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Experimental Study / *Deneysel Çalışma*

Reflection of Sport Awareness On Body Composition in Students at the School of Physical Education and Sports

Beden Eğitimi ve Spor Yüksekokulu Öğrencilerinde Spor Bilincinin Vücut Kompozisyonuna Yansıması

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Objectives: We examined the reflection of sport awareness on body composition in the students at the School of Physical Education and Sports by determining the changes in body fat ratios over a period of four years.

Study Design: A total of 42 students (20 boys and 22 girls) from the School of Physical Education and Sports (aged between 17 to 21 years) were compared in terms of the body fat ratios using three different anthropometry-based equations. The study groups of both sexes consisted of students who exercised regularly in any type of sport at least two hours per day and three days a week within the last year. Tukey-Kramer multiple comparison test was used to compare the groups.

Results: The body fat ratios increased in all groups contrary to the expected reduction. Although there was a reduction in year 2006 values, they were still higher than year 2003 values.

Conclusion: While the educational system should be reconsidered to give a shape to enhance sport and physical education awareness and willpower in the students, they should be able to force their willpowers to act as guided by their awareness as well.

Key words: Sport awareness; body fat; physical education; skinfold thickness.

Amaç: Dört yıllık bir periyotta vücut yağ oranlarındaki değişimlere bakarak Beden Eğitimi ve Spor Yüksekokulu öğrencilerinde spor bilincinin vücut kompozisyonuna yansıma derecesi incelendi.

Çalışma Planı: Yaşları 17-21 arasındaki 20 erkek ve 22 kızdan oluşan toplam 42 Beden Eğitimi ve Spor Yüksekokulu öğrencisi, üç farklı antropometri formülü ile hesaplanan vücut yağ oranları açısından karşılaştırıldı. Her iki cinste çalışma grupları, herhangi bir sporu, son bir yıldır en az haftada üç gün ve günde iki saat olacak şekilde düzenli olarak yapan öğrencilerden oluşturuldu. Grupların karşılaştırmaları Tukey-Kramer çoklu karşılaştırma testi ile yapıldı.

Bulgular: Vücut yağ oranları tüm gruplarda beklenenin aksine arttı. 2006 değerlerinde bir azalma gerçekleşmiş olmasına rağmen bunlar yine de 2003 değerlerinden yüksekti.

Sonuç: Eğitim sisteminin öğrencilerde spor bilinci ve iradeleri yükseltecek şekilde yeniden gözden geçirilmesi gerekirken, öğrencilerin de spor bilincinin gerektirdiği yönde iradelerini zorlayabilmeleri gerekmektedir.

Anahtar sözcükler: Spor bilinci; vücut yağı; beden eğitimi; deri kıvrım kalınlığı.

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Sedentary lifestyle and overweight issues are major public health, clinical, and economical problems in modern societies.[1] Body composition (BC) assessment provides important information regarding the absolute or relative amount of bone, lean and fat tissue. Traditional techniques for BC analysis include skin fold thickness (anthropometric) measurements, radioisotope dilution methods, hydrodensitometry and underwater weighing, while newer techniques include bioelectrical impedance analysis (BIA), air displacement plethysmography (ADP), dual energy X-rays absorptiometry (DEXA), computer tomography and magnetic resonance imaging. In addition, positron emission tomography helped functional investigation of adipose tissue, in particular of brown tissue.[2] Different techniques have been applied in numerous studies.[3-6]

Sport and exercise improves body composition not only by reducing fat mass but also increasing bone and muscle mass, thereby helping to restore higher metabolic rates. The scientific evidence indicates that almost everybody (younger, older and sedentary) must make reductions in caloric intake and increase their energy expenditure to avoid excess fat and weight gain.[7-11] Because there is a direct relation between body composition and sport, sport awareness is one of the important and effective factors of having a good body composition. Sport awareness means to have realization, perception, knowledge or alertness about sport and its effects on our biological (body composition) and social lives.

The School of Physical Education and Sports have the potential to make significant and distinctive contributions to students' development in a number of aspects: physical, lifestyle, affective, social, and cognitive.[12] Physical Education also prepare the students to implement an active lifestyle in their lives by the development of sporting skills through age/ability-appropriate and sequential lessons.[13] By having a good body composition, the students at the School of Physical Education and Sports are therefore among the first potential candidates, at least in terms of performing regular physical activity and being aware in this regard.

In this study, we aimed to contribute to the development of sport awareness in students at the School of Physical Education and Sports in Adnan Menderes University by detecting the reflection level of sport awareness upon body composition by determining the changes in body fat ratios over a period of four years by using three different anthropometry-based equations.

