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BODY MASS INDEX STUDY OF TECHNICAL UNIVERSITY STUDENTS

The body mass index (BMI) of I and II year students at Sofia Technical University, Plovdiv Branch, has been studied by the methods of mathematical statistics. The obtained results from the survey have been analyzed and presented in tabular and graphical form.

Keywords: Analysis, mathematical statistics, body mass index.

Introduction. Body mass index (BMI) is one of the parameters, used for defining the normal human weight (recommended, healthy) for people of different height. BMI is a medical biological parameter, which can be used to detect the availability of either obesity or malnutrition, respectively.

BMI was formulated and introduced by the Belgian mathematician and statistician Adolphe Quetelet. It became popular in the 50s and 60s of the last century, when the problem with obesity and the consequences from it came up for discussion.

Queteler proposed the following dependence for calculating the BMI:

$$BMI = \frac{m}{h^2}, \tag{1}$$

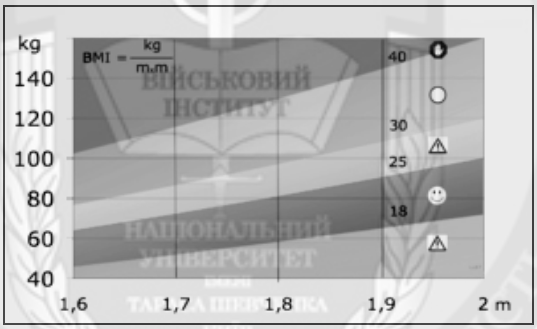


Fig. 1

where BMI is the body mass index, m – the body mass in kilograms, h – the height in metres. The obtained results for the BMI are in kg/m^2.

However, people should not be diagnosed based on this index since it does not comprise all factors but only height and weight.

The dependence, proposed by Queteler for defining the BMI takes into account neither the body constitution, nor the ratio between the fatty and the muscular tissues. The formula is definitely not appropriate for pregnant women, for adolescents and elderly people, as well as for professional sportsmen.

From all mentioned above it goes without saying that the value of BMI for a particular individual can give a signal of obesity, which might not prove to be true. This is because the weight could be chiefly due to muscular mass or body fat. The relative weight of the muscular mass is greater than the relative weight of the fat. In result, active sportsmen may be qualified as overweight according to their BMI, while not being overweight at all.

The individual BMI should be viewed primarily as a guideline on height and weight proportions.

BMI is mostly used for statistical information, as an indicator of the level of obesity of the population from the 80s of the last century.

Aim and objectives of the present paper. The introduction makes an analysis of the

applicability of the BMI. The present paper aims at studying the obtained results from a BMI survey among first and second year students at TU Sofia, Plovdiv Branch by the methods of mathematical statistics.

The problems to be solved for achieving the aim were:

- To systematize the collected data about the BMI;
- To process the data statistically;
- To draw conclusions, related to the students' BMI.

Experimental data. During the experiment the BMI of 142 first and second year students at Sofia TU - Plovdiv Branch was defined and the following rules were observed in the process of data collection:

- The measurements were done by the same methodology;
- The measurements were done by the same instruments;
- The data from the measurements were collected under the same conditions;
- The symmetrical body parts were in the same position;
- The data were collected at the same time (in the morning) on an empty stomach or not earlier than two hours after food intake.

The results about the calculated BMI value of the tested students are given in Table 1 and Table 2 - for men and women, respectively. Dependence (1) was used for defining the BMI. The obtained results for the BMI are in the units of kg/m^2.

