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Age changes in the basic anthropometric characteristics of the average Bulgarian females

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Abstract

The current article presents a study of the age changes in the basic anthropometric characteristics (body height and body weight) of Bulgarian females. We do that after dividing the measured subjects into three age groups: I) 18-25 years, II) 25-30 years and III) 30-40 years. The data used in the investigation are gathered by performing our own anthropometric measurements. In group I) we measured 36 objects, in group II) – 19, and in group III) – 51 females. We present the average values of the height, weight and body mass index of any of the groups, as well as the corresponding probability distributions of the height, weight and body mass indexes in the groups. The results obtained can be used when one needs such anthropometric and mass characteristics in problems appearing in rehabilitation, medicine (orthopaedics and traumatology), sports, ergonomics, for investigating criminology cases – body fall, car crash, etc.

Keywords: Body weight, body height, body mass index

1. Introduction

The physical features of the human body change throughout one's life span. These changes arise not only at the whole-body level, but also on a cellular level, and tissue level. The rates of change are also not constant throughout the process of ageing. Naturally, the two basic characteristics in which these changes are mirrored are the height and weight of the human.

Stature, like other phenotypic characteristics, is controlled by a blend of genetics and environmental factors [1-6], among which are the genetic heritage of parents, anatomy and physiology of the individual, individual metabolism, pregnancy and birth weight, infections, diseases and hormonal dysfunction, age, psychosocial environment, way of living, the level of development of the public healthcare system, etc. Concerning weight, even to date, it is not clear the relative importance of various factors influencing weight. It is usually claimed that the most important is the hormonal factors, but a poor diet and lack of physical activity surely are among the most responsible for weight gain too.

The scientific field devoted to anthropometric measurements and their changes with age has been the topic of different issues, like, e.g., the impact of ageing on anthropometric dimensions and its importance to workplace design [7], anthropometric differences detected between the genders and the numerous age groups in the elderly [8,9,10,11,12,13], comparison of anthropometric measures for different nationalities [14,15], etc.

Changes in the stature and weight of the Bulgarians in the last century and the early XXI century are described in [16-24].

Till nowadays the data collected by [24] are the most representative anthropological investigation of the Bulgarian population performed during the period 1988-1993. In this study, the authors measured a total of 5290 individuals (2435 males and 2855 females) aged between 30 and 40 years.

The current work aims to present and assess in a comparative aspect the data about two of the basic anthropological characteristics from the individual's physical development of the Bulgarian woman: *i)* stature (height) and *ii)* weight (mass). We do that after dividing the measured subjects into three age

groups: I) 18-25 years, II) 25-30 years and III) 30-40 years. It is usually accepted that the basic physical characteristics of humans physical dimensions are at their peak from age 20 to 35 years.

The data used in the investigation are gathered by performing our own anthropometric measurements. In group I) we measured 36 objects, in group II) – 19, and in group III) – 51 females.

We present the average values of the height, weight and body mass index of any of the groups, as well as the corresponding standard deviations as well as probability distributions of the height, weight and body mass index in the groups.

The results obtained can be used when one needs such anthropometric and mass characteristics in problems appearing in rehabilitation, medicine (orthopaedics and traumatology), sports, ergonomics, for investigating criminology cases – body fall, car crash, etc.

2. Comparative analysis of the stature, weight and body mass index of the Bulgarian female

As already mentioned above the purpose of this work is to present a study of the age changes in the basic anthropometric characteristics (body height, body weight and body mass index) of Bulgarian females.

Table 1 contains data for the average body height [cm], body weight [kg] (with their minima, maxima, and standard deviation) and body mass index [kg/m^2] of all participating females divided into three age groups: I) 18-25 years, II) 25-30 years and III) 30-40 years.

We performed anthropometric measurements of 106 Bulgarian females – all of which are inhabitants of Sofia – the capital of Bulgaria. In group I) we measured 36 objects, in group II) – 19, and in group III) – 51 females.

Table 1
Average age, body height, body weight and body mass index of all participating females

Age (year)	n	Height (cm)			Weight (kg)			Body mass index (kg/m^2)
		Average	Min	Max	Average	Min	Max	
18-25	36	165.11 (SD = 6.35)	148	176	54.3 (SD = 7.91)	40	78	19.83 (SD = 1.97)
25-30	19	166.4 (SD = 6.87)	158	181	57.63 (SD = 9.27)	44	80	20.78 (SD = 2.94)
30-40	51	166.12 (SD = 7.19)	150	182	62.53 (SD = 11.09)	45	85	24.36 (SD = 4.33)

The inspection of the results shows a small increase in individual height, by about 1 cm, in the range "female aged 25 – 30" and "female aged 30 – 40" in comparison with "female aged 18 – 25". One concludes that, due to the acceleration, the height of the body quickly reaches its maximum. At the same time, however, the weight change is more significant– the average weight of a "female aged 30-40" is about 8 kg heavier than that of the average "female aged 18-25".

