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Morphological parameters of soccer players and vertical jump performance (Case of senior teams)

Mounir D'BICHI[1], Nabila TOUABTI[2], Harouna SAMAKE[3]
1Laboratory of Training and Technology, ES/STS, Algiers, Algeria. m.dbichi@gmail.com
[2] Laboratory of Biological Sciences applied to Sport, ES/STS Algiers, Algeria. n.touabti@gmail.com
[3] National Institut of Sports and Youth, Bamako, Mali. Zharouna02@gmail.com

Abstract: The aim of this study is to see the correlation between physical indexes and vertical jump in soccer players. We used the anthropometric method and vertical jump tests in two soccer teams. 20 players per team participated in the study (aged 29 ± 7.97 for the group of students from the ES/STS ; and 27 ± 3.34 for the players from the Jeunesse Sportive de Kabylie). Two tests of vertical jump were carried out: the squat jump and the countermovement jump. Anthropometric measurements were used to determine physical indexes

Theresults showed a significant correlation between vertical jump and morphological parameters. We can deduce that the comparison between the two teams showed several significant differences in four morphological parameters and the power coefficient.

Key-words: soccer, vertical jump, morphological indexes, segments mass.

***Corresponding author**

1. Introduction

Soccer is one of the most popular sports on the planet, competing with other sports. Every four years, millions of people from more than 200 countries watch the World Cup, which is the great tournament of soccer associations. Competing players need a high level of power, speed and agility to be impetuous in movements such as heading, shooting, sprinting and dribbling. Soccer players run on average 13-15 km during 90 min and this depends on the playing positions. Based on theanthropometric, psychological and physiological studies, the analysis of soccer players' technical and tactical performance has become popular (ACAR et al, 2009). Specialists have conducted their studies from different views both on and off the field. They have studied performance during matches and training sessions (STOLEN et al. 2005; BANGSBO et al. 2006). Therefore, previous studies focused on improving soccer players' endurance capacityusingdifferent training methods; such as high intensity reduced play, intermittent running and specific training.
According to COMETTI (2010), soccer is composed of explosive efforts which are repeated many times. Vertical jump is a very important parameter for professional players (COMETTI. G, 2002), whether in the defensive or offensive phase. For ZIVE and LIDOR (2009), coaches need to obtain regular information on vertical jump to plan an efficientshort, medium and long term training programs with regard to this quality. This is not the case with African teams, who generally do not place much emphasis on working on jump capacities. This is why we decided to study vertical jump capacities.
According to several other authors (EKBLOM1986; LEATT et al. 1987; BREVERET DAVIS 1992; CAPRANICA et al. 1992; GARGANTA et al. 199; Castaleno et al. 2012) the muscular power of the lower limbs is considered to be one of the determining factors of the soccer player'sperformance. MIMOUNI N. (2015), states that "sports morphology data can optimize the preparation system of high level athletes, however it is obvious that the majority of athletes will never reach the top, and even the most sophisticated technology will not allow the modification of a number of primary factors including morphological factors".
This study looks at the effect of a plyometric program on the evolution of performance such as explosiveness, sprinting and jumping. By studying the effects of strength training, according to the needs of the soccer players we will carry out a wishful thinking research. The strength is defined as the maximum

force that the muscle can usually generate during a movement and thepower (or explosive force) is the product of force and speed; it refers to the neuromuscular capacity.

Few studies about the vertical elasticity of the soccer player are available exist. However, many tests and evaluation systems have been used. Since the SARGENT test (1921), several tests and measures have been suggested. Among these tests, we have the BOSCO (1983) tests on contact mats (Ergotest) which are the most mentionedby COMETTI (2002).

We were interested in studying the correlation between the mass of thelower limbs'segments and the indexes of high jump in soccer players, knowing that this quality is very important during aerial duels, the tackles areconsidered as the last defensive attack. The aim is to see if there is a correlation between anthropometric parameters and vertical jump in soccer players.

2. Methods and tools:

Several questions are namely:

➢Would a plyometric work program improve high jump indexes in soccer players?