Table 1

BMI of the tested students-men						
№	1	2	3	4	5	6
ИТМ	29,2	23,1	28,2	28,1	24,4	25,1
№	7	8	9	10	11	12
ИТМ	22,8	25,6	25,9	25,4	29,3	25,5
№	13	14	15	16	17	18
ИТМ	26,2	23,7	27,5	30,9	25,5	25,6
№	19	20	21	22	23	24
ИТМ	31,6	24,3	25,1	27,7	24,4	26,6
№	25	26	27	28	29	30
ИТМ	26,8	39,0	23,7	20,5	27,1	27,5
№	31	32	33	34	35	36
ИТМ	28,6	28,2	26,5	23,4	28,6	28,3
№	37	38	39	40	41	42
ИТМ	34,4	30,6	23,7	28,8	30,0	25,1
№	43	44	45	46	47	48
ИТМ	24,2	27,4	24,2	24,2	28,7	29,2
№	49	50	51	52	53	54
ИТМ	34,6	22,2	21,8	23,3	21,2	23,4
№	55	56	57	58	59	60
ИТМ	26,4	29,2	29,5	31,3	24,1	28,1
№	61	62	63	64	65	66
ИТМ	33,3	22,1	24,1	22,2	34,8	21,3
№	67	68	69	70	71	72
ИТМ	27,4	21,8	28,0	19,3	27,5	26,4
№	73	74	75	76	77	78
ИТМ	25,4	28,0	22,6	22,4	27,6	19,6
№	79	80	81	82	83	84
ИТМ	26,3	35,9	32,2	25,0	33,1	25,3
№	85	86	87	88	89	90
ИТМ	25,1	33,8	32,7	21,5	26,2	21,2
№	91	92	93	94	95	96
ИТМ	25,5	26,4	36,6	24,8	28,8	24,4
№	97	98	99	100	101	102
ИТМ	22,1	30,9	24,1	21,2	29,2	24,4
№	103	104	105	106	107	108
ИТМ	30,1	26,8	25,7	30,9	30,0	29,5
№	109	110	111	112		
ИТМ	21,6	24,4	22,1	30,9		

Table 2

BMI of the tested students – women						
№	1	2	3	4	5	6
BMI	16,5	21,5	19,5	15,5	18,5	22
№	7	8	9	10	11	12
BMI	15,5	21,0	19,5	20,0	20,5	21,0
№	13	14	15	16	17	18
BMI	23,0	21,5	21,0	19,5	21,5	23,0
№	19	20	21	22	23	24
BMI	17,0	20,0	20,5	16,5	20,5	19,0
№	25	26	27	28	29	30
BMI	17,0	17,5	20,0	19,5	20,0	20,0

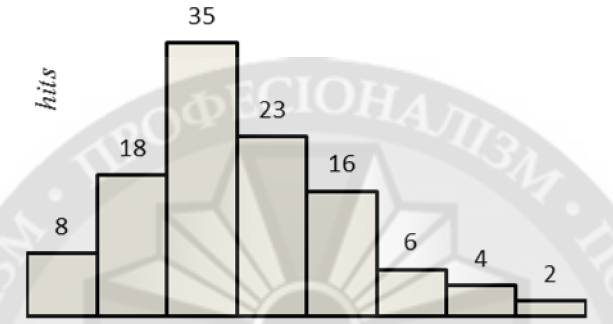
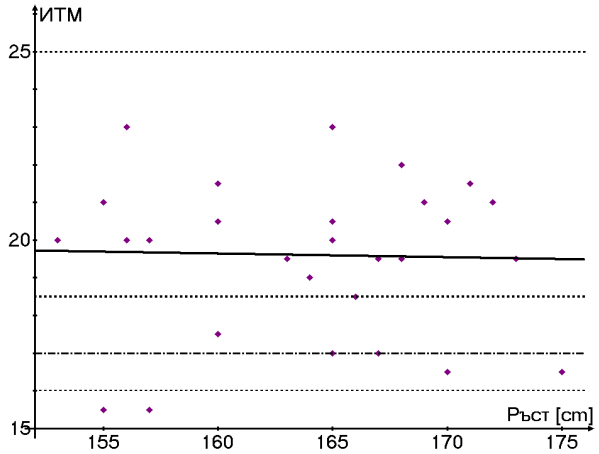


Fig. 2. Frequency histogram – men

Fig. 3. Frequency histogram - women

Analysis of the obtained data was carried out by means of AdancedGrapher.



