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Social Implications of Nutritional Status and Consequences on Cardiovascular Risk Disease among Undergraduate Trained Students

Elena SÎRBU[1], Corina PANTEA[2], Șerban GLIGOR[3]

Abstract

The aim of this study is to show the validity of the neck circumference (NC) for measuring the nutritional status in students from the Physical Education and Sports Faculty. We also want to study the correlation of the neck circumference with other anthropometric parameters and to assess the nutritional behaviour in these students. We have studied 95 males and 53 females with a mean age of 21.96 years (21.96 ± 5.01 years, ranging from 19 to 47 years). All of them were healthy and from different socioeconomic statuses. We measured weight, height, obesity indices, neck and abdominal circumferences, indices of body fat distribution and indices of body fat. The data was divided according to age and gender. In our study lot, 16 students (10.81%) presented a neck circumference of over 39.5 cm and the majority was male. We have obtained a strong negative association between the NC values and the results of the nutritional questionnaire ($p < 0.01$). The nutritional behaviour was dominated by the intake of fast food, eating disorder and intake of carbohydrate-rich drinks ($p < 0.01$). Also, we found a strong positive association between neck circumference and abdominal circumference, body mass index (BMI), weight and resting metabolism (RM) ($r_1 = 0.8467$, $r_2 = 0.7272$, $r_3 = 0.8434$, $r_4 = 0.8849$). No association between the values of neck circumference and the students' age ($r = 0.1366$) has been found. The same results (strong positive association) were obtained when correlating the values of the abdominal circumference with the BMI, weight and RM.

Keywords: neck circumference; abdominal circumference; metabolic syndrome; nutritional behaviour.

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Introduction

The metabolic syndrome (MetS) is a cluster of the most dangerous heart attack risk factors: diabetes and prediabetes, abdominal obesity, high cholesterol and high blood pressure. A quarter of the world's adults have MetS. MetS causes moderate increases in all-cause and CVD mortality (Bihan *et al* 2009; Saito *et al* 2009). Adolescent obesity has increased in the most developed countries. 25% of US children are overweight and 11% are obese. In some European countries, such as the Scandinavian countries, the prevalence of childhood obesity is lower than in Mediterranean countries, but the proportion of obese children is rising in both cases. The prevalence of childhood obesity is high in the Middle East, Central and Eastern Europe (Dehghan, Akhtar-Danesh & Merchant., 2005). In the assessment of central obesity, various techniques are used: waist circumference (WC), waist/hip ratio, waist/thigh ratio, subscapular/triceps skinfold ratio, mid-upper arm circumference, and neck circumference (NC). It has been showed that NC is an indicator of central adiposity and it can be used to determine overweight and obesity in children (Dehghan *et al,* 2005; Hatipoglu *et al*., 2010). Obesity is linked to the environmental, sociocultural and behavioural characteristics. Ultimately, energy balance plays an important role in obesity. Increased intake of foods that are high in energy and fat, low physical activity and high levels of inactivity are major contributors to the rising levels of obesity. In addition, cultural factors such as dietary knowledge, attitudes, behaviours and socio-demographic factors may play a central role in the etiology of obesity (Lou, *et al*., 2012; Ickes, 2011). This study aims to show the validity of the neck circumference for measuring nutritional status in students from the Physical Education and Sports Faculty. We also want to study the correlation of neck circumference with other anthropometric parameters and to assess the nutritional behaviours in these students.

Methods

We have studied 148 students recruited from the Physical Education and Sports Faculty, West University of Timisoara, 95 males (64.19%) and 53 females (35.81%). From the total number of students, 79 (53.38%) were 1st year students, 48 (32.43%) were 2nd year students and 21 (14.19%) were 3rd year students. All of them were healthy and from different socioeconomic statuses. The mean age for the students was 21.96 years (21.96 ± 5.01, ranging from 19 to 47 years of age).

Weight, height, body mass index (BMI), body fat percentage, neck and abdominal circumferences were recorded. The data was divided according to age and sex. Weight and body fat percentages were measured with the Body Composition Monitor Omron BF511 using the Bioelectrical Impedance (BI) method.

