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Body Composition of Young Laborers: The Results of a Bioelectrical Impedance Analysis

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ABSTRACT

The aim of this study was to determine the changes caused by physical stress on the body composition of young males. In order to show these changes, the study was performed with 104 young male laborers who worked through their adolescence and who were currently working in workshops in the industrial sector (Group 1, mean age 18.48±0.61 years). For the control group, two groups of the same age but having a difference in terms of socioeconomic status were chosen. The first one of these was comprised of individuals who had the same socioeconomic status as the laborers (Group 2, n=102, mean age 18.39±0.58 years) but were not laborers. The second control group was composed of individuals from the higher socioeconomic levels of society (Group 3, n=103, mean age 18.43±0.67). Measurements of the height of the individuals were taken with a standard portable anthropometer, and their body weight and BIA measurements were taken with Tanita TBF-305 leg-to-leg body composition analysis equipment. The results of the analysis show that the weight, height, BMI and fat mass values of the laborers were significantly lower (P < 0.05–0.001) than those of Group 3, but were not statistically different from those of Group 2. These findings reveal that the effects of socioeconomic conditions on body composition outweigh those of working conditions.

Key words: *young laborers, BIA, body composition, fat mass, fat-free mass, physical structure*

Introduction

The observations and measurements which were initially performed in factories in the United Kingdom and Belgium during the industrial revolution revealed that heavy working conditions, accompanied by low socioeconomic conditions, impeded the physical development of children and caused visible deformation in body structure[1,2]. To a great extent the results of present day studies support the observations made in the 19th century[3–10]. Nevertheless, the studies done both in the 19th century and in the present are based mainly on the measurement of height and weight, and thus reflect the general morphology of the body. Changes in body composition caused by working conditions are an area that has not yet been taken into consideration.

Due to recently developed techniques, body composition can be investigated relatively easily. One of these newly developed techniques is called bioelectric impedance analysis (BIA). Due both to its ease of use and its reliability in field studies, BIA has become a frequently preferred technique in nutrition, sports sciences and public health studies[11,15]. Based on the principle of determining the decrease in voltage after giving alternative currents at different frequencies through electrodes to the tissue bed, BIA makes it possible to easily calculate the amount of body fat, fat-free mass, and the amount of body water[11,16].

The aim of this study is to determine the kinds of changes that have occurred in the body composition of the young laborers who spent their adolescence doing heavy work under physical stress using bioelectrical impedance analysis.

Material and Methods

The study was conducted using 309 male individuals whose ages varied between 17.49 and 20.14 (Table 1). The individuals were studied in three groups. Group 1 (*n*

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TABLE 1
SAMPLE SIZE AND AGE PROFILE OF THE LABOR AND NON-LABOR GROUPS

	N	X	SD	Min	Max
Group 1	104	18.48	0.61	17.49	19.84
Group 2	102	18.39	0.58	17.50	19.98
Group 3	103	18.43	0.67	17.49	20.14

= 104) was comprised of laborers who have lower socioeconomic status (SES) and who work in workshops and businesses in the industrial quarters in Ostim and Iskitler, Ankara, Turkey. These laborers work for 5 or 6 days and receive one day formal training every week in vocational training centers under the authority of Ministry of National Education.

Group 2 (n = 102) consisted of male students who have the same (lower) SES as the laborers. These students attend schools in the slum areas of Ankara, which are usually attended by children of lower income families. Group 3 (n = 102) was composed of young males selected from upper SES. These individuals were selected from students attending state and private colleges, which generally serve higher income sections of society. The average ages and descriptive statistics of these three groups are shown in Table 1. According to the results of one-way analysis of variance (ANOVA), there is no difference between these three groups in terms of the mean average age ($P < 0.63$). The bivariate analyses performed in the post hoc (Tukey) test also show that no significant difference ($P < 0.60$–0.90) exists between the groups.

