ANTHROPOMETRIC MEASUREMENTS OF THE SELECTED SEGMENT OF YOUTHS

Vanda Lieskovská – Silvia Megyesiová – Naqibulah Daneshjo – Erika Dudáš Pajerská — Monika Čonková

Abstract

This contribution follows the project of the Ministry of Education of the Slovak Republic within the VEGA grant scheme and presents partial results of its research. The project as a whole will focus its attention on marketing activities which we consider to be one of the potential tools to support the health policy. However, in order to be able to apply the appropriate tools of marketing mix to reduce the incidence of chronic diseases, in the initial phase we had to conduct a primary research focused on the students of selected secondary schools (total number of 247) as well as students of chosen colleges (total number of 189). In addition to measuring the overall psychological and physical well-being of young people including blood pressure measurement, heart rate measurement and blood glucose testing, other anthropometric data (height, weight, percentage of body fat) were also recorded with assistance of experts from the secondary medical school. In the presented paper, we will focus on various alternatives in evaluating anthropometric measurements while taking into account not only the Body Mass Index, but also Broca Index. In the end, we will compare our findings with the conclusions drawn from other available research with the aim of taking specific measures.

Key words: obesity, anthropometric measurements, measurement analysis

JEL Code: D18, K22, M31

Introduction

According to experts, the main segments of non-infectious diseases in Europe that most Europeans suffer and die from involve diagnoses such as diabetes, cardio-vascular diseases, cancer and chronic respiratory diseases. All of these diseases are directly connected to obesity. Obesity can be classified as a civilizational disease having a negative impact on the deterioration of the actual health condition of an individual. According to the data published by the DÔVERA insurance company, in Europe, almost 63% of adult men and 55% of adult

women are overweight. In Slovakia, these numbers are even worse – 69% of men and 60% of women are overweight. As part of prevention, it would be suitable to act upon the all-society environment in which people live, work, study and spend their leisure time. In relation to that, marketing and education play an important role, mainly through their impact on spreading the awareness of healthy alternatives to life style. Sufficient amount of information and stimuli not only helps explore healthy possibilities but also enables a simpler realization of those. The issue of observing the life style of the youth as well as obtaining and evaluating anthropometric measurements of youths has become part of the solution of a grant project called VEGA 1/0376/17. In the submitted paper, we rivet our attention to the comparison of two alternatives of anthropometric measurement and evaluation of obtained data.

1. Anthropometric Methods Based on the Assessment of Ideal Weight

Observing obesity has become a subject of multiple health policies, starting with the WHO, through health policies of individual countries to observing individual indicators of patients in ambulances of general practitioners and pediatricians. There are various approaches to the classification of obesity. Anthropometry is one of the methods of anthropology – the study of humans, their development, culture etc. It is a system of measurements, observations of human body, its parts and physical dimensions. We investigate a small number of physical dimensions that are selected in order to describe the main size and shape proportions of human body. The choice of suitable dimensions (length, surface, volume etc.) is subject to anthropometry which elaborated the standard methodology to detect individual parameters and developed necessary systems. Based on some physical dimensions, the so-called indexes can be calculated. Those are numbers determining the proportion of a certain dimension in the amount of another particular dimension. (Ferák, 1981). In the submitted research, we focused on the measurement of height and weight as selected anthropometric characteristics that were crucial to use two particular methods: Body Mass Index and Broca index. Height was perceived as a vertical distance between the highest point at the top of the head (vertex) and the surface. While being measured, the posture was erect, standing with both feet next to each other and the head in an orienting position. The height was measured by a stadiometer (Seca 2013, SecavHamburg, Germany). The weight was measured by a calibrated electronic scales KERN MFB 150K100. When measuring, the posture was in the center of the bearing area, without any movement.

1.1 Body Mass Index

At the beginning of the 19th century, in 1836, Adolphe Quetelet[1], a Belgian mathematician and statistician created an index to calculate the percentage proportion of fat in a body based on the height and weight of the measured individual. The Quetelet index can be identified with the Body Mass Index (BMI) which expresses the relation between the height and weight of a person (Marádová, 2010). The body mass index is the most frequent and widespread way of determining the obesity level. The body mass index calculation is based on the formula: "BMI=" "physical weight in kg" /〖"(physical height in m)" 〗

The term *BMI index* has become popular and frequently used mainly since 1972 when Ancel Keys found that BMI is the best way to calculate the percentage of body fat based on height and weight in the July volume of the *Journal of Chronic Diseases* magazine.