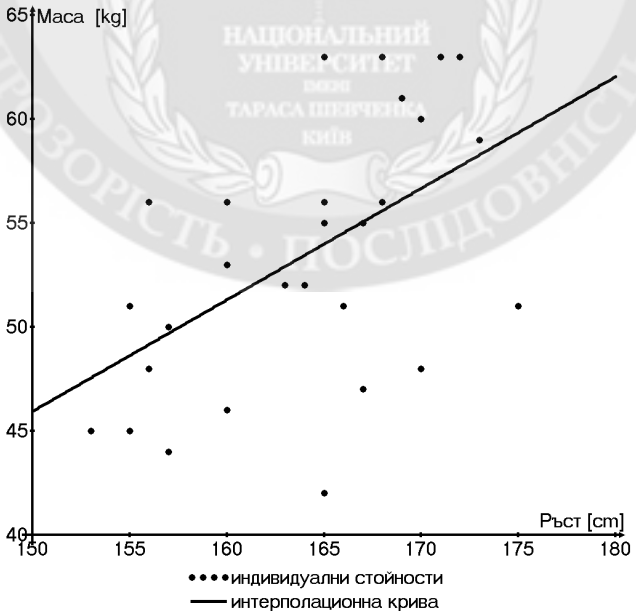
BMI; Height

Fig. 4. BMI distribution according to the height for women

Fig. 3 and Fig. 5 show BMI and the mass distribution according to the height for women. Fig. 4.gives the legend to the graph in Fig 3.

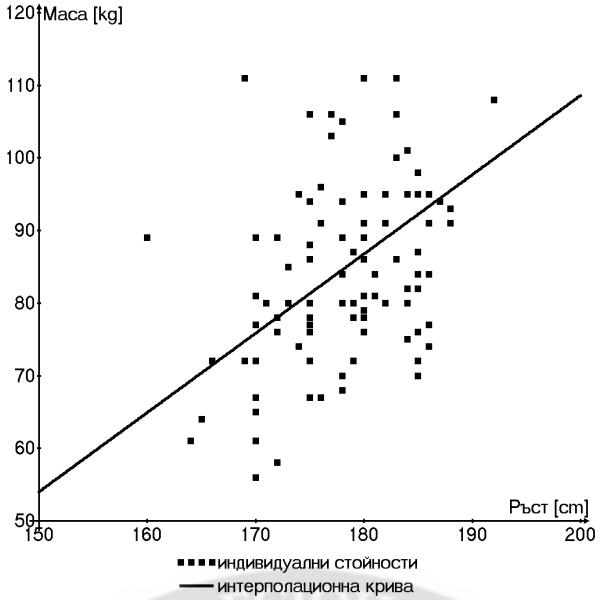
……individual values
…….normal weight (lower limit)
……normal weight (upper limit)
……..linear interpolation
…….limit of mild malnutrition
…..limit of moderate malnutrition

Fig. 5. Legend to Fig.4



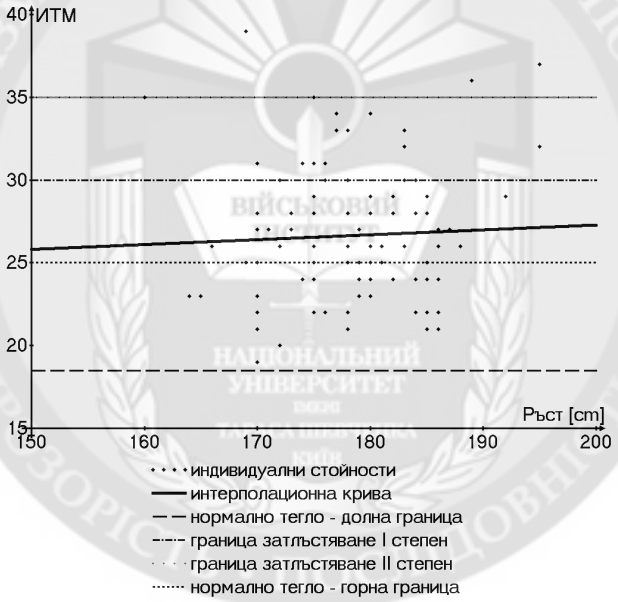
Mass; Height; individual values; interpolation curve

Fig. 6. Mass distribution according to the height for women



Mass; Height; individual values; interpolation curve.

Fig. 7 . Mass distribution according to the height for men



BMI; Height; individual values; interpolation curve; normal weight (lower limit); first class obesity limit; second class obesity limit; normal weight (upper limit).