➢ Does the development of lower limb muscle mass have an impact on the soccer player's head game?

In our sample, we have a group of 20 male players from the ES/STS students and 20 soccer team players of the Jeunesse Sportive de Kabylie (JSK).

Tableau n° 1:General characteristics of the sample

	ES/STS Group	JS K
Age (years)	29,9 5 ± 7,97	27,15 ± 3,34
Weight(kg)	74,90 ± 8,64	75,51 ± 6,78
Stature (cm)	177,63 ± 5,25	176,59 ± 5,66

The sample ofthe ES/STS' group play football at school (ES/STS), while, all JSK' players play at the national first division championship. Allplayers train according to a special preparation program (plyometrics) during six microcycles (three training sessions lasting 40 minutes per microcycle).

2.2 Anthropometry : For anthropometric measurements, we used an anthropometric suitcase of the G.P.M. type for the measurement of the selected parameters: weight, determined by a medical scale; stature, distance from the ground to the vertex; upper limb length (UL); lower limb length (LL); thigh circumference (TC); leg circumference (LC), (MIMOUNI N. 2015). In order to determinethe body weight composition, we used Mateigka's formulas, (1921): Calculation of fat mass, muscle mass and bone mass.

We estimated the mass of body segments of athletes from the regression equations of SELOUYANOV (1981), mentioned by ZATSIORSKY (1984). The anthropometric parameters recorded in our protocol according to the standard program are: arm segment mass (MSC Arm), forearm segment mass (MSC Forearm), thigh segment mass (MSC Thigh), leg segment mass (MSC Leg). We calculated the power coefficients, based on the mass of the body segments.

The most commonly used regression equation of sportsmen is SELOUIYANOV (1981) equations:

$$Y=B0 + B1X1 +B2X2 + B3X3 + BnXn,$$

where Y = the mass of the body segment (MSC) B = Coefficient calculated from anthropometric parameters and the masses assessed by radio - istope methods. X = Concreteanthropometriccharacteristics (or parameters).

- **Mass of the Arm Segment (MSC. B)** MSC of the Arm :

Y= -2.58 + [0.04*Vertex VII cervical + 0.104*Circumference relaxed arm + 0.651*(Distal Arm Diameter + Distal Forearm Diameter / 2)].

- **Mass of the forearm segment (MSC. Forearm)**

Y= -2.04 + [0.05*Front Arm Length + 0.0049*Hand Diameter +0.087*(Proximal Front Arm Circumference + Mean Front Arm Circumference + Distal Front Arm Circumference / 3)].

- **Thigh segment mass (MSC. C)**

Y = -17.819 + [0.153*Thigh length + 0.230*Thigh diameter + 0.367*(Proximal thigh circumference + Mid-thigh circumference + Distal thigh circumference / 3)].

- Mass of the Leg segment (MSC. J)

Y = - 6.017 + [0.0675*Leg Length + 0.0145*Leg Diameter + 0.205*(Proximal Leg Circumference + Mid Leg Circumference + Distal Leg Circumference / 3)].

➢ Calculation of the Power Coefficient

Power coefficient P1 and P2 are calculated as follows. -

Power coefficient 1: This is the quotient of the mass of the thigh segment over the length of the thigh multiplied by 100. Coef P1 = (Thigh mass / Thigh length)*100. -

Power Coefficient 2 F: it is the quotient of the mass of the thigh segment on the proximal circumference of the thigh multiplied by 100. Coef P2 = (Thigh Mass / Proximal Thigh Circumference)*100.