A questionnaire was administered to the participants in order to obtain information regarding the socioeconomic and demographic features of the individuals. Following the questionnaire, height, weight, and BIA measurements of the participants were collected. Techniques proposed by Lohman et al.[17] were used in the measurement of height and weight. Height measurements were taken with the participants standing in bare feet with their heads in Frankfurt plane. A Martin-type portable anthropometer was used in these measurements and sensitive reading of closest values was done in millimeters. The measurements of body weight as well as BIA measurements were taken with Tanita TBF-305 leg--to-leg body composition analysis equipment (Tanita Corp. Tokyo, Japan). The impedance measurement uses a 50 kHZ-500 mA current and has an impedance range of 150–900V. Subjects were measured barefoot, while standing erect with feet placed on the analyzer's footpads, and wearing only undergarments. Fat-free mass and body density were calculated using the prediction equations supplied by the manufacturer, which take into consideration weight, age, and sex. All measurements were performed in the morning. In addition, participants were asked not to exercise 12 hours, and not to drink alcohol 48 hours prior to being measured.

Using the recorded values of height and weight, the body mass index (BMI) of the participants was calculated to determine the morphological structure of the body in addition to its dimensional properties. The formula of weight (kg)/height^2 (m) was used to obtain the BMI values. In addition, body composition was investigated according to a bi-compartmental model consisting of fat--mass (FM) and fat-free mass (FFM). Values of body fat percentage (FM%), fat mass index (FMI) [FM (kg) / height^2 (m)] and fat-free mass index (FFMI) [FFM (kg) / height^2 (m)] were also calculated using these constituents.

The birth dates of the participants were recorded on the measurement forms as day/month/year format and later decimal ages[18] were calculated by subtracting the birth dates from the date when the study was done. Participants whose exact dates of birth were not known were not included in the study. In the study, all statistical calculations and processes were performed by using The Statistical Package for Social Sciences (SPSS, version 12.0) program and the differences between groups were tested using Kruskal-Wallis non-parametric analyses of variance and Mann-Whitney U test, since all parameters were not normally distributed. The relationship between work history and duration of daily work as well as the relationship between FM was investigated using linear regression analysis.

The distribution of laborers according to vocation is displayed in Table 2. As seen in the table, the laborers work predominantly in workshops specializing in automotive repair and furniture production. When work histories and number of hours worked daily are considered (Table 3), it can be seen that the laborers have been working on average for 5 years and that their daily average of hours worked exceeds 10 hours.

Observations done in the work environments of the laborers revealed that the majority of the individuals work in small shed-like workshops. These workshops have no ventilation system and provide little protection

TABLE 2
WORK FIELDS OF YOUNG LABORERS

Job	N	%
Automotive repair	43	41.4
Furniture manufacturing	37	35.7
Auto reupholstering	10	9.60
Auto body repair	8	7.70
Metal production	6	3.80
Total	104	100.0

TABLE 3
WORKING BACKGROUND AND DAILY HOURS

	X	SD	Min.	Max.
Years worked	5.00	1.45	3	11
Hours worked daily	10.30	1.58	8	17

TABLE 4
FAMILIAL SOCIOECONOMIC AND DEMOGRAPHIC CHARACTERISTICS OF LABOR AND NON-LABOR GROUPS

Family characteristics	Group 1 %	Group 2 %	Group 3 %
Family size			
≤ 3	7.7	11.8	38.8
4	24.0	23.5	44.7
5	28.8	38.2	15.5
6	22.1	15.7	1.0
≥ 7	17.3	10.8	0.0
Father's occupation			
Building contractor, company owner, merchant	0	0	12.6
High bureaucrat, doctor, lawyer, engineer, architect	0	0	55.4
Bank manager, economist, administration manager, specialist	0	0	9.7
Big trades (jeweler, auto gallery owner, etc)	0	0	10.7
Teacher	0	0	2.9
Small trades, farmer	22.1	11.7	0
Municipality, workshop and concrete worker	60.6	64.1	1.9
Civil servant, retired civil servant and worker	10.6	19.6	6.7
Unemployed, street peddler	6.7	5	0
Mother's education level			
Illiterate (no formal education)	13.5	7.8	0.0
Literate (no formal education)	7.7	2.0	0.0
Primary school	62.5	82.4	4.8
Junior high school	11.5	6.9	3.8
High school	1.9	1.0	33.0
Higher education	0.0	0.0	58.3
Residential status			
Shanty	65.4	66.7	0.0
Non-shanty	34.6	33.3	100.0
Number of rooms per house			
1–2	13.5	8.8	0.0
3	49.0	62.7	4.9
4	33.7	27.5	72.8
≥ 5	3.9	1.0	22.3