Usually, BMI (body mass index, BMI) is calculated by dividing the individual's weight by the square of the corresponding height, i.e.:

$$BMI = \frac{mass_{(kg)}}{height^2_{(m)}}$$

It is a popular measurement used to determine the normal, healthy weight in people of different heights and to diagnose obesity and malnutrition. BMI is a reliable indicator of body fatness for most people and is used to screen for weight categories that may cause health problems. It is evident from Table 1 that the body mass index for the three studied groups is within the normal range (18.5- 24.9) which indicates optimal weight.

Table 2 contains data for the average body height [cm], body weight [kg] (with their minima, maxima and standard deviation) and body mass index [kg/m^2] of women aged 30-40 from the capital Sofia for the period 1989-1993, (see Ref. [24)] versus our data made from 2018 to 2019. Inspecting the data in this

Table one can conclude that for the period of about 35 years, the height of the Bulgarian woman has increased by about 5 centimetres, while the weight has decreased by about 3 kilograms. The body mass index in the study by Yordanov et al. (see Ref. [24]) is in the limits 25.0 – 29.9, which means overweight (pre-obese). In our study subjects were of normal weight (18.5- 24.9).

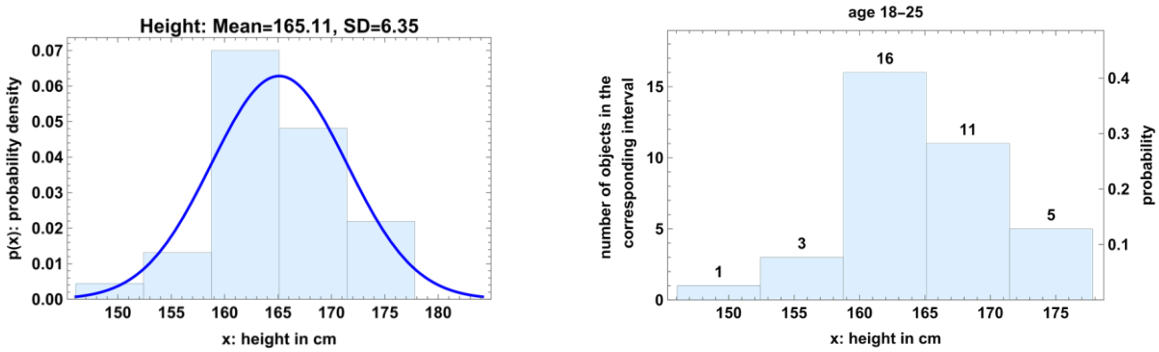
Table 2
Comparison of weight, height and body mass index of women aged 30-40 for the period 1989-1993 versus 2018-2019 from the capital Sofia

	n	Height (cm)			Weight (kg)			Body mass index
		Average	Min	Max	Average	Min	Max	
Yordanov et al. (2006)	275	161.0 (SD = 5.81)	147	179	65.4 (SD = 12.9)	42	112	25.3 (SD = 4.33)
Our data	51	166.12 (SD = 7.19)	150	182	62.53 (SD = 11.09)	45	85	24.36 (SD = 4.33)

3. Histograms and probability density functions of the measured quantities for the different groups studied in the current investigation

We present the histograms, probability density function (distribution), mean value, and standard deviation of each of the measured values (height, weight and body mass index) in the groups.

3.1 Data for the group 18-25 years



(a) (b)