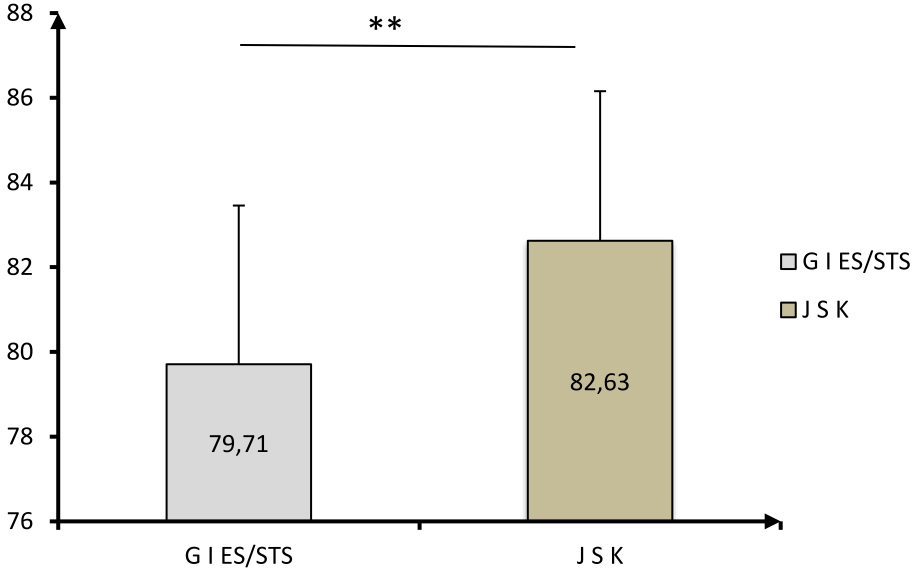
2.3 Physical tests:

To realizethe vertical jump tests, we used two basic tests of BOSCO according to COMETTI (2002): The squat jump;the counter movement jump. The players in the ES/STS group play football at school (ES/STS), while all JSK players play at the national first division championship. All players train according to a special preparation program (plyometrics), during six microcycles (three training sessions lasting 40 minutes per microcycle).

3. Results:

3.1 Upper limb length:

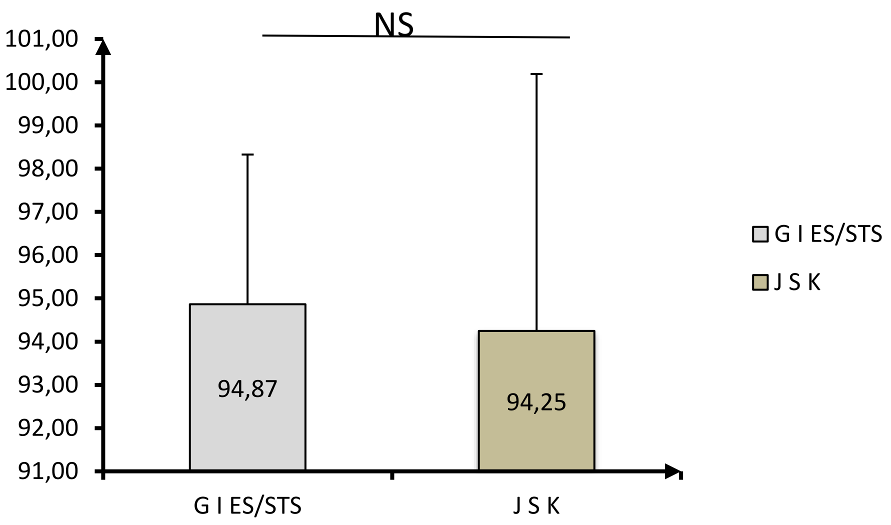
Figure 1: The length of the upper limb.



For the length of the upper limb, the results recorded in Figure 1, indicated that the average of JSK team is 82.63cm ± 3.53 and the coefficient of variation is 4.27%. The average value of the length of the upper limb of ES/STS group is 79.71cm ± 3.75, which is lower. The coefficients of variation showed a very low homogeneity. The Student test analysis gave ~~gives~~ us asignificant statisticallyt difference between both teams at $p < 0.01$.

3.2 Lower limb length (L M I)

Figure 2: Lower limb length.

