, northeast India. Participants were divided according to their positional roles on the pitch as goalkeepers (n = 6), defenders (n = 10), and midfielders (n = 11). The players of the present study were at least state-level performers with a minimum of 3 to 4 years of formal training history and no history of any hereditary and cardio-respiratory diseases. All the subjects had almost the same socio-economic status, had similar dietary habits, and had training in the same environmental/ climatic conditions. Hence, they were considered as homogeneous (Figure 1).

Figure 1: Bio-impedence analysis of female football players of Manipur

Measurement Procedure

The decimal age was calculated from the date of birth recorded from the original birth certificate produced by the subjects at the time of testing. The physical characteristics, including height (to the nearest 0.1 cm) and weight (to the nearest 0.1 kg), were measured by a digital stadiometer (Seca 242, Itin Scale Co., Inc., USA) and body composition analyzer (Chorder, USA), respectively. The estimation of maximal aerobic power ($\dot{V}_{O2}$max) was performed by a popular shuttle running field test, also known as multistage fitness test (MSFT), in these women athletes. Total cholesterol was measured by a quick-check ultra cholesterol analyzer kit (Acon Pharma, India), and lactate measurement was accomplished using Lactate Scout ver.4 (SKU 20785-1; FM Mein Arztbedarf Ltd., Austria).

Multi-Frequency Bioelectrical Impedance Analysis (MF-BIA)

Total body electrical impedance to an alternate current (0.2 mA) with four different frequencies (5, 50, 100, and 200 KHz) was measured using a multi-frequency analyzer (Chorder, Bioscan USA) following the standard testing manual of Chorder International (Chorder Bioscan operating and service manual. 2010).

Prior to the measurement, the subjects were given instructions according to the following guidelines of Stolarczyk *et al*.:[4] 1) no intake of alcohol 48 hours before the test; 2) no heavy exercise 12 hours before the test; 3) no heavy meals and intake of caffeinated products 4 hours before the test; 4) no intake of diuretics for seven days before the test and 5) consumption of liquids limited to 1% of body weight, or, two 8-oz. glasses of water, 2 hours before the test.

Ethical Consideration

The present study was conducted according to the guidelines laid down in the Declaration of Helsinki, and consent was given to all procedures involving human subjects by the Ethical Committee of National Sports University, Manipur, India. Before initial testing, a complete explanation of the tests' purposes, procedures, and potential risks and benefits was given to all the subjects, and a signed consent was obtained from them.

Statistical Analysis

All the selected variables ' mean and standard deviations (± SD) were calculated. The assumption of normality was verified using the Shapiro-Wilk W-test. One-way ANOVA followed by an LSD post-hoc test for the multiple comparisons among the selected variables was performed. The significance level was defined as $p<0.05$. Data was analyzed using the Statistical Package for Social Science (version 21.0, SPSS, Inc., Chicago, IL, 2012).

RESULTS

Table 1 represents the comparison of the mean for the general physical characteristics of the soccer players according to their positions. Goalkeepers were shown to be larger in height, weight, and BMI than their outfield counterparts in defender, midfielder, and forward groups. In any parameter, there was no such significant difference between the groups. This table compares the mean for the general physical characteristics of soccer players according to their playing positions. Insignificant differences were found in

Table 1: Summary of general physical characteristics of the soccer players according to playing position

Variables	*Goalkeeper*	*Defender*	*Midfielder*	*Forward*	*F value*
Age (yr)	16.49 ± 0.09	16.74 ± 1.55	15.50 ± 1.94	17.35 ± 1.00	1.718
Height (cm)	61.95 ± 3.19	53.50 ± 7.14	54.81 ± 7.46	50.70 ± 4.91	1.165
Weight (kg)	163.9 ± 0.70	158.45 ± 6.05	156.88 ± 7.72	156.03 ± 3.28	0.672
BMI ($kg.m^{-2}$)	23.05 ± 1.34	21.26 ± 1.95	22.18 ± 1.31	20.76 ± 1.67	1.077