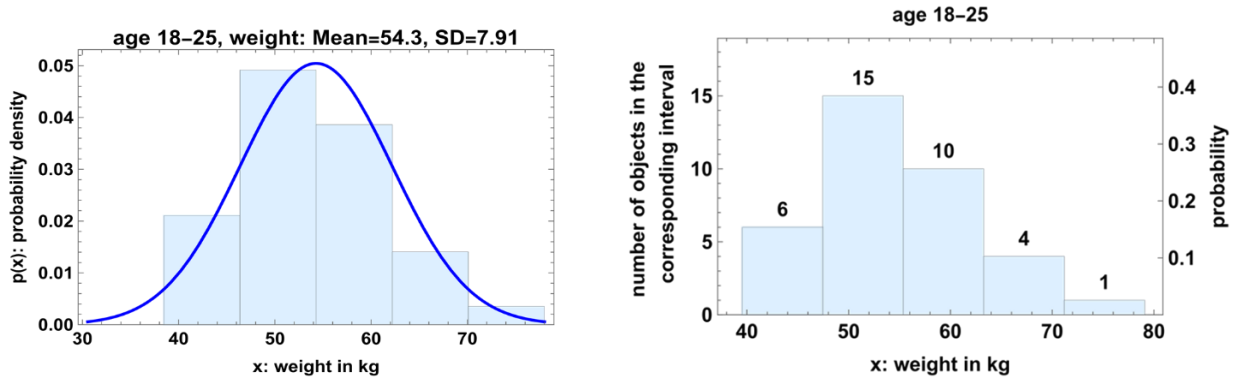
Fig. 1. Probability density function (a) and histogram (b) for the height of the group 18-25 years.

Fig.1 presents, the probability density function (Fig. 1a) and histogram (Fig. 1b) for the height of the group 18-25 years. The histogram demonstrates that the mean value of the woman's height is 165.11 cm with a standard deviation of 6.35 cm. The width of the bin intervals is also 6.35 cm. We observe that 40% of the females in the group are in the interval 160-165 cm, and 30% in 165-170 cm. By determining the fraction of values divided by bin width one can build the density of the probability distribution of the measured data. This can be compared, in its turn, with the normal probability distribution (the blue bold curve) centred around the calculated mean value of 165.11 cm and having the corresponding standard deviation of 6.35 cm. We conclude that our data with a good approximation can indeed be considered of being normally distributed.

Fig.2 presents, the probability density function (Fig. 2a) and histogram (Fig. 2b) for the weight of the female belonging to the group 18-25 years old. Fig, 2b shows that the mean value of the woman's weight in the group is 54.3 kg with a standard deviation of 7.91 kg. The width of the bin intervals is also 7.91 kg. We observe that 40% of the females in the group are in the interval 48-56 kg, and about 30% in 56-64 kg. The normal probability distribution (the blue bold curve in Fig 2a) is centred around the mean value of 54.3 kg.

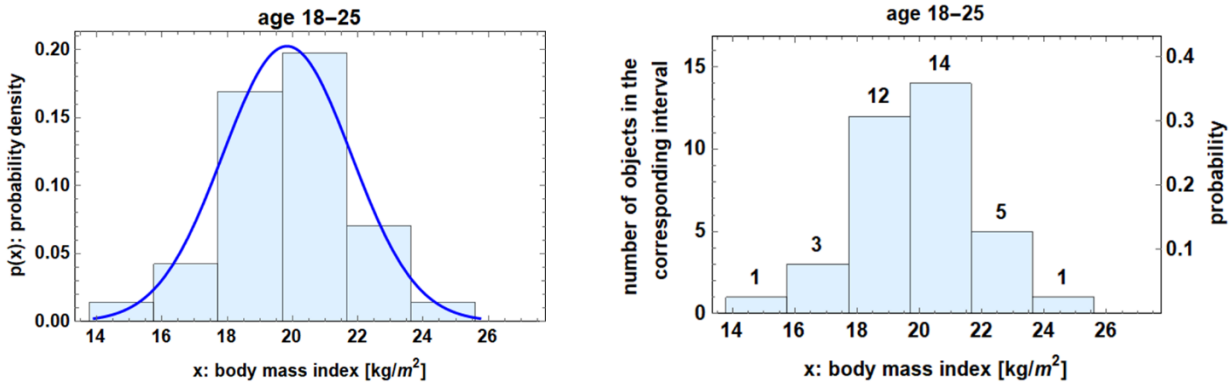
The probability density function of the body mass index of the females in the group 18-25 years old is given in Fig. 3a, and the corresponding histogram of the measured data is shown in Fig. 3b. The width

of the bin intervals is equal to the standard deviation of 1.97 kg/m^2. The average value is 19.83 kg/m^2. We observe that about 65% of the females are with BMI between 16.8 – 21 kg/m^2. The normal probability distribution (the blue bold curve in Fig 3a) is centred around the mean value of 19.83 kg/m^2.



(a) (b)

Fig. 2. Probability density function (a) and histogram (b) for the weight of the group 18-25 years.