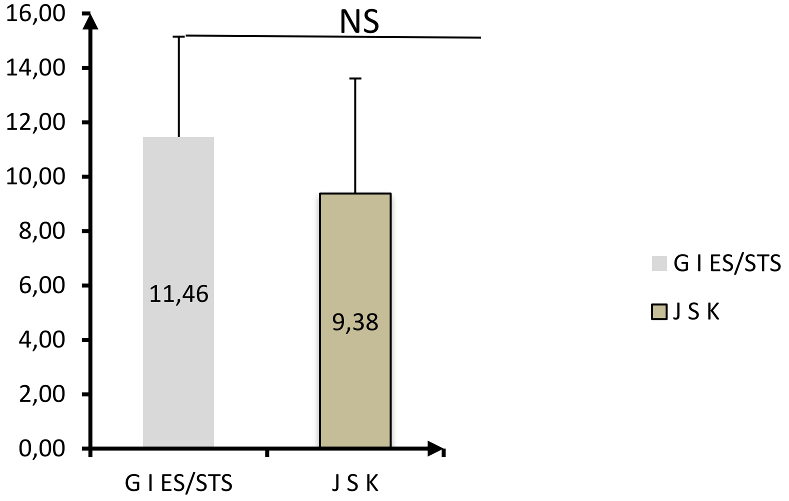


For the length of the lower limb, the results indicate that the average value of the ES/STS team is 94.87 cm ± 3.46 (Cv = 3.65%); the average value of the length of the JSK team is 94.25 cm ± 5, (CV = 6.30%). Thus, there is a very good homogeneity between the two groups. The analysis of the Student test gave us aninsignificantstatistically difference between the two teams.

3.3 Body Fat (BF)

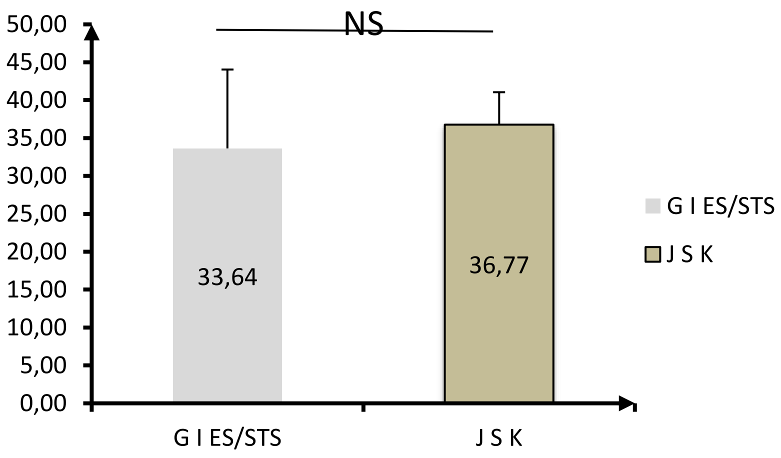
As regards fat mass, the results give us an average of 11.46 kg ± 3.69 for the ES/STS group, J S K team 9.38 kg ± 4.23. The coefficients of variation are 32.17% and 45.10% respectively, showing heterogeneity in the groups. The Student test shows a non- significant difference.

Figure 3: Fat mass.