MATERIALS AND METHODS

Subjects

A total of 42 students (20 boys and 22 girls, aged 17 to 21 years) enrolled at the School of Physical Education and Sports in 2003, located in Aydın province of Turkey, joined this study to compare their body fat ratios (BF) using three different equations based on anthropometry. Participation was voluntary and informed consent was obtained from each subject after approval of the study by human ethics committee of Adnan Menderes University. All students were monitored until their graduation (from 2003 to 2006). The study groups for both sexes were formed from the students who exercised regularly. The measurements were taken at the end of each academic year (in May). After the anthropometry measurements, the important and effective factors of body composition were repeatedly explained to students, although they were taught this subject during their school education. The regular exercising groups were composed of students engaged in any type of sport at least two hours per day three days a week within the last year. The students participated in a wide spectrum of sporting activities. In the list of the most regular sporting activities, the rank showed athletics, soccer, basketball, volleyball, swimming, handball, hiking and weight-lifting in men, whereas athletics, volleyball, gymnastics, basketball, swimming, handball and taekwondo in women.

Body composition measurements

Weight and height. All measurements were performed by trained staff. The weight and height were measured to the nearest 10 g using a digital scale (SECA, Germany). Students were weighed

in their swimwear and bare feet. Height was measured to the nearest 10 mm using a stadiometer mounted to the scale.

Skinfold thicknesses. Skinfold thicknesses were measured using Holtain/Taner-Whitehouse Skinfold Caliper (sensitivity: 10 qms/mm and 0.2 mm) at seven sites (triceps, biceps, subscapula, suprailiac crest, abdomen, thigh and chest) on the right hand side of the subjects.

Determination of body fat percentages. Body fat percentages (BF%) were predicted with generalized equations developed by Durnin and Womersley[14] as well as Jackson and Pollock[15,16] from body density (BD) using Siri's[17] equation, % fat = (4.95/density-4.50) x100. The BF % was also predicted from Peterson et al.'s[18] equation. Peterson et al's equation is not a body density-based formula. The equations used in calculations were as follows:

Durnin & Womersley (DW) equation

Males: BD = 1.1620 – 0.0630 (log sum4) for 17-19 years and BD = 1.1631 – 0.0632 (log sum4) for 20-29 years.

Females: BD = 1.1549 – 0.0678 (log sum4) for 17-19 years and BD = 1.1599 – 0.0717 (log sum4) for 20-29 years.

Sum4 for both sexes was sum of suprailiac, subscapular, triceps and biceps skinfold thicknesses.[14]

Jackson & Pollock 1 and 2 (JP1 and JP2) equations

Males:

JP1; BD = 1.11200000 – 0.00043499 x (X_1) + 0.00000055 x $(X_1)^2$ – 0.00028826 x (X_3)

JP2; BD = 1.1093800 – 0.0008267 x (X_2) + 0.0000016 x $(X_2)^2$ – 0.0002574 x (X_3)

X_1 was the sum of the chest, axilla, triceps, subscapular, abdomen, suprailiac and thigh skinfold thicknesses; X_2 was the sum of the chest, abdomen and thigh skinfold thicknesses; X_3 was the age.[15]

Females:

JP1; BD = 1.0970 – 0.00046971 x (X_1) + 0.00000056 x $(X_1)^2$ – 0.00012828 x (X_3)

JP2; BD = 1.0960950 – 0.0006952 x (X_2) + 0.0000011 x $(X_2)^2$ – 0.0000714 x (X_3)

X_1 was the sum of the chest, axilla, triceps, subscapular, abdomen, suprailiac and front thigh skinfold thicknesses; X_2 was the sum of the triceps, abdomen, suprailiac and thigh skinfold thicknesses; X_3 was the age.[16]

Peterson et al. (PT) equation

Males: BF% = 20.94878 + (age x 0.1166) – (height x 0.11666) + (sum4 x 0.42696) – ((sum4)^2 x 0.00159)

Females: BF% = 22.18945 + (age x 0.06368) + (BMI x 0.60404) – (height x 0.14520) + (sum4 x 0.30919) – ((sum4)^2 x 0.00099562)

Sum4 was the sum of the triceps, subscapular, suprailiac and midthigh skinfold thicknesses.[18]

Statistical analysis

Data were expressed as mean ± standard error of mean (SEM). The measured percentages of body fat from each individual method were analyzed in GraphPad Instat 3.05 program (GraphPad Software, San Diego CA, USA). The difference of groups were carried out by using analysis of variance (ANOVA) followed by Tukey-Kramer Multiple Comparison test. A probability of less than 0.05 was considered to be statistically significant.