Body Mass Index (BMI) (1)

$$BMI = \frac{\text{real physical weight (kg)}}{\text{height } (m)^2} \; x \; 100$$

BMI = weight in kg / height in m^2

The height is measured to the nearest 1 cm and weight to the nearest 0.1 kg.

Tab. 1: Weight assessment based on BMI categories (kg/m^2)

Weight assessment based on BMI categories (kg/m^2)				
	Underweight	*Optimal weight*	*Overweight*	*Obesity*
Men	< 20	20 - 25	25 - 30	> 30
Women	< 19	19 - 24	24 - 29	> 29

Based on the BMI, the World Health Organization (WHO) subdivided obesity and overweight into multiple levels according to the health risk rate. The category of underweight is further divided into two subgroups: slightly underweight and markedly underweight. Obesity is further divided into three groups into slight, medium and marked obesity.

Tab. 2: Categorization of BMI based on the WHO

Obesity level	**BMI category**
Markedly underweight:	under 15,0
Slightly underweight:	15,0 – 18,5
Standard values:	18,5 – 24,9

[1] Faerstein 2012

Overweight:	25,0 – 29,9
Slight obesity:	30,0 – 34,9
Medium obesity:	35,0 – 40,0
Marked obesity:	over 41,0

Source: UVZ

In the scientific journal dedicated to internal medicine, Dr. Sucharda (2015) claims that there is no definition of extreme obesity among people whose BMI ranges from 41 to 60. He considers it necessary to think about adding another category which would be higher than marked obesity.

Through categorizing obesity and classifying it as exactly as possible, one could declare the requirements in terms of care of impacted patients in a more accurate way. Whether we are talking about the equipment of an adequate bed but also necessary items related to patient care at the intensive care unit. In his paper, Bellamy (2012) extends the obesity classification based on the BMI by three additional categories: super obesity, super super obesity and hyper obesity. The classification into individual categories is presented in Table 3.

Tab. 3: Extended BMI categorization according to Bellamy

Obesity level	**BMI**
Super obesity	50-59,9
Super super obesity	60-69,9
Hyper obesity	over 70

Source: Belamy 2012

In case of the extended classification, it would be less demotivating for the obese patient to strive to get from a higher BMI category into a lower one through various diet, sport-physical or combined measures related to the patient.

It is necessary to consider the fact that the BMI varies from country to country. Although the way of calculating it may be the same (except for the mass and height units used in Great Britain, for instance), the classification into some groups may look rather different. For example, in Japan, what is perceived as normal weight is the BMI ranging from 18.5 to 22.9. On the other hand, we assume that in countries with distinctive portion of markedly obese individuals, it might be useful to work with the fourth and fifth obesity category, which represents the stage preliminary to morbid obesity.

1.2 Broca's Formula for Ideal Weight and the Broca Index

The Broca index got its name from a French doctor and anthropologist Paul Broca. It expresses the body mass index that had been used before the BMI body mass index was implemented. It is a simpler index than the BMI, however, it is also less accurate. It bases upon a simple relationship. According to Broca, the parameter of ideal weight can be achieved when 100 is deducted from one's physical height.

Broca's formula for ideal weight (kg) = physical height (in cm) – 100

Subsequently, the Broca index (BI) is calculated as a proportion between the physical weight and ideal weight multiplied by 100. The weight assessment based on realized calculations is as follows:

The Broca index (BI) (2)

$$\text{BI} = \frac{\text{actual physical weight (kg)} BI\ (\%)}{\text{ideal weight (in kg)}}\ x\ 100$$

Health issues occur in case the overweight exceeds the normal weight by 20%.

Tab 4: Weight categorization based on the BI

Alternatives of weight perception	BI in %
Ideal weight	90 – 100
Overweight	101-115
Slightly obese	116-125
Medium obesity	126-150
Markedly obese	151-200
Morbidly obese	Over 201

Source: Osacká, P.: 2011

The Broca index (BI) ranging from 90 to 110% is considered as ideal physical weight – lower values imply underweight. BI over 115% implies overweight. The modified Broca index states how many kilograms of weight is beyond the ultimate limit of recommended weight, or, more precisely, how many kilograms one needs to gain to meet the limit.