We used a Bioelectrical Impedance (BI) method in order to estimate the body fat percentage, depending on fat distribution. This distribution could be visceral (fat surrounding internal organs) or subcutaneous (fat below the skin). Body fat percentage refers to the amount of body fat mass in regards to the total body weight expressed as a percentage: body fat percentage (%) â body fat mass (kg) / body weight (kg) x 100. Height was determined using a portable Seca stadiometer. The BMI was calculated as weight (kg)/height (m^2).

Neck circumference is an important parameter which allows to highlight the persons with BMI ≥ 30 Kg/m^2 and which presents an increased of developing metabolic syndrome. Measurement of neck circumference at this level may have included a posterior upper cervical fat pad if present (Sarría *et al.*, 2001). Neck circumference (NC) is a relatively new method of differentiating between normal and abnormal fat distribution (Mazicioglu *et al*., 2010; Ben-Noun, Sohar & Laor, 2001). The neck circumference was measured with a flexible tape in a standardised manner, horizontally, at the level of the upper margin of the cricothyroid cartilage. In the case of men with laryngeal prominence (Adam's apple), it was measured below this prominence. All the data was recorded with the subjects standing upright, with their faces staring frontwards and shoulders relaxed (Laakso, Matilainen & Keinänen-Kinkaanniemi, 2002).

Waist circumference (WC) was measured at the midpoint between the costal margin and the iliac crest using an inelastic metric tape with the subject in a standing position (Sarría *et al*., 2001; Nafiu *et al*., 2010). All students completed a 51-item „Eating Behaviour Patterns Questionnaire" (EBPQ). This questionnaire was developed by Utah State University, adapted from Schlundt, SODA Questionnaire (Williams & Christensen, 2010). The EBPQ was used to assess eating behaviours in the following domains: low fat eating (11 questions), emotional eating (8 questions), snacking on sweets (10 questions), cultural/lifestyle behaviours (9 questions), haphazard planning (6 questions) and meal skipping (7 questions). Each question was scored from 1 to 5 as following: strongly agree (5), agree (4), neutral (3), disagree (2) and strongly disagree (1). The total scores for each section were divided by the total number of questions included in that section. If the average is 4 or 5, it means it has the characteristics of that eating behaviour (Schlundt *et al*., 1996).

Statistical analysis was performed using the Statistical Package from the Social Sciences statistical package (SPSS).The independent *t* test (two-tailed) was used to compare two means and in particular when those means come from different groups of subjects. The students'*t* test for paired data (two-tailed) was used for comparing mean values in each group of patients. Values of $p < 0,05$ were considered significant.

Results

Anthropometric parameters and nutritional behaviour of our study subjects are shown in table 1.

Table 1. *Anthropometric parameters and nutritional behaviour of the students from Physical Education and Sports Faculty*

Parameters	First year	Second year	Third year
Body fat percentage (BFA)	19.74 ± 7.25	21.77 ± 8.37	21.01 ± 5.61
Skeletal muscle percentage (SMP)	38.87 ± 6.06	36.98 ± 6.72	36.47 ± 5.19
Body mass index (BMI)	22.79 ± 2.79	23.48 ± 3.65	21.99 ± 2.80
Resting metabolism (RM)	1603 ± 224.12	1565.27 ± 295.22	1460 ± 261.61
Abdominal circumference (AC)	77.81 ± 8.34	77.64 ± 11.37	77.19 ± 9.90
Neck circumference (NC)	35.74 ± 3.05	35.30 ± 4.12	34.16 ± 4.13
Low fat eating (LE)	2.82 ± 0.49	2.89 ± 0.52	3.27 ± 0.68
Snacking and convenience (SC)	2.71 ± 0.63	2.47 ± 0.62	1.98 ± 0.52
Emotional eating (EE)	2.44 ± 0.60	2.43 ± 0.59	2.04 ± 0.53
Planning ahead (PA)	2.81 ± 0.45	2.85 ± 0.48	2.84 ± 0.54
Meal skipping (MS)	2.36 ± 0.61	2.38 ± 0.51	2.25 ± 0.52
Cultural/Lifestyle behavior (C/LB)	8.09 ± 30.82	2.49 ± 0.51	2.33 ± 0.52

We observed that increased values of the neck circumference (e" 39.5 cm) were present in 5 first year students (all male), who represent 6.33% from the total number of 1st year students; the mean value of their neck circumference was 41.1 ± 1.67 cm. 7 second year students (14.58% of 2nd year students) were in the same situation, with the mean value of their neck circumference being 41.64 ± 2.46 cm. 4 third year students (19.05%) have a mean neck circumference of 40.25 ± 0.5 cm. Both the 2nd and 3rd year students with increased values of the neck circumference were male. The mean value of the neck circumference of the study lot was 35.37 ± 3.6 cm.