against the cold in the winter or heat in the summer. It was observed that the apprentices working in the sectors of metalworking and automobile repair used dangerous tools like welding torches, drills, and electric saws without the necessary protective gear such as masks and gloves. It was also noted that the apprentices in the furniture production and upholstery sectors worked without protection against various dyeing agents and toxic chemicals.

Results

Information regarding the socioeconomic features of the three groups is presented in Table 4. Based on this information, it can be concluded that the group of laborers and the group with lower SES have similar living conditions and the third group, which is composed of individuals with upper SES, have considerably higher living standards.

Kruskal-Wallis test results revealed that all variables, with the exception of FFMI displayed statistically significant differences among the groups (Table 5a). The Mann-Whitney U test was performed in order to determine where the source of the differences stemmed from. The results of the test are given in Table 5b. According to the results, the laborers were shorter and weighed less than their peers in both Group 2 and Group 3. While the difference between the laborers and the group with upper SES in terms of height and weight was statistically significant ($P < 0.001$), the difference between the laborers and their non-labor peers in the lower SES group (Group 2) was not significant ($P > 0.05$). However, the BMI values showed that the laborers were thinner than the others.

TABLE 5A
MEAN, STANDARD DEVIATION AND KRUSKAL-WALLIS TEST VALUES OF LABOR AND NON-LABOR GROUPS

	Group 1		Group 2		Group 3		
	X	SD	X	SD	X	SD	Chi-square
Weight (kg)	63.68	9.69	65.22	10.94	73.39	13.02	36.42***
Height (cm)	170.23	7.03	171.21	7.12	177.13	5.53	58.64***
BMI	21.96	2.93	22.21	3.22	23.36	3.80	8.37*
Fat mass (kg)	8.15	4.48	8.50	4.87	11.81	7.06	20.82***
Fat mass (%)	12.25	0.05	12.35	0.05	15.10	0.06	14.47***
Fat-free mass (kg)	55.52	6.07	56.72	6.83	61.59	7.08	41.09***
Fat mass index	2.82	1.49	2.89	1.60	3.76	2.23	13.09***
Fat-free mass index	19.15	1.60	19.32	1.77	19.60	1.80	4.11

Group 1 – Laboring, Group 2 – Non-labor lower SES, Group 3 – Non-labor upper SES, *$P<0.05$; ***$P<0.001$.

TABLE 5B
THE COMPARISON OF PHYSIQUE AND BODY COMPOSITION PARAMETERS OF LABOR AND NON-LABOR GROUPS BASED ON MANN-WHITNEY U TEST

	Groups	Difference	Z	Sig.
Weight (kg)	1 vs 2	–1.54	–1.266	0.206
	1 vs 3	–9.71	–5.635	0.000
	2 vs 3	–8.17	–4.600	0.000
Height (cm)	1 vs 2	–0.98	–0.971	0.331
	1 vs 3	–6.89	–6.912	0.000
	2 vs 3	5.92	–6.254	0.000
BMI (kg/m^2)	1 vs 2	–0.25	–0.538	0.591
	1 vs 3	–1.40	–2.720	0.007
	2 vs 3	1.15	–2.200	0.028
Fat mass (kg)	1 vs 2	–0.11	–0.454	0.650
	1 vs 3	–2.85	–4.211	0.000
	2 vs 3	2.75	–3.643	0.000
Fat mass (%)	1 vs 2	0.38	–0.065	0.948
	1 vs 3	–1.05	–3.393	0.001
	2 vs 3	1.44	–3.191	0.001
Fat-free mass (kg)	1 vs 2	–1.44	–1.459	0.145
	1 vs 3	–6.87	–6.073	0.000
	2 vs 3	–6.87	–4.749	0.000
Fat mass index	1 vs 2	–0.07	–0.220	0.826
	1 vs 3	–0.94	–3.280	0.001
	2 vs 3	–0.87	–2.970	0.003
Fat-free mass index	1 vs 2	–0.15	–0.655	0.513
	1 vs 3	–0.45	–2.010	0.045
	2 vs 3	–0.28	–1.302	0.193