2. Research and Interpretation of Results of Weight Measurements

An anthropometric examination was part of the research about the life style of the youths. The research was realized on a sample consisting of 436 respondents out of which 247 were high school students and 189 were university students from the district of Košice. Based on the obtained data regarding their height and weight, we determined the BMI and BI and compared it afterwards. Body weight and height are the most important indicators of the state of nutrition by means of which we could calculate the BMI and BI body mass indexes. Physical

weight was measured by means of a calibrated scales with the necessary range of measurement. The scales was balanced beforehand. The examined person stood in the center of the bearing area, without any movement. So the physical height could be measured accurately, the person needed to stand on the whole surface of their feet while being erect, hands down, heels next to each other and head in an orienting position. S/he was touching the mat with his/her heels, gluteal area, spatulas and occiput. We measured the distance between the vertex and the surface they were standing on.

2.1 Results of Anthropometric Measurements of Height and Weight

After the research was done, we saved the acquired values in Excel and created a database in order to further process the outputs. We used the IBM SPSS Base software to analyze them. Out of the tests, we applied the quantitative analysis of nominal data: Chi-square tests realized on the level of importance of 0.05, meeting the condition of minimum anticipated compounding frequency (or verifying the relationship by means of the accurate Fisher's test). Through a subsequent post-hoc analysis of levels of analyzed variables, we specified the examined impacts by means of adjusted residuals (AR) in case of which the values of residuals > |±2| imply a statistically important impact of a particular level of factor.

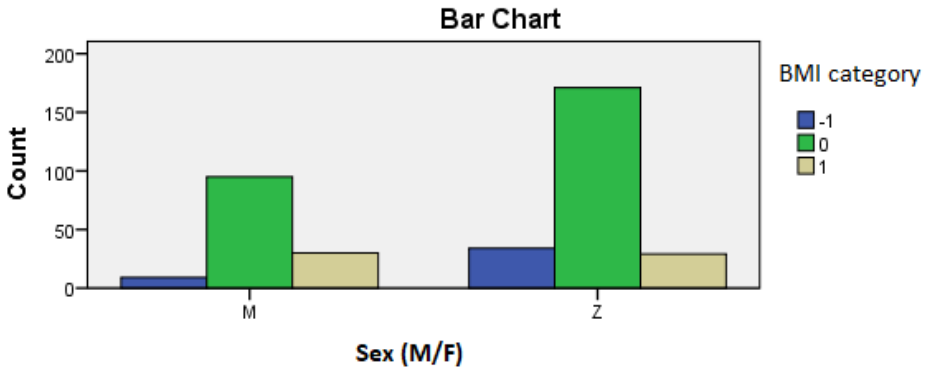
The relationship between the sex and the BMI. In the primary process, we created three basic categories of respondents based on the calculation of measured values. The classification into categories was as follows:

- - 1 – underweight, BMI < 18.5,
- 0 – ideal weight, BBMI ranging from 18.5 to 25,
- + 1 – overweight to obese, BMI > 25.

Among pilot findings within the range of a specified sample of students, through tests, statistically important differences in terms of the BMI index categories were verified between the groups of male and female students (see the following table and graph). We can conclude that along with the unimportant difference in relative frequency of male and female students with ideal weight, what is considered as statistically important is the higher portion of female students (F) with lower BMI and lower portion of female students whose BMI was higher than the ideal BMI (+1) compared to the anticipated frequency and, on the contrary, among the male students (M), the relative portion of students with lower BMI (-1) is lower and the portion of students with higher BMI (+1) is higher compared to the anticipated frequency of

independent classification. Through the contingency coefficients, the strength of the relation of nominal variables was calculated as 0.16, p-value 0.007.

Fig. 1: BMI classification based on the sex



Tab. 5: Categorization of the weight based on the sex

Sex (M/F) * BMI category Cross tabulation

			BMI category			Total
			-1	0	1	
1. sex (M/F)	M	Count	9	95	30	134
		% within sex (M/F)	6,7%	70,9%	22,4%	100,0%
		Adjusted Residual	**-2,2**	-,4	**2,5**	
	Z	Count	34	171	29	234
		% within sex (M/F)	14,5%	73,1%	12,4%	100,0%
		Adjusted Residual	**2,2**	,4	**-2,5**	
Total		Count	43	266	59	368
		% within sex (M/F)	11,7%	72,3%	16,0%	100,0%

Source: author's own calculations

2.2 Comparison of the Categorization of Studied Respondents based on their BMI and BI

Subsequently, we came up with a decomposition of the studied sample to a group of high-school youth and university youth. We compared the categorization into individual categories based on the BMI and BI.