In our study group 16 students (10.81%) had an increased neck circumference of over 39.5 cm. The students with an increased neck circumference, who required additional evaluations in order to highlight their overweight and obesity status, represented 43.04% in the 1st year, 33.33% in the 2nd year and 19.05% in the 3rd year, the majority (88.89%) being male. A number of 14 students (9.46%) from our study lot, all male (6 from the 1st year, 5 from the 2nd year and 3 from the 3rd year) presented an increased abdominal circumference, typical of the metabolic syndrome. The mean value of the abdominal circumference was 95.16 ± 2.97 cm

in 1st year students, 100.6 ± 9.5 cm in 2nd year students and 95 ± 1 in 3rd year students. The mean value of the abdominal circumference of the students from our study lot was 77.66 ± 9.57 cm.

Another important parameter in determining the presence of overweight and obesity is the BMI. According to this parameter, there were 32 overweight students (21.62%), the majority of them (87.5%) being males. Furthermore, 3 students (2.03%) had 1st degree obesity (BMI between 30 and 34.9 Kg/m^2) and 1 student (0.67%) with 2nd degree obesity (BMI between 35 and 39.9 Kg/m^2). The mean value of the students BMI was 22.9 ± 3.11 Kg/m^2. There were no significant differences regarding the neck circumference of these students; the highest value can be found in 1st year students (35.74 ± 3.05 cm). The same aspect was recorded for the abdominal circumference (77.81 ± 8.34 cm) ($p>0.05$).

The nutrition-related questionnaire revealed 3 first year students (2.03%, 2 male and 1 female) with a nutritional habit of "snaking and convenience". Furthermore, there were 2 students (1.35%, from the 1st and 2nd years) with "emotional eating", 5 students (3.38%) with "low fat eating", the majority (60%) being 2nd year students and female (80%). A nutritional habit characterised by "meal skipping" has been found in the case of a 1st year male student; a "cultural/lifestyle behaviour" and a "planning ahead" nutritional habit have been found in the case of one student per each type (0.67%), both females, one from the 1st year and one from the 2nd year.

Table 2. *Statistical comparison between 1st year and 2nd year students*

	BFP	SMP	BMI	RM	AC.	NC	LE	SC	EE	PA	MS	C/LB
p	0.1519 p > 0.05	0.2323 p > 0.05	0.2636 p > 0.05	0.443 p > 0.05	0.931 p > 0.05	0.5258 p > 0.05	0.4765 p > 0.05	0.04 p < 0.05	0.9062 p > 0.05	0.6785 p > 0.05	0.821 p > 0.05	0.2758 p > 0.05

Legend: LE – Low fat eating, SC – Snacking and convenience, EE – Emotional eating, PA – Planning ahead, MS – Meal skipping, C/LB – Cultural/Lifestyle behaviour, BMI – body mass index, RM – resting metabolism, NC – neck circumference, AC – abdominal circumference, BFP – body fat percentage, SMP – skeletal muscle percentage

Table 3. *Statistical comparison between 1st year and 3rd year students*

	BFP	SMP	BMI	RM	AC	NC	LE	SC	EE	PA	MS	C/LB
p	0.4579 p > 0.05	0.1 p > 0.05	0.2493 p > 0.05	0.0138 p < 0.05	0.772 p > 0.05	0.1143 p > 0.05	0.0091 p < 0.05	4.462E-06 p < 0.01	0.0076 p < 0.05	0.7884 p > 0.05	0.4353 p > 0.05	0.2456 p > 0.05