3.4 Muscle mass (M M)

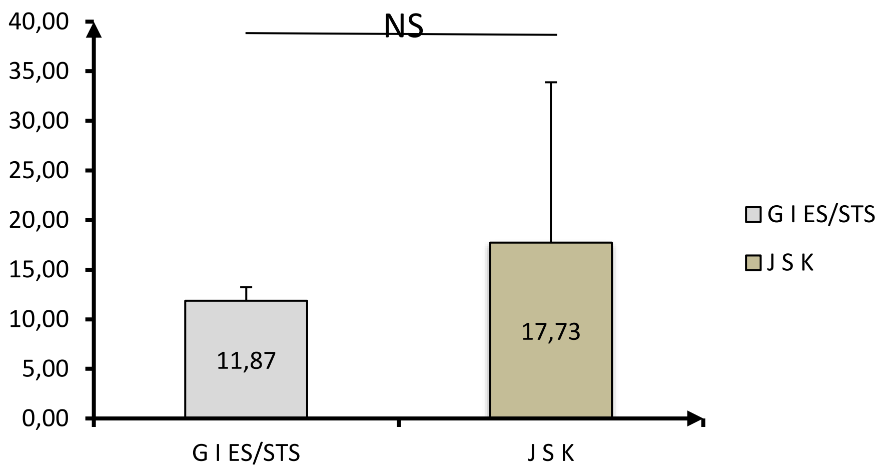
Figure 4: Muscle mass



The results show that the muscle mass obtained by the ES/STS group on average is 33.63kg ± 10.40, with a coefficient of variation of 30.99%, thus demonstrating heterogeneity in the group.JSK team obtained an average of 36.76 ± 4.28 and itis higher. The coefficient of variation is equal to 11.65%, showing an average homogeneity. The student test analysis showed a non-significant difference.

3.5 Bone mass (M O)

Figure 5: Bone mass

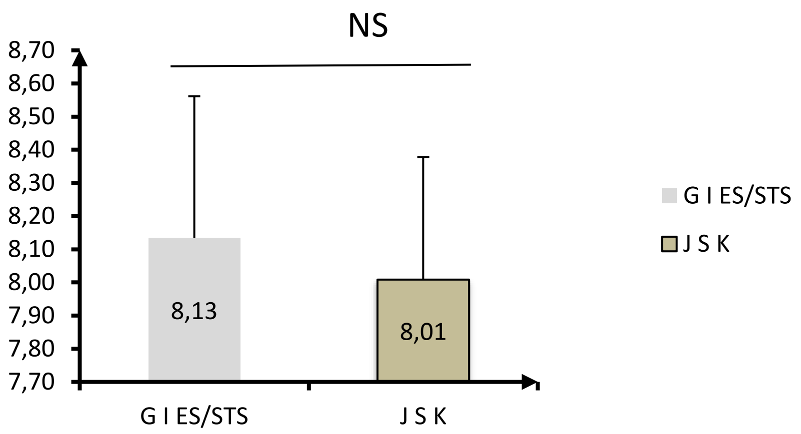


For bone mass, the average value of JSK team is the highest 17.73 kg ± 16.16. The lowestvalue is presented by ES/STS team, which has a mean value of 11.87 kg ± 1.37. The coefficients of variation are 91.18% for JSK, showing great heterogeneity, and 11.51% for ES/STS, with average homogeneity. The Student's t test analysis showed a non-significant difference.

3.6Calculated Arm Segment Mass (CSM b)

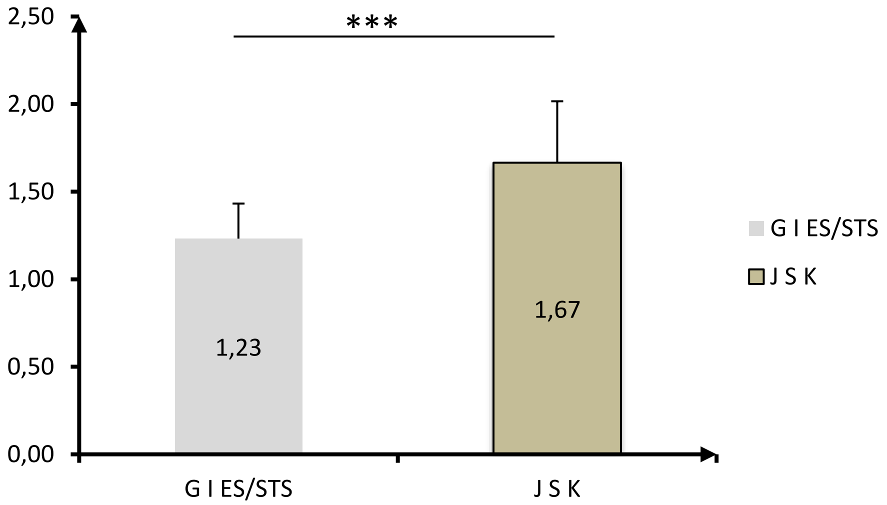
The mean value of the arm segment mass recorded by the Group I team 8.13 kg ± 0.43 is higher than that of JSK, which recorded a mean value of 8.01 kg ± 0.37. The coefficients of variation CoefVar% = 5.26; CoefVar% = 4.62 give us a good homogeneity. The student test analysis shows a non-significant difference between teams.