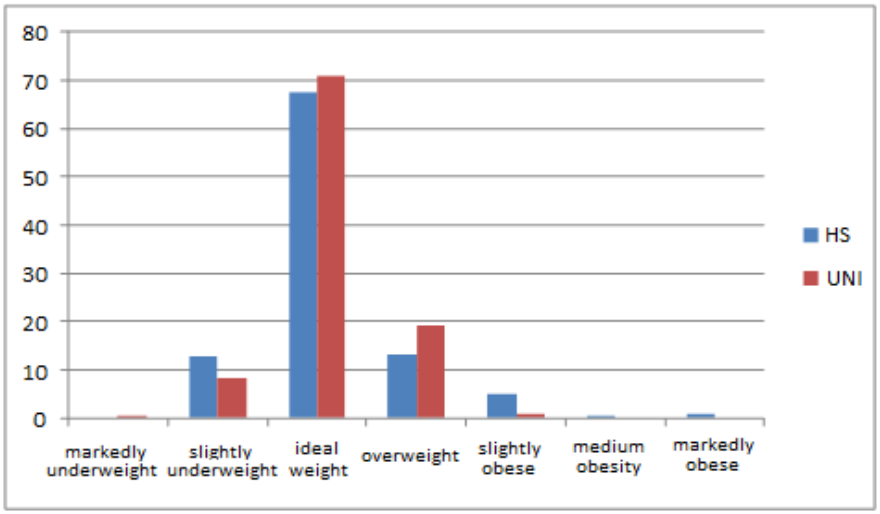
Tab 6: The comparison of categorization of high school students and university students into categories based on their BMI

	AF (HS)	RF (HS)	AF (UNI)	RF (UNI)
Markedly Underweight	-	-	1	0,5
Slightly underweight	32	13	16	8,5
Ideal weight	167	67,5	134	70,9
Overweight	33	13,4	36	19,1
Slightly obese	12	4,9	2	1
Medium obesity	1	0,4	-	-
Markedly obese	2	0,8	-	-
ALTOGETHER	247	100	189	100

Source: author's own calculations

The results of the categorization of students into categories based on their BMI are presented in Figure 2.

Fig. 2: The comparison of categorization of HS and UNI students into categories based on their BMI



Source: Author's own work

As these data imply, in case of the university youth, there is a larger portion of respondents with ideal weight, but also of overweight ones compared to medium and marked obesity which only occurred in case of the high school youth, the representation being of only negligible character anyway.

Subsequently, we evaluated the acquired anthropologic measurements in accordance with the methodology of calculation of the Broca index. The Broca index does not take underweight into consideration – the categorization begins with ideal weight. With regard to the recommendation of ideal weight, the BI ranging from 90 to 100%, we came up with

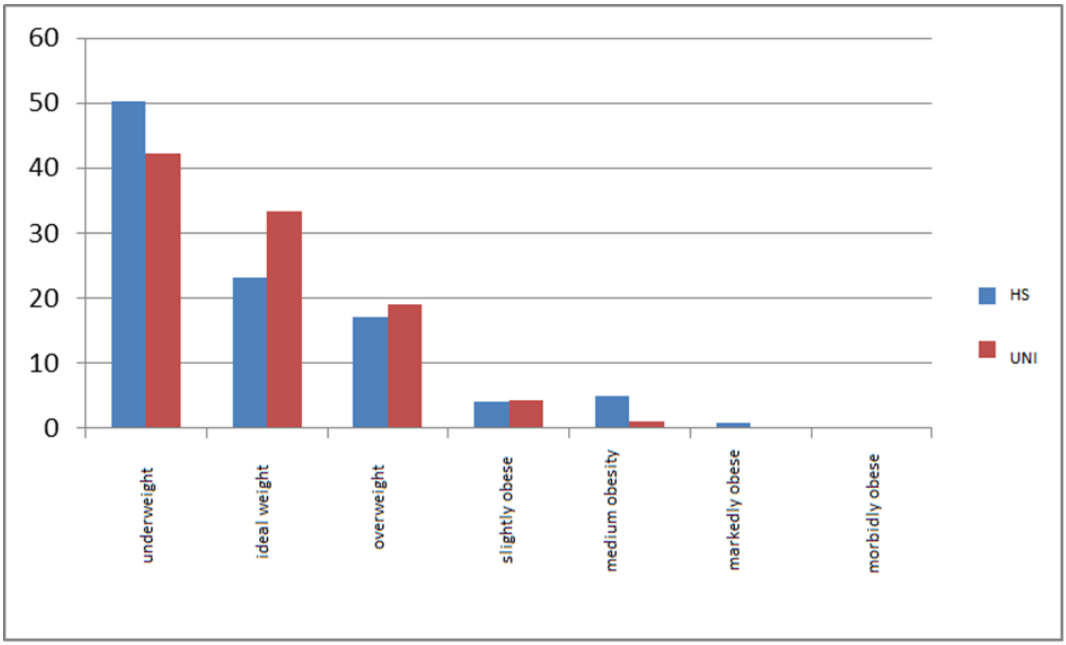
another category when evaluating the acquired measured values and called it “underweight”. The results are presented in Table 7 and Figure 3.