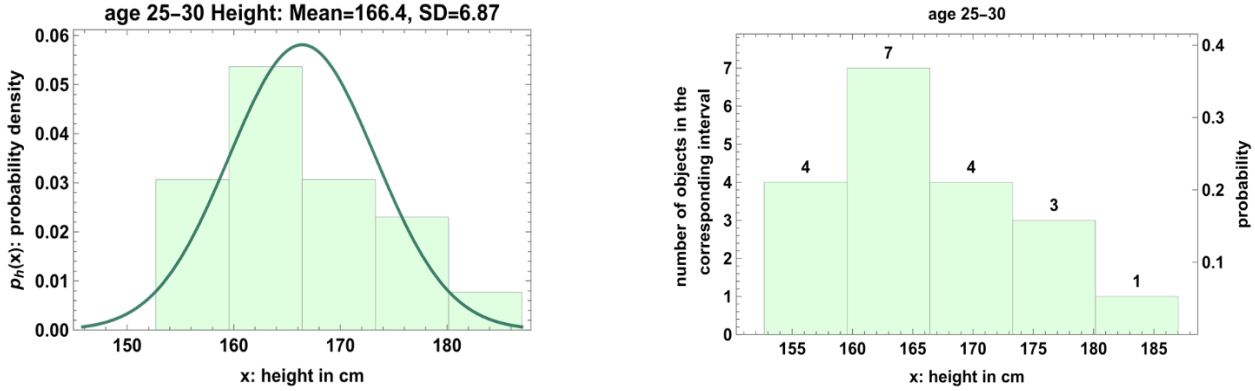


(a) (b)

Fig. 3. Probability density function (a) and histogram (b) for the body mass index of the group 18-25 years.

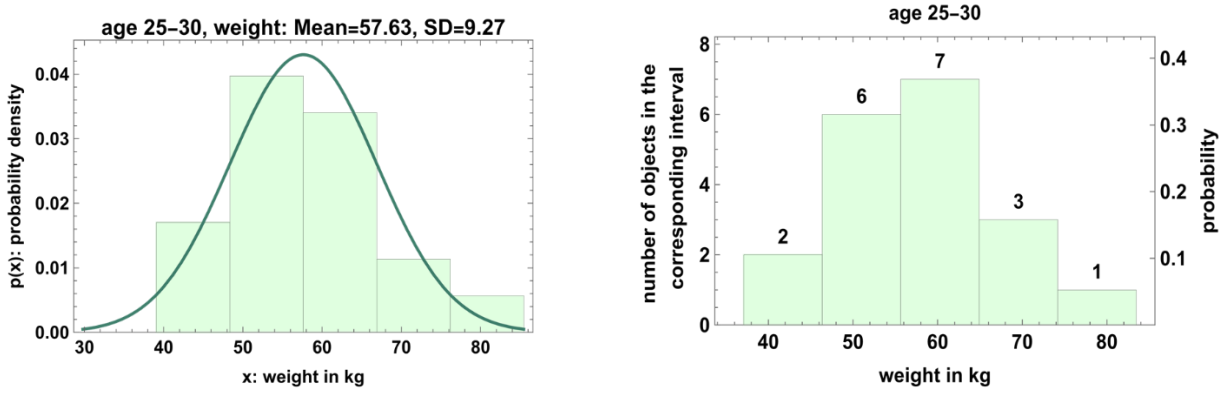
3.2 Data for the group 25-30 years

The data for the group of females in the group 25-30 years old are presented in Fig. 4, 5 and 6. The corresponding normal probability distributions (the bold green curves) are shown in Figs. 4a, 5a, and 6a. The histograms of the specific data are shown in Figs. 4b, 5b and 6b. The width of the bin intervals is always equal to the corresponding standard deviation of 6.87 cm for the height, 9.27 kg for the weight, and 2.94 kg/m^2 for the body mass index.



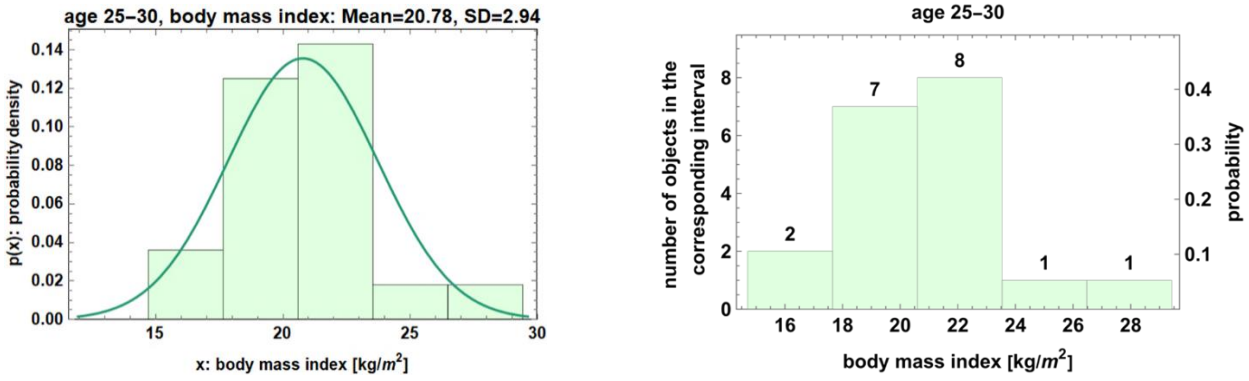
(a) (b)