When body composition parameters are considered, the FM, FFM, FMI, and FFMI values of the laborers were significantly lower than those of the upper SES group. The comparison of the young laborers with the non-working individuals in the lower SES yields a different picture as the variables do not differ between the laborers and lower SES group statistically. Thus, when the two non-working groups are compared the individuals in the upper SES group have greater values in terms of body composition variables with the exception of FFMI.

The results of regression analysis indicate that there is no association between work history and FM (adjusted $R^2 = –0.009$, $P = 0.84$). The correlation values between the duration of daily work and FM also indicate that no significant association exists between these two variables (adjusted $R^2 = –0.003$, $P = 0.40$). In sum, the regression analyses reveal that work history and the duration of daily work have little effect (less than 1 %) on the variation in the amount of body fat.

Discussion

The traditional knowledge regarding the studies on child and adolescent laborers is that these individuals almost always belong to the lower socioeconomic levels of society and that they display retarded growth. The most important difference of these individuals from their non-working peers lies in their maturing in harsh and often unhealthy working conditions where they are forced to work in vocations requiring strenuous physical activity from an early age. These practices stem poverty and cultural practices. This difference also means that the working individuals are exposed to more environmental stress.

Contemporary studies done in India, one of the countries where child and adolescent labor is most common, provide rather useful information to understand the negative effects of heavy working conditions on growing bodies. For instance, in the study performed by Singh et al.[7] with children and adolescents aged 6–18 working in the salt mines in Rajastan, India, the wasting ratio was found to be 16 %, the underweight ratio was found to be 25.5 %, and the stunting ratio was found to be 31 %. In another study done by Ambadekar et al.[3] with 233 children aged 8–15 who generally worked in automobile repair shops, workshops, and construction sites, it was discovered that they were below standards especially in terms of NCHS standards when comparing height to age. In a recent study by Hawamdeh and Spencer[5,6] carried out in three different parts of Jordan, male children aged

10–16 who work in agricultural, industrial and commercial sectors were found to lag behind more in terms of height growth when compared with British growth standards. Similar findings were observed in the studies conducted by Gross et al.[19] in Jakarta, Indonesia, by Omokhodion and Omokhodion[9] in Nigeria, and by Yamanaka and Ashworth in Nepal [8].

There are many child and adolescent laborers in Turkey, which is among the first six countries to join the International Programme on the Elimination of Child Labour (IPEC) initiated by International Labour Organization (ILO) in 1992[20]. These laborers, who usually start to work between the ages of 12–15 in small business establishments requiring intense physical effort, work during their most critical growth period. This causes some permanent negative effects on their physical and psychological growth[21,22]. The few studies regarding body development of working children and adolescents in Turkey resulted in findings similar to the ones from studies carried out in various other countries[10,21–24].

Although similar findings were suggested by the studies concerning child and adolescent laborers mentioned above, the socioeconomic conditions of the participants were not investigated in the majority of these studies. However, these conditions are quite influential in growth and nutrition levels. When the height, weight and BMI values obtained in this study are examined, it can be noted that there is quite a significant difference between the working group and the members of the upper SES. Nevertheless, a similar difference is not seen when the lower SES group is compared to the labor group.

When body composition is taken into consideration, the fat mass ratio of the laborers is 3.5 kg (2.8 %) less than the non-labor individuals in the upper SES. Nevertheless, when the effect of socioeconomic conditions is taken into consideration as in this study, it is understood that there is no significant difference between the laborers and the lower SES individuals in terms of all body composition indicators.