Tab 7: The comparison of categorization of HS and UNI students into categories based on their BI

BI	Absolute frequency (HS)	Relative frequency (HS) in %	Absolute frequency (UNI)	Relative frequency (UNI) v %
Underweight	124	50,2	80	42,3
Ideal weight	57	23,1	63	33,4
Overweight	42	17	36	19,1
Slightly obese	10	4	8	4,2
Medium obesity	12	4,9	2	1
Markedly obese	2	0,8		
Morbidly obese				
ALTOGETHER	247	100	189	100

Source: Author’s own work

Fig 3: The comparison of categorization of HS and UNI students into categories based on their BI



Source: Author’s own work

When comparing the results of the categorization into categories based on the BMI and BI we can see that by means of using the Broca index, there was a percentage boost regarding the categories of overweight, slightly obese and medium obesity. Morbid obesity was not represented.

Conclusion

The results of the anthropometric measurement were compared by means of using two methods: BMI and BI. Although the BMI method is currently a recommended alternative and the results acquired using the Broca index are considered as less accurate, there are also studies claiming that people with optimal body mass have – according to the Broca index – more stable health condition.

Through the data analysis we succeeded in confirming that while using the BMI, we recorded 19.5% of high school youth and 20.1% of university youth with their weight beyond the normal value; by means of the Broca index, there were 26.7% of high school students and 24.3% of university students with their weight beyond the normal values. However, the excessive kilograms may not only comprise of fat, but also muscles. The construction of BMI nor BI does not, though, count on this alternative. Therefore, we can yield a situation in which an athlete doing force sports with a considerable portion of muscles could appear as an overweight individual. By the same token, when being on drastic diets, there is a rapid reduction of not only fat reserves but also muscular tissues. If – after some time – the original dietary habits are redeemed, fat occurs again, but muscles do not. In that case, the BMI and BI indexes may show normal values although the physical condition of an individual is much worse. That is why we recommend observing the surplus values based on the BI and specifying the physical activities and incorporating the measurement of another anthropometric parameter such as the fat volume. A more complex information about physical parameters creates a larger space for potential recommendations in the field of diet or physical activities in order to achieve a healthier life style.

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https://www.dovera.sk/

Contact

Vanda Lieskovská
The University of Economics in Bratislava
Faculty of Business Economics with seat in Košice
Tajovského 13 Košice 040 00
Slovakia
vanda.lieskovska@euke.sk

Silvia Megyesiová
The University of Economics in Bratislava
Faculty of Business Economics with seat in Košice
Tajovského 13 Košice 040 00
Slovakia
silvia.megyesiova@euke.sk

Naqibullah Daneshjo
The University of Economics in Bratislava
Faculty of Business Economics with seat in Košice
Tajovského 13 Košice 040 00
Slovakia
naqibullah.daneshjo@euke.sk

Erika Dudáš Pajerská
The University of Economics in Bratislava
Faculty of Business Economics with seat in Košice
Tajovského 13 Košice 040 00
Slovakia
erika.dudas.pajerska@euke.sk

Monika Čonková
The University of Economics in Bratislava
Faculty of Business Economics with seat in Košice
Tajovského 13 Košice 040 00
Slovakia
monika.conkova@euke.sk