Figure 6: The mass of the arm segment.



3.7 Calculated Forearm Segment Mass (CFSM b)

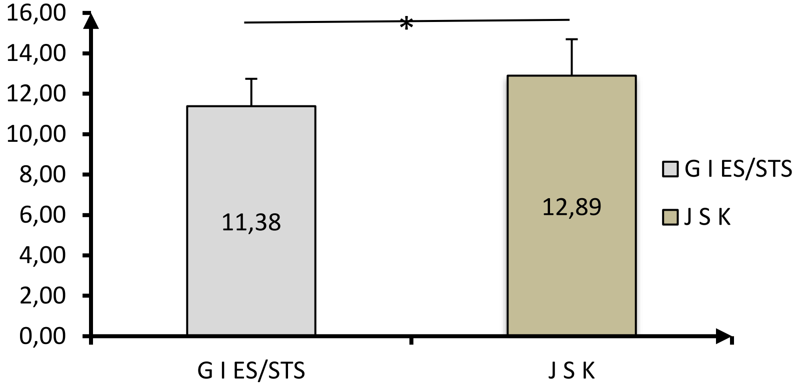
Figure 7: The mass of the forearm.



For the forearm, the results show that the average forearm segment mass of the ES/STS team is 1.23 kg ± 0.20. andfor the JSK is 1.67 kg ± 0.35;which is highest. The coefficients of variation (16.24% and 21.08%) show average homogeneity and less heterogeneity respectively. The Student test analysis shows a significant difference at $P < 0.001$.

3.8 Calculated Thigh Segment Mass (CTSM)

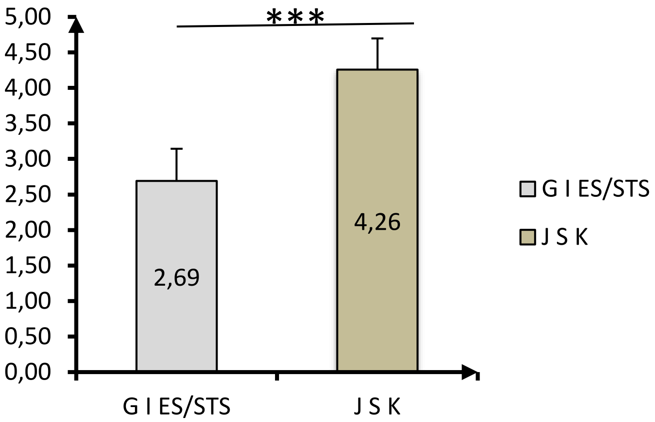
Figure 8: Thigh segment mass.



For the thigh segment mass, the results of the ES/STS group indicate that the team average is 11.38 kg ± 1.36 and that the coefficient of variation coefvar = 11.91% shows an average homogeneity. The average value of the thigh segment mass ofJ S K team is 12.89 kg ± 1.80 is the highest, with a coefficient of variation of 13.89% thus showing average homogeneity. The Student test analysis shows a significant difference at $p < 0.05$.