Although the studies conducted with athletes who were involved in intense physical activity reveal that these individuals have less fat accumulation and more fat-free mass,[25–27] there are few studies investigating the correlation of work history and intensity with body composition of manual workers. In a study in which physical activity levels, physical fitness, and selected health parameters were investigated, Tuxworth et al.[28] studied 1394 male factory workers aged 35–60 years. In this study, although it appears that the individuals who are more physically active have higher levels of physical fitness, it was also found that there was a negative relationship between blood pressure and body fat accumulation. In a similar study done by Tammellin et al.,[29] it was found that the hand grip power, muscle growth, and cardiovascular adaptation of laborers working in physically more demanding jobs are higher in comparison to those working in less demanding jobs. Nevertheless, as mentioned above, an evaluation of working conditions and body fat accumulation was not directly performed in these studies.

The greater portion of knowledge about the relationship between intensity and history of physical activity and body composition comes from the studies done among athletes, who are physically active. Important changes in body composition occur before and after activity in athletes who are exposed to intense physical activity for specific periods. For example, Annesi et al.[30] observed that in individuals who were exposed to exercise of medium- and high-intensity for 45 minutes three times a week for a period of 12 weeks, a significant increase in the amount of muscle was recorded, and significant decrease in the amount of fat occurred at the end of the 12th week. Similar findings were obtained from studies performed with individuals who were exposed to an intense exercise program for a period of 10 weeks without changing their dietary habits[31] as well as in studies with long distance runners[32,33]. When the findings obtained from our study are taken into consideration, no significant relationship was found between the number of hours worked daily, work history, and the parameters of body composition in the group of laborers who worked 10.5 hours a day and who had been working for an average of 5.30 years. When the fact that the working group is physically more active than the other two, as in the case of the athletes, is taken into consideration young laborers are expected to have lower fat reserves. It would also be expected that a negative correlation between their work history, number of hours worked daily, and fat reserves would exist. However our findings did not verify such an association. As emphasized by Malina, these findings indicate once more that living standards and nutritional conditions must be taken into account in studies concerning child and adolescent laborers[34].

In conclusion, it can be said that young male laborers display retarded growth and that their body fat ratios are lower than their peers who live in better socioeconomic conditions. However, when young laborers are compared with non-laborers who have similar socioeconomic status, no significant difference is observable in terms of physical structure and body composition. At the same time, when it is considered that the work history and number of hours worked daily has no significant effect on the body composition, these findings indicate that the effect of socioeconomic conditions and nutritional status on physical growth and body fat accumulation can outweigh the effects of working conditions.

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KOMPOZICIJA TIJELA KOD MLADIH RADNIKA: REZULTAT ANALIZE BIOELEKTRIČNE IMPEDANCIJE

SAŽETAK

Cilj studije bio je otkriti promjene u kompoziciji tijela uzrokovane fizičkim stresom kod mladih muškaraca. U istraživanjima je sudjelovalo 104 radnika koji rade u industrijskom sektoru, a koji su radili i tijekom svoje adolescentske dobi (grupa 1, prosjek godina 18.48±0.61). Odabrane su tri grupe od kojih je jedna bila kontrolna, a ispitanicima su bili istih godina ali različitog socioekonomskog statusa. Prva grupa bila je sastavljena od individualaca koji su imali isti socioekonomski status kao radnici, iako to nisu bili (grupa 2, n=102, prosjek godina 18.39±0.58). Druga kontrolna skupina bila je sastavljena od individualaca višeg socioekonomskog statusa (grupa 3, n=103, prosjek godina 18.43±0.67). Mjere visine uzete su standardnim prijenosnim antropometrom, a težina i BIA mjere uzete su priborom za analizu kompozicije tijela Tantia TBF-305. Rezultati ove analize pokazali su kako su težina, visina, indeks tjelesne mase i vrijednosti masnoća radnika bili su značajno manji (P<0.05-0.001) od onih u grupi 3, ali se statistički nisu razlikovali od onih u grupi 2. Ovi pronalasci otkrili su kako socioekonomski status utječe na kompoziciju tijela na način da povoljniju kompoziju imaju oni koji su u radnim uvjetima.