RESULTS

The physical characteristics of subjects in men and women are shown in Table 1 and 2. In both groups, height, weight and BMI were not significantly different between the sexes ($p>0.05$). The results of the predicted BF% means and SEMs for each equation are shown in Table 3 and 4. As seen in Table 3, 4 and Figure 1, the BF% values for both men and women were similar, which also have the same tendency for underestimation. They increased until 2005 in both sexes. Then, while the BF% values in 2006 remained almost the same as values in 2005 in men, it was less than 2005 values in women. In men, there were no significant differences among BF% values of the 2003-2006 groups in internal comparison of each formula, whereas in women, the BF values

Table 1. Means and standard errors for physical characteristics and skinfold thicknesses in men

Men	2003 (n=15)	2004 (n=16)	2005 (n=11)	2006 (n=16)
Age (year)	19.20±0.26	20.25±0.23	21.18±0.30	22.25±0.23
Height (cm)	177.03±1.34	174.94±1.73	175.41±2.16	174.97±1.61
Weight (kg)	67.15±1.68	66.38±1.74	70.32±2.14	69.56±1.58
BMI (kg/m^2)	21.41±0.44	21.68±0.44	22.82±0.45	22.69±0.33
Suprailiac (mm)	6.31±0.48	5.56±0.52	6.80±0.76	5.83±0.36
Subscapular (mm)	8.89±0.41	8.83±0.51	9.31±0.53	9.01±0.50
Triceps (mm)	6.28±0.48	7.46±0.65	6.67±0.54	7.48±0.48
Biceps (mm)	3.64±0.22	4.02±0.41	4.21±0.34	4.66±0.29
Chest (mm)	5.33±0.27	5.39±0.28	6.66±0.67	5.71±0.38
Axilla (mm)	5.17±0.23	6.34±0.51	6.61±0.43	6.21±0.36
Abdomen (mm)	8.69±0.52	9.96±1.03	12.28±1.85	9.77±0.65
Thigh (mm)	7.71±0.75	9.74±0.83	10.33±0.61	10.59±0.81

of 2004, 2005 and 2006 were significantly higher than 2003 values with the exception of PT 2006 ($p<0.001$). BF% value of PT 2006 was also higher than PT 2003. However, its statistical significance was less than 0.01 (Table 3, 4 and Figure 1). Unlike the reduction or remaining almost at the same level, the elevations in the BF% values in both sexes clearly show that sport awareness was not entirely understood or performed by the students at School of Physical Education and Sports followed in this present study.

DISCUSSION

A lot of factors are effective in body composition such as genetic basis, nutritional status, eating habits, drinking, dehydrating, sleeping, age and medicines in addition to physical activity.[19-21] Keeping body composition in a good balance requires first a development of awareness in this regard. Sport and physical education awareness can be promoted by education and media in all over the community, particularly by starting at earlier ages and schools. In this regard, Kim St. Pierre says that being physically active should start at schools.[22]

For the physical education and sport, Bailey[12] points out some important points in his review as follows: "It was suggested that physical education and sport (PES) have the potential to make distinctive contributions to the development of children's

Table 2. Means and standard errors for physical characteristics and skinfold thicknesses in women

Women	2003 (n=19)	2004 (n=19)	2005 (n=16)	2006 (n=16)
Age (year)	18.95±0.29	19.90±0.28	20.88±0.30	21.75±0.31
Height (cm)	163.24±1.55	162.58±1.52	163.64±1.78	162.84±1.89
Weight (kg)	57.36±1.74	55.40±1.90	57.34±2.25	54.17±1.12
BMI (kg/m^2)	21.49±0.48	20.93±0.57	21.37±0.63	20.45±0.35
Suprailiac (mm)	4.91±0.83	8.94±0.89	10.21±1.43	7.53±0.48
Subscapular (mm)	10.12±0.63	10.76±0.94	13.02±1.44	8.88±0.35
Triceps (mm)	3.32±0.34	14.28±1.14	14.46±1.23	11.98±0.72
Biceps (mm)	3.78±0.24	6.82±0.81	9.88±1.51	7.99±1.04
Chest (mm)	5.23±0.33	8.27±1.04	10.64±1.28	10.39±1.21
Axilla (mm)	6.23±0.86	10.65±1.36	10.34±1.68	7.49±0.41
Abdomen (mm)	9.82±1.14	17.55±1.68	21.96±2.38	15.41±1.11
Thigh (mm)	3.54±0.20	23.05±1.65	24.81±2.06	19.91±1.53