Table 2: Summary of $\dot{V}_{O2}$ max, cholesterol, and lactate levels of the soccer players according to playing position

Variables	*Goalkeeper*	*Defender*	*Midfielder*	*Forward*	*F value*
$\dot{V}_{O2}$max (ml/kg/min)	31.90 ± 3.09	33.74 ± 3.55	35.50 ± 3.94	37.35 ± 4.00	1.718
Serum cholesterol (mg/dL)	161.95 ± 3.19	153.50 ± 7.14	154.81 ± 7.46	150.70 ± 4.91	1.165
Serum lactate (mmol/L)	1.03 ± 0.04	1.6 ± 0.05	1.8 ± 0.02	1.9 ± 0.08	0.672

Table 3: Summary of Mean and level of significance of hydration status of the players according to playing positions

Variables	*Goalkeeper*	*Defender*	*Midfielder*	*Forward*	*F value*
Total Body Water (L)	32.50 ± 0.42	27.03 ± 2.34@	28.40 ± 2.59	27.20 ± 20@	2.11*
Extracellular Water Mass (L)	12.65 ± 0.07	10.90 ± 1.00@	11.43 ± 1.00	10.73 ± 0.58@	2.27*
Intracellular Water Mass (L)	20.85 ± 0.21	18.15 ± 1.37@	18.96 ± 1.61	17.50 ± 50@	2.62*
TBW/FFM	73.00 ± .00	73.00 ± 0.15	73.13 ± 0.17	73.10 ± 0.10	1.24

* indicates a significant F value, and @ indicates a significant difference with Goalkeeper.

Table 4: Summary of the body composition and mineral percentage of the soccer players according to playing position

Variables	*Goalkeeper*	*Defender*	*Midfielder*	*Forward*	*F value*
FFM (%)	43.15 ± 0.30	38.16 ± 2.15@	40.11 ± 2.49	37.13 ± 1.59@	2.52*
Lean mass (kg)	42.01 ± 0.26	36.21 ± 2.99@	38.10 ± 2.17	35.13 ± 1.99@	2.31*
Trunk fat mass (kg)	7.35 ± 2.19	6.10 ± 3.11	5.65 ± 2.59	5.20 ± 1.57	0.29
Trunk lean mass (kg)	20.30 ± 0.14	17.13 ± 1.66@	17.88 ± 1.64	16.80 ± 1.13@	2.60*
Trunk tissue mass (kg)	26.80 ± 2.12	22.53 ± 4.55	22.85 ± 4.05	21.03 ± 2.95	0.869
Skeletal muscle mass (kg)	25.05 ± 0.21	21.45 ± 1.82@	22.55 ± 2.02	20.80 ± 1.47@	2.73*
Protein mass (kg)	9.05 ± 0.41	7.78 ± 0.63@	8.16 ± 0.69	7.56 ± 0.55@	2.74*
Fat mass index (%)	6.0 ± 1.41	5.43 ± 1.71	5.30 ± 1.48	4.96 ± 0.90@	0.91
Mineral (%)	5.20 ± 0.28	5.58 ± 0.52	5.50 ± 0.40	5.63 ± 0.25	0.48
Protein (%)	14.65 ± 0.91	14.65 ± 0.99	15.00 ± 1.19	14.90 ± 0.51	0.14^{s}
Subcutaneous Fat area (mm)	159.80 ± 38.04	134.35 ± 51.48	129.61 ± 49.42@	117.33 ± 25.57@	0.34
Waist hip ratio	0.85 ± 0.02	0.83 ± 0.02	0.84 ± 0.01	0.83 ± 0.01	0.48
Waist circumference (cm)	79.40 ± 3.81	75.20 ± 5.15	76.20 ± 3.90	74.06 ± 3.16	0.66
Hip circumference (cm)	92.80 ± 2.26	90.10 ± 3.51	90.43 ± 3.91	88.36 ± 2.53	0.66

* indicates a significant F value, and @ indicates a significant difference with Goalkeeper.