Analysis of the obtained results. The analysis of the obtained results is based on the Standar

Table 3

BMI according to the World Health Organization

Condition	Body mass index
Underweight	< 18,5
Severe malnutrition	< 16,0
Moderate malnutrition	16,0 — 16,99
Mild malnutrition	17,0 — 18,49
Normal weight	18,5 — 24,99
Overweight	≥ 25,0

Condition	Body mass index
Condition before obesity	25,0 — 29,99
Obesity	≥ 30,0
First class obesity	30,0 — 34,99
Second class obesity	35,0 — 39,99
Third class obesity	≥ 40,0

From the obtained data it can be seen that the BMI of 66% of the students-women at TU-Sofia, Plovdiv Branch, corresponds to the standard (optimal) body mass. There are no cases of body mass above the standard (or we can say that students with body mass above the standard are an exception). Among the rest of the cases there are ones of mild malnutrition and, by exception, of moderate malnutrition. Reduction of BMI by a linear dependence is observed together with increase of the height (Fig.2.)

From the obtained data about students-men it can be seen that 35,7% (40 students) fall into the group with normal weight according to the standards of the World Health Organization – Table 5. There are no men under the lower limit for normal weight, and 47,3% are in the group of students, whose condition is regarded as a condition before obesity (53 students). The rest of the cases are characterized by first class obesity.

The relationships between the BMI and the height for women and men, respectively, are expressed by the dependencies:

$$BMI = -0.0097636*x+21.2002489 \quad (2)$$

$$BMI = 0.029492*x+21.3835364 \quad (3)$$

where by x the height in cm is denoted.

The interpolative dependences between mass and height defined by means of the AdvancedGrapher for women and men, respectively, are:

$$Mass = 0.5362305*x-34.4881784 \quad (4)$$

$$Mass = 1.0918704*x-109.7672129 \quad (5)$$

where by x the height in cm is denoted.

The obtained dependencies are linear, and together with increase in the height a relatively smaller mass increase is observed. This is also confirmed by the fact that together with increase in height there is reduction in BMI.

The assessment of the ideal weight is subjective and should not be taken for granted. It is usually a bit higher than the recommended from a medical point of view.

British specialists offer a simple and practical way for studying the body mass index – by means of a ribbon, a piece of string, or a measuring tape. The height is measured by one of them – from the top of the head to the floor. Then the ribbon or the string is bent in two and we try whether the obtained circle can be easily moved around our waist. If this is the case, then we have no problems with the body mass index. If the loop does not move freely and sticks tightly to the belly, then we have an obesity problem.

So far the tests for defining the body mass index have often given erroneous readings for people with heavier bone construction or with more pronounced muscles. Such people are often described as people at risk of obesity, just like people, leading sedentary life or with large fatty accumulations.

The team manager Doctor Margaret Ashwell underlines that the tests, measuring the height and the waist circumference are much more precise than the conventional tests for defining the body mass index. They better take into consideration the risk factors for obesity.

It is good for the students both to realize the necessity of practicing physical exercises even after graduating from the university and to set long term goals related to independent sports activities for maintaining a normal body mass and a healthy BMI.

It is necessary to prepare innovative educational and recreational sports programmes, guaranteeing an optimal balance between students' workload, physical activity, age and adaptability

of the organism. For the purpose the system Yoga should be used for a holistic (integrated) impact on the body of the involved students.

As a consequence of the insufficient physical activity on the side of the young people, as well as of their lifestyle, mostly related to psycho-sensory stress loading of their nervous system, the overweight and obesity among them reach threatening levels and definitely harm their health.

By increasing the physical activity of the students we could build mentally healthy and able-bodied future scientists and engineers.

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ИССЛЕДОВАНИЕ ИНДЕКСА МАССЫ ТЕЛА СТУДЕНТОВ ТЕХНИЧЕСКОГО ВУЗОВ

Индекс массы тела (ИМТ) I и студентов в Софии технического университета II год, Пловдив отделения, был изучен с помощью методов математической статистики. Полученные результаты обследования были проанализированы и представлены в табличной и графической форме.

Ключевые слова: анализ, математическая статистика, индекс массы тела.