Table 3. Means and standard errors of body density, percent fat predicted from generalized equations and skinfold sums in men

Men	2003 (n=15)	2004 (n=16)	2005 (n=11)	2006 (n=16)
Durnin & Womersley (DW)				
Percent fat (%)	10.66±0.61	10.68±0.76	11.28±0.70	11.34±0.47
Body density (kg/m^3)	1.075±0.0014	1.075±0.0018	1.073±0.0016	1.073±0.0011
Sum of four	25.12±1.31	25.86±1.77	26.99±1.56	26.98±1.12
Jackson & Pollock 1 (JP1)				
Percent fat (%)	5.49±0.40	6.38±0.54	7.34±0.68	6.84±0.43
Body density (g/ml)	1.087±0.0009	1.085±0.0013	1.082±0.0016	1.084±0.0010
X_1	48.38±2.60	53.28±3.50	58.66±4.44	54.59±2.81
Jackson & Pollock 2 (JP2)				
Percent fat (%)	5.28 ±0.42	6.44±0.56	7.83±0.87	6.96±0.50
Body density (g/ml)	1.087±0.0010	1.084±0.0013	1.081±0.0020	1.083±0.0012
X_2	21.73±1.39	25.09±1.80	29.26±2.84	26.07±1.65
Peterson et al. (PT)				
Percent fat (%)	13.57±0.62	14.70±0.65	15.29±0.60	15.39±0.55
Sum of four	29.19±1.79	31.58±2.01	33.11±1.86	32.91±1.69

Sum4 in Durnin and Womersley (DW)'s equation: the sum of the suprailiac, subscapular, triceps and biceps skinfolds; X_1 in Jackson and Pollock 1 (JP1)'s equation: the sum of the chest, axilla, triceps, subscapular, abdomen, suprailiac and thigh skinfolds; X_2 in Jackson and Pollock 2 (JP2)'s equation: the sum of the chest, abdomen and thigh skinfolds; X_3 in JP1 and JP2 equations: the age.

fundamental movement skills and physical competences, which are necessary precursors of participation in later lifestyle and sporting physical activities. They also, when appropriately presented, can support the development of social skills and social behaviors, self-esteem and pro-school attitudes, and, in certain circumstances, academic and cognitive development. These benefits will

Table 4. Means and standard errors of body density, percent fat predicted from generalized equations and skinfold sums in women

Women	2003 (n=19)	2004 (n=19)	2005 (n=16)	2006 (n=16)
Durnin & Womersley (DW)				
Percent fat (%)	15.12±0.58	23.04±0.96*	25.19±1.28*	22.04±0.74*
Body density (g/ml)	1.064±0.0013	1.047±0.0021	1.042±0.0028	1.049±0.0016
Sum of four	22.13±1.24	40.81±3.45	47.57±5.07	36.36±2.00
Jackson & Pollock 1 (JP1)				
Percent fat (%)	10.29±0.55	18.81±1.13*	20.67±1.41*	17.09±0.75*
Body density (g/ml)	1.075±0.0013	1.056±0.0025	1.052±0.0031	1.060±0.0017
X_1	43.16±3.16	93.51±7.39	105.44±9.83	81.58±4.54
Jackson & Pollock 2 (JP2)				
Percent fat (%)	8.21 ±0.51	19.16±1.09*	20.98±1.35*	17.05±0.79*
Body density (g/ml)	1.080±0.0012	1.055±0.0024	1.051±0.0030	1.060±0.0018
X_2	21.58±1.89	63.83±4.54	71.44±5.95	54.82±3.12
Peterson et al. (PT)				
Percent fat (%)	18.93±0.58	26.60±0.93*	27.69±1.12*	24.80±0.52**
Sum of four	21.88±1.41	57.04±4.00	62.50±5.25	48.29±2.51

Sum4 in Durnin and Womersley (DW)'s equation: the sum of the suprailiac, subscapular, triceps and biceps skinfolds; X_1 in Jackson and Pollock 1(JP1)'s equation: the sum of the chest, axilla, triceps, subscapular, abdomen, suprailiac and thigh skinfolds; X_2 in Jackson and Pollock 2 (JP2)'s equation: the sum of the triceps, abdomen, suprailiac and thigh skinfolds; X_3 in JP1 and JP2 equations: the age.
*$p<0.001$ versus 2003 and **$p<0.01$ versus 2003 in internal comparison of each equation.