3.9 Calculated Leg Segment Mass (CSM j)

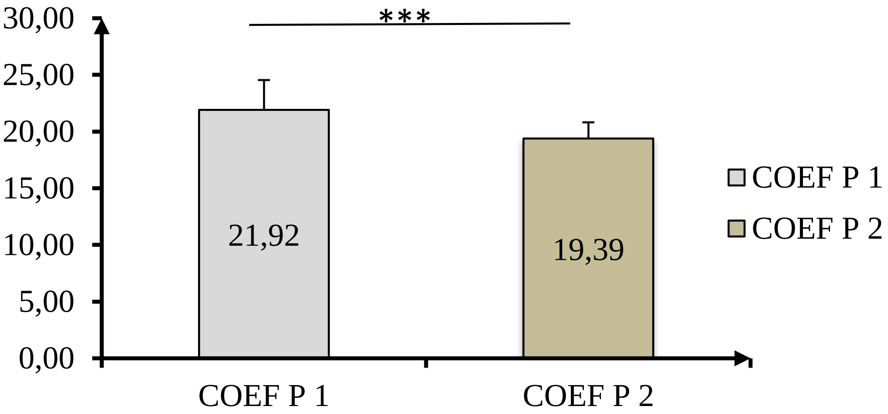
Figure 9: Leg segment mass



The mean value of the leg segment mass of JSK team is higher than thoseof the ES/STS group. Both groups show a medium homogeneity. Student's t test analysis showing a significant difference at $p < 0.001$.

3.10 Power coefficient (coef P 1, coef P2), ES/STS

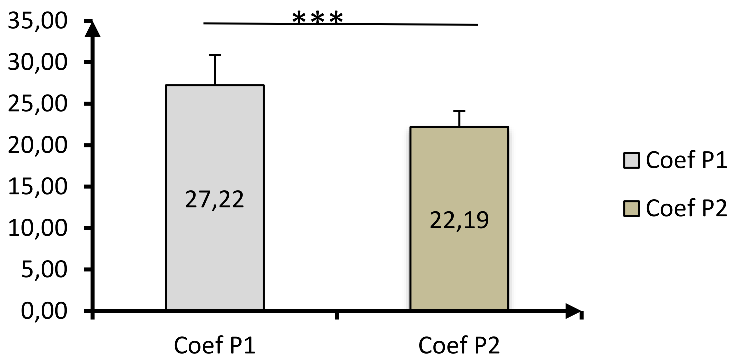
Figure 10: Power coefficient (coef P 1, coef P2), ES/STS



For the power coefficient (coef P1 and coef P2), the average results for P1 is 21.92 watt ± 2.63 higher than the average of P2 19.39 watt ± 1.43. The figure n°10 shows us an average homogeneity of the coefficient of variation 12,01% for P1 and 7,35% for P2 a good homogeneity. The analysis of the Student test gives us a very significant statistical difference between the two powers at P< 0.001.

3.11 Power coefficient (P1 and P2), JSK

Figure 11: Power coefficient (P1 and P2), JSK



For JSK team, the results indicate a mean value for the power coefficient (P1) 27.22 watt ± 3.63that is higher than the power coefficient (P2) 22.19 watt ± 1.92. The coefficient of variation 13.33% shows us a medium homogeneity for P1, while the coefvar 8.65% shows a higher homogeneity. The Student test analysis shows a highly significant difference at p < 0.001.

Analysis of physical tests:

Squat jump height (SJ): For the squat jump (SJ), the average jump height of ES/STS group team is 35, 07 cm ± 5.77 and the coefficient of variation (coefvar = 16.45%) shows a medium homogeneity. The average value recorded by JSK is slightly higher 35.19 ± 4.08 with a coefficient of variation of 13.31%, showing average homogeneity. The Student test analysis showed a non-significant difference.

Counter Movement Jump (CMJ): The average height obtained in the counter movement jump by JSK team is 40.06 cm ± 3.71. However, we note that ES/STS team obtained an average value of 39.02 ± 7.95. The coefficient of variation of the two teams (coefvar = 9.27%; coefvar 20.38%) is therefore low homogeneity and heterogeneity respectively. The analysis of the Student's test shows a non-significant difference.