Legend: LE – Low fat eating, SC – Snacking and convenience, EE – Emotional eating, PA – Planning ahead, MS – Meal skipping, C/LB – Cultural/Lifestyle behaviour, BMI – body mass index, RM – resting metabolism, NC – neck circumference, AC – abdominal circumference, BFP – body fat percentage, SMP – skeletal muscle percentage

Table 4. *Correlations between the abdominal circumference and the results of the nutritional questionnaire (students from all years of study)*

AC	LE	SC	EE	PA	MS	C/LB
R	-0.07301	-0.00642	-0.00193	-0.05977	-0.12435	0.1024
P	p < 0.01	p < 0.01	p < 0.01	p < 0.01	p < 0.01	p < 0.01

Legend: AC – abdominal circumference, LE – Low fat eating, SC – Snacking and convenience, EE – Emotional eating, PA – Planning ahead, MS – Meal skipping, C/LB – Cultural/Lifestyle behaviour.

Table 5. *Correlations between neck circumference and the results for the nutritional questionnaire (students from all years of study)*

NC	LE	SC	EE	PA	MS	C/LB
R	-0.0812	-0.01192	-0.00909	-0.05535	-0.13022	0.08808
P	p < 0.01	p < 0.01	p < 0.01	p < 0.01	p < 0.01	p < 0.01

Legend: AC – abdominal circumference, LE – Low fat eating, SC – Snacking and convenience, EE – Emotional eating, PA – Planning ahead, MS – Meal skipping, C/LB – Cultural/Lifestyle behaviour.

The results of the nutritional questionnaires were not significantly different between 1st and 2nd year students ($p > 0.05$), with the exception of SC (snaking and convenience), which registered a statistically difference ($p < 0.05$). In contrast, the nutritional habits were highly significantly different between 1st and 3rd year students regarding LE, SC and EE ($p < 0.01$) and significantly different as regards RM ($p < 0.05$). Furthermore, no correlation was found between student's abdominal circumference and the results of the nutritional questionnaire (Pearson coefficient test). The same result was obtained when the neck circumference was correlated to the questionnaire's results. A strong positive association has been

obtained between the neck circumference and the abdominal circumference, BMI, weight and RM (r_1 = 0.8467, r_2 = 0.7272, r_3 = 0.8434, r_4 = 0.8849). No positive association between the neck circumferences and the students' age has been found (r = 0.1366). The same results (strong positive association) have been obtained when correlating the abdominal circumference to the BMI, weight and RM (r_5 = 0.8695, r_6 = 0.9101, r_7 = 0.8110). No association between the values of the abdominal circumference and the percentage of adipose tissue and the student's age has been found (r = 0.1794, r = 0.2393 respectively).

Discussion

The incidence of global overweight and obesity are very high. It can be said that they are a public health problem because of this high incidence. Unfortunately a large number of cases can be found in young population. Our study group includes subjects whose average age is 21.96 years. Obesity in young population is associated with metabolic and cardiovascular disease, and induces very important psychosocial problems (Reilly et. al., 2003). The association between visceral obesity and the risk of cardiovascular disease is well known (Fox *et al*., 2007). Recent studies demonstrate that the regional adiposity and especially the upper body depot (central obesity) is associated with chronic disease such hypertension or diabetes (Dehghan, Akhtar-Danesh & Merchant, 2005). It seems that the upper body adipose tissue is an important contributor to circulating free fatty acids (FFA) and is more lipolytically active than lower body adipose tissue (Jensen, 1995). Less is known about the upper body subcutaneous fat depot. The concentrations of FFA are associated with insulin resistance (Ferrannini *et al*., 1983), hepatic VLDL production (Kissebah *et al*., 1976), and endothelial dysfunction (Steinberg *et al*., 1997), and can induce numerous cardiovascular problems (Yang *et al*., 2010; Ben-Noun & Laor, 2003). The BMI is the most common method to evaluate the obesity, but this method is not a good descriptor of regional adiposity (Ogden *et al*., 2008). Given this fact, other anthropometric methods of measure of the central adiposity have been described (Okosun *et al*., 2000; Laakso *et al*., 2002).