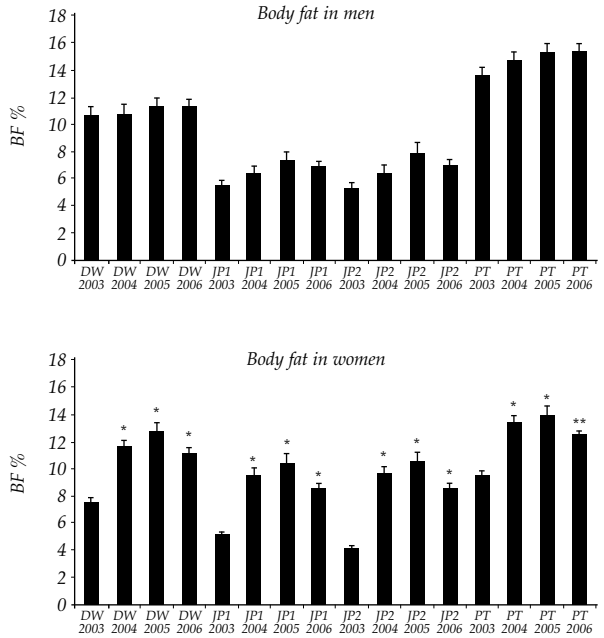

Fig. 1. *Figure of body fat percentages for men and women aged 17-21 years. Details of generalized regression equations are given in Table 3 and 4. DW: Durnin and Wimberley's equation; JP1: Jackson and Pollock's equation using 7 sites skinfold; JP2: Jackson and Pollock's equation using 3 sites skinfold; PT: Peterson et al.'s equation. *p<0.001 versus 2003 and **p<0.01 versus 2003 in internal comparison of each equation.*

not necessarily result from participation, per se; the effects are likely to be mediated by the nature of the interactions between students and their teachers, parents, and coaches who work with them". Haywood[13] also reports following points on this subject: "Because we are also preparing students to implement an active lifestyle in their lives, the development of sport and dance skills through age/ability-appropriate and sequential lessons is as important as the "present" opportunity for physical activity. Teachers must be knowledgeable in the subdisciplines of physical education and well versed in those teaching methods that promote vigorous activity and maximum participation. The lifetime public health goal dictates we help students to develop a knowledge base concerning exercise and health. This goal requires us to learn more than we presently know about promoting positive attitudes toward healthy living".

The primary purpose of this study was to assess whether some of the educational goals was assimilated by the students at the School of Physical Education and Sport in Adnan Menderes University, at least in terms of sport awareness (cognitive aspect), by comparing body fat ratios between the years 2003 and 2006. We think that BF status is one of the important signs of sport awareness. Based on the results, we observed that some of the cognitive goals were not reached by the school or the students.

In this instance, we followed the same 42 students from when they joined the school up until their graduation (four years). The body ratios were calculated by three different anthropometry-based equations to get a stronger idea and results. We chose the Durnin and Womersley, Jackson Pollock and Peterson et al. equations because of their popularity in the field and in research settings.[23-25] After four years of observation, all methods gave almost similar results, that is the body fat ratios did not decrease in the students. The BF ratios progressively increased between 2003-2005 and remained the same in men but decreased in women in 2006 (Table 3, 4 and Fig. 1). This outcome could be due to the total energy expenditure of the students per week during physical activity being less than 2500 kcal/week reported by Lakka and Bouchard[1] or less than moderate intensity activity of approximately 45 to 60 minutes per day or 1.7 PAL (Physical Activity Level) reported by Saris et al.[26] Interestingly, the BF% values in 2003 and 2006 (Fig. 1) show that the students or persons who tend to be more involved in sport for body and health, do so when they come to a new phase in their lives such as entrance into university/college or trying to get a job after graduation from the school.

On the other hand, willpower is also effective in this subject. The ability to resist our impulses is commonly described as self-control or willpower. The elusive forces behind a person's willpower have been the subject of increasing scrutiny by the scientific community trying to understand why some people overeat or abuse drugs and alcohol. What researchers are finding is that willpower is essentially a mental muscle, and certain physical and mental forces can weaken or strengthen our self-control.[27] As happened in awareness, education may play a role in strengthening of the willpower, at least by providing currently known effective factors over the willpower.

In conclusion, the higher BF ratios observed in the students expected to have ideal body composition show that sport awareness was not entirely understood in these students. Therefore, the educational system should be reconsidered to give a shape to increase sport and physical education awareness and willpower in the students and people. Meanwhile, they should be able to force their willpowers to act as guided by their awarenesses as well.

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