Table 2: Correlation matrix between morphological parameters and vertical jump.(*P<0.05, **P<0.01, ***P<0.001)

Correlations between physical tests and anthropometric parameters Group I.ES/STS JSK	**Group. ES/STS**	**JSK**
MG / SJ	0,0952	-0,1444
MM / SJ	-0,1337	**0,4266 ***
MO / SJ	0,1013	0,0045
MG / CMJ	0,0460 NS	-0,0759
MM / CMJ	**-0,3286 ***	**0,3624 *****
MO/CMJ	0,1688	-0,2604
Weight / SJ	**-0,4001 ***	0,2117
Weight /CMJ	**-0,3249 ***	0,0272
MSC b / SJ	**-0,6327 *****	0,2768
MSC av. b / SJ	**-0,6373 *****	0,0166

The results in Table 2 indicate that muscle mass (MM) is correlated with vertical relaxation (squat jump) for the JSK'teamand with counter movement jump (CMJ); whereas the team of the ES/STS group shows us a negative correlation with CMJ. This leads us to assume that the muscle mass of the Algerians is not sufficiently developed. With regard to other parameters such as body weight, calculated segment mass, MSC b and MSC av b, we have a negative significance with both jump tests. This may possibly explain that the upper limb is not very important in the vertical jump.

Discussion:

Physical tests showed non-significant differences between both groups of soccer players. The values of the squat jump and counter jump are in agreement with the research of Artegaand al.(2000), Wilmot and Campilllo (2000) and Apostolodisand al. (2004), as well as the values of the counter jump arm are close to the studies of Miranda and al.(2004) and Cometti (2006). The results are in perfect alignment with the study by Villa Vicente, et al (1999).

All the results of the anthropometric parameters showed significant differences between the different levels of training, except for weight and height. Our results confirm the morphological differences that exist between the both groups. The current trend is towards a levelling of physical preparation, and consequently a reconciliation between the different anthropometric parameters and above all the development of the muscle mass of the lower limbs. The results of the morphological parameters (weight-lengths) of the two teams taken during the tests all showed a non-significant difference at $P < 0.05$. In contrast, we showed only one significant difference at $P < 0.05$ in upper limb length between the ES/STS group and the JSK. These results are consistent with the studies of Tokmakidis. Y, al (1991); Cazorla. G (1998).

The results of the body comparison and the mass of the arm segments, have no significant difference while the mass of the forearm, thigh, and leg segments show us a significant difference at $P < 0.05$; and $P < 0.000$. With regard to body fat (BF) of both teams, ES/STS group had the highest mean. These results are consistent with the study by Cazorla. G (2007), which confirmed that high level soccer players have an amount of fat mass close to our sample is close to this result. Therefore, the players in group I. ES/STS have a fat mass of high level soccer players.

The results of the body comparison and the mass of the upper arm segments did not differ significantly, while the mass of the forearm, thigh, and leg segments showed a significant difference at $P<0.05$; and $P<0.000$. These results are consistent with the study by Cazorla. G (2007).

For the power coefficients of the teams, ES/STS group has a higher power coefficient (P1) than the power coefficient (P2). For the power coefficients of the teams, J S K team has a higher power coefficient (P1) than the power coefficient (P2). This leads us to favor the formula for calculating the power coefficient P1that is, thigh mass divided by thigh length (Selouyanov, 1984).

Conclusions:

The demands of modern soccer are constantly increasing. It is well known that team sports such as soccer are very complex due to theinvolved anthropometric, physiological, psychological, perceptual and technical parameters. Indeed, we have chosen to work on the anthropometric parameters and to see their correlation with the chosen relaxation tests. In addition, the knowledge of the limbs segmentsmasseswould allow a better appreciation of the vertical relaxationofthe athlete. Among the relaxation tests, we chose the squat jump test, and the countermovement using the Bosco mat. The aim of this studyis tomeasure the vertical jump and parameters in soccer teams. The two teams recorded a highly significant difference at $P < 0.0001$ for power coefficient (Coef P1 Coef P2), forearm segment mass (MSC av b), leg segment mass (MSC j); a significant difference for thigh segment mass (MSC c) and upper limb length (LMS) at $P < 0.05$ and $P < 0.01$ respectively.A good coordination can help the player to perform a good vertical elasticity. Among others the squat jump, counter jump. It would be interesting to suggest an appropriate program for the development of the vertical elasticity and to check whether it is maintained or returns to its initial value.

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