Table 5: Summary and level of significance of functional profiles of the players according to playing positions

Variables	*Goalkeeper*	*Defender*	*Midfielder*	*Forward*	*F value*
BMR (J/h.kg)	1358.50 ± 10.60	1228.83 ± 67.54@	1266.83 ± 75.10	1203.66 ± 75.10@	2.581*
Total energy expenditure (Kcal)	1929.50 ± 14.84	1745.50 ± 96.23@	1799.83 ± 106.85	1710.33 ± 79.28@	2.565*

* indicates a significant F value, and @ indicates a significant difference with Goalkeeper.

age (F = 1.718), Height (F = 1.165), Weight (F = 0.672), and BMI (F = 1.077) among the playing positions of the soccer players. Table 2 represents the comparison of the mean for the $\dot{V}_{O2}$max, cholesterol, and lactate levels of the soccer players according to their positions. Goalkeepers have been shown to have non-significant high $\dot{V}_{O2}$max and cholesterol levels and least lactate levels. In any parameter, there was no such significant difference between the groups.

Table 3 compares the mean for the hydration status of soccer players according to their playing positions. Total body water, including extracellular water mass and intracellular water mass, was found to be significantly ($p < 0.05$) greatest in goalkeepers, whereas significantly lowest in forwards, midfielders, and defenders. TBW/FFM, no significant differences were observed among the field positions.

Table 4 reveals the comparison of the mean for lean body composition and mineral status of soccer players according to their playing positions. Fat-free mass, lean mass, trunk mass, skeletal muscle, and protein mass were significantly higher ($p < 0.05$) in goalkeepers than in defender, midfielder,

and forward players. Among the groups, no such significant difference was observed in trunk fat mass, trunk tissue mass, fat mass index, mineral, Protein, subcutaneous fat area, waist-hip ratio, waist circumference, and hip circumference.

Table 5 represents the comparison of the mean for the physiological profiles of soccer players according to their playing positions. BMR and total expenditure showed a significant difference among the group's goalkeepers, which was higher than the selected groups' defender, midfielder, and forward players.

Discussion

Certain contact field sports, such as football, are still nascent and less popularized for women, although a large number of athletes have begun to train and compete more intensely than in the past.[5] Anthropometric research on male and female football players has shown that body height, weight, and composition are important factors. Consequently, football differs from other individual sports in that there are no definite characteristics of each player, whereas anthropometric characteristics of height and weight are necessary for good performance; their relationship is equally important due to the fact that top football involves clashing, hitting the ball with the head, and alternating attack and defense, and all this is related to the efficient implementation during the match.[6] In our study, no statistically significant differences were recorded in relation to team positions. However, the highest body height and weight were recorded for goalkeepers compared to midfield and attack players. Body height is an advantage for goalkeepers who use hand play the most during the game, whereas midfielders and defenders tend to lower height.[7] These morphological characteristics in midfielders allow them to move more efficiently and cover greater distances on the field.[8] Additionally, a lower body height allows them to handle the ball well and outplay defensive players[7] because low body height keeps the center of gravity closer to the ground, and their dynamic balance is facilitated during dribbling. For defensive players, body height is suitable when the ball is to be hit with the head from a jump or the ground,[9] and they are the tallest and heaviest players due to the frequent jumps they have to perform during tactical tasks.[10]

The results showed that the goalkeepers have higher body mass and height values than the defenders and attackers. The goalkeepers were taller only in regards to the midfielders. Similar findings have been observed in studies along with the defenders,[8, 11] where goalkeepers are the tallest and heaviest players. Although it could have been expected that the defenders would have had similar height values as the goalkeepers, given that body height plays an important role in playing the position, this was not the case. Similar results were found in players from the English Premier League,[11] professional players from Croatia,[12] and professional players from Brazil,[13] where the goalkeepers were taller and heavier, and the midfielders were the shortest and lightest, respectively. Players with the lowest percentage of body fat often have a better performance. Because body fat is a direct reflection of the intensity of training,[14] the body composition of soccer players is likely to change during the competitive season due to training, competition, and diet.[15] In general, the results showed that the size and body composition of the soccer elite players of Manipur are similar to those of international studies.