Neck circumference (NC) is a relatively new method of differentiating between normal and abnormal fat distribution (Mazicioglu *et al*., 2010; Laakso, Matilainen & Keinänen-Kinkaanniemi, 2002). The values of the neck circumference associated with an increased risk of developing the metabolic syndrome are: ≥ 39.5 cm for men and ≥ 36.5 cm for women. A decreased value of the neck circumference (≥ 37 cm for men and ≥ 34 cm for women) indicates the need for additional evaluation in order to highlight the overweight and obesity statuses (Ben-Noun *et al*., 2001; Onat *et al*., 2009). In our study lot, 16 students (10.81%) presented a neck circumference of over 39.5 cm, the majority being male.

As one can see from our study, NC is strongly correlated with other methods of assessing overweight or obesity. All the subjects with the level of NC higher than 39.5 cm have the BMI and WC higher than the normal value. The same situation was reported in other studies (Chan *et al*., 2003; Maffeis *et al*., 2001). This study confirms that the NC is strongly correlated with the BMI and that it is possible to use this method as an additional tool for identifying children or adults who are obese (Hatipoglu *et al*., 2010). Because of its simplicity, this method can be used as a screening method for early detection of these situations of overweight or obesity, especially in the case of young adults, as is the case in our study. Furthermore, we have obtained a strong negative association between the NC values and the results of the nutrition-related questionnaire ($p < 0.01$). This means that the higher the values of the NC, the more improper the student's eating behaviour tends to be, especially in the domains of SC, LE, EE ($p < 0.01$).

A higher abdominal circumference (≥ 94 cm in males and ≥ 85 cm females – according to IDF- „International Diabetes Federation") is associated with other abnormal parameters (triglycerides, HDL cholesterol, systolic arterial blood pressure, diastolic arterial blood pressure and fasting glucose), represent typical traits of the metabolic syndrome (29, 30). We have noticed that the mean value of the abdominal circumference of these students was 77.66 ± 9.57 cm, so under normal values.

In our study we used a questionnaire to discover faulty eating habits. We noted predominantly the intake of fast food, eating disorderly and the intake of carbohydrate-rich drinks. Finally, all the subjects have received the recommendation to extend the investigation which we have previously described. We have noticed that the students from the 2nd and 3rd years present improper eating habits, especially in the domains of SC, LE, EE ($p < 0.01$). Recent research has focused extensively on body composition and CVD risk. Emphasis has been placed on whether an individual has an upper-body or lower-body fat distribution or what proportion of fat is stored in visceral *vs.* subcutaneous fat depots. Typically, central obesity, particularly high levels of upper-body visceral fat, is associated with adverse metabolic outcomes such as insulin resistance, diabetes, hypertension, and elevated triglycerides, whereas individuals with lower-body obesity tend to have lower levels of these adverse metabolic outcomes (Yang *et al*., 2010).

Finally, our results indicate the need to extend the investigations by using some biochemical tests (glucose, triglycerides, total cholesterol, HDL cholesterol, LDL cholesterol levels), IMT (intima media thickness) carotidal and also the cross-sectional abdominal CT scan at the level of the L4 pedicle (Borkan *et al*., 1982).

Conclusions

Measuring neck circumference is one of the simplest methods for assessing the nutritional status. This method cannot be used alone, but it can be used as a screening method. In association with the BMI and WC, one can discover the young or adult people with overweight or obesity which require further investigation to prevent cardiovascular disease or diabetes. The finding of our paper was that the students from Physical Education and Sports Faculty recorded increased NC and WC values being predisposed to the future development of metabolic syndrome. Also, the data here suggest that NC and WC were correlate negatively with the the eating behaviors among undergraduate trained students. The results of the nutritional questionnaires were not significantly different between 1st and 2nd year students, with the exception of SC questionnaire (snaking and convenience). This study indicates that, despite the practice of regular physical activities, there is a strong positive correlation between the NC and metabolic syndrome. This can be explained either by impropriate eating habits or because they have to supplement their physical activity with an extra-school regular physical activity program. Energy balance plays an important role in obesity and this is linked to the environmental, sociocultural and behavioural characteristics. In conclusion, the most important finding of this study is to highlight the importance of educational actions for the control and prevention of disordered eating behaviors among under-graduate students.

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