Our study reveals that goalkeepers have the highest levels of fat-free mass (FFM) in comparison to the other groups when compared statistically. Similarly, goalkeepers had the highest surface area and height when compared to the rest of the groups. Regarding the anthropometrical variables that predict the FFM, the results demonstrated that body weight and age presented high predictive values. These results are consistent with studies carried out with adults[16-18] to the extent that they showed significant correlations with the FFM. It was also shown that all the players playing in different positions had normal visceral fat, and most of the players had a high and very high muscle mass. This is in agreement with similar studies where a high muscle mass was found among athletes.[19] In Manipur, most players (66.6%) ate either once or twice a day and so could not meet their dietary goals. Good dietary intake is important to a soccer player's health and sporting future. Despite this, the soccer players are not meeting their dietary goals, and this could be due to players having low financial status and not being able to afford three meals a day.

Further, it is observed that BMI, percentage body fat, and subcutaneous fat increased in goalkeepers as they were shown to have a slightly higher age over other counterparts. This was similar to the work done by Meeuwsen *et al*.,[20] who also reported a direct relationship between age and BMI and percentage of body fat. This means that as one grows older, his or her BMI increases. A very high percentage of body fat was more prevalent among the goalkeepers compared to other playing positions. According to playing positions, the goalkeepers had the highest mean total energy intake and the highest mean intake of carbohydrates, proteins, and fats, even though they were not statistically significant.

Another relevant aspect is hydration before, during, and after physical activity since low levels of hydration can decrease strength and power, essential characteristics for the position.[21] Also, it can affect cognitive performance, reduce attention and reaction levels, increase the speed of resolution to situations, and disturb moods.[22] Total body water (TBW) was significantly higher in GK when compared with other positions of players in our study. This may be because of the fact that GK has easy access to refilling the fluid intake, while for the other players, access to water is only possible during the breaks or halts during a match. It has also been found that the average sweating rate is lower in goalkeepers than in other positions, although a large number of environmental factors, including heat and humidity, can influence the situation.[23] Our study reveals a similar pattern

when compared in intracellular and extracellular water mass; however, we found no significant differences in the ratios of Total water content and free fat mass among all the players playing in different playing positions.

It can be verified from our results that, as could be expected, the Basal Metabolic Rate (BMR) in athletes presented higher values in goalkeepers, and this fact is due to the higher amount of slim mass found in those athletes, as the slim mass is the main component of such variable. As to body mass, goalkeepers have been shown to be heavier than the other assessed positions. These results are similar to the ones found by several authors from several countries, who also attained the same answers.[24] The behavior of this variable seems to partially explain the lower distance they run, besides their specific role during a game. This may be attributed to the amount of residual glycogen stored in the goalkeepers compared to other playing counterparts, as it has been found that the more muscle glycogen content there is, the higher the basal metabolic rate.

No significant difference was observed in our study's total energy expenditure among players playing in their subsequent positions. These results are in line with the study conducted by Prado *et al*.[13] on professional soccer players in Brazil following the same trend with similar observations.

Conclusion

Coaches, physicians, nutritionists, and exercise physiologists should ensure they provide gender specifications for optimizing performance. This study highlights information on the essential characteristics of successful women's soccer team performance at their peak time of the season. One of the limitations of our study is that we could not take the data at three time points throughout the sports season. The study showed that although some players may have performed different field roles and positions, their body composition characteristics vary accordingly. This study presents a report using body composition data, which can be used as a reference for better body composition, training load, and performance management for coaches and their staff. However, we recommend that those nutritional interventions are accomplished in the soccer elite, seeking to maximize their athletic performance.

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PEER-REVIEWED CERTIFICATION

During the review of this manuscript, a double-blind peer-review policy has been followed. The author(s) of this manuscript received review comments from a minimum of two peer-reviewers. Author(s) submitted revised manuscript as per the comments of the assigned reviewers. On the basis of revision(s) done by the author(s) and compliance to the Reviewers' comments on the manuscript, Editor(s) has approved the revised manuscript for final publication.