Fig. 4. Probability density function (a) and histogram (b) for the height of the group 25-30 years.



(a) (b)

Fig. 5. Probability density function (a) and histogram (b) for the weight of the group 25-30 years.

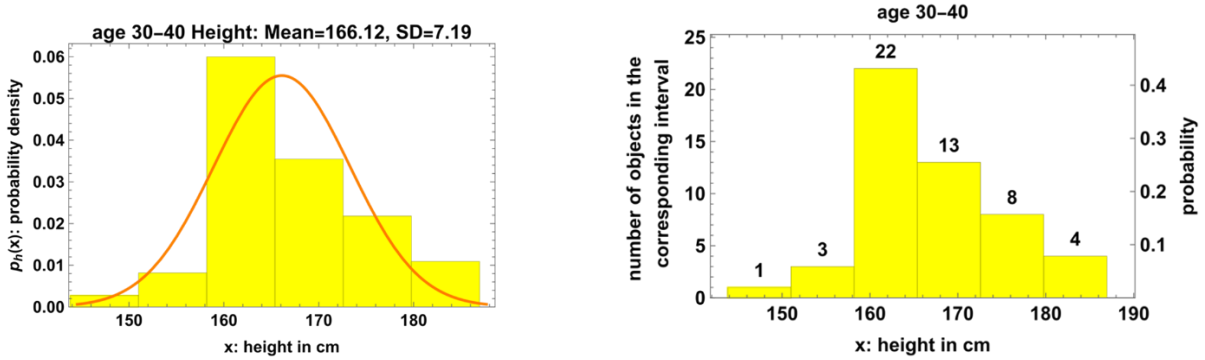


(a) (b)

Fig. 6. Probability density function (a) and histogram (b) for the body mass index of the group 25-30 years.

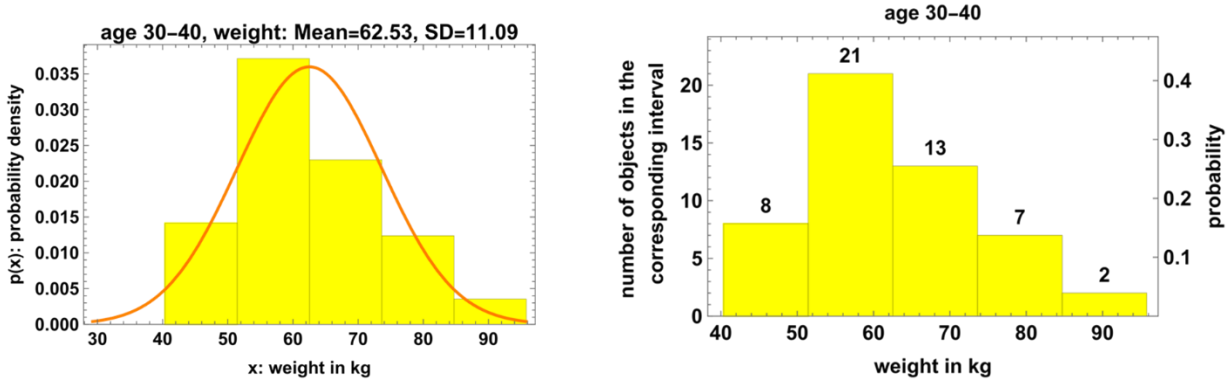
3.3 Data for the group 30-40 years

The data for the group of females in the group 30-40 years old are presented in Fig. 7, 8 and 9. The corresponding normal probability distributions (the bold red curves) are shown in Figs. 7a, 8a, and 9a. The histograms of the specific data are shown in Figs. 7b, 8b and 9b. The width of the bin intervals is equal to the corresponding standard deviation of 7.19 cm for the height, 11.09 kg for the weight, and 4.33 kg/m^2 for the body mass index. The inspection of the BMI shows that in this age group there is already a noticeable amount of about 16% of females with overweight (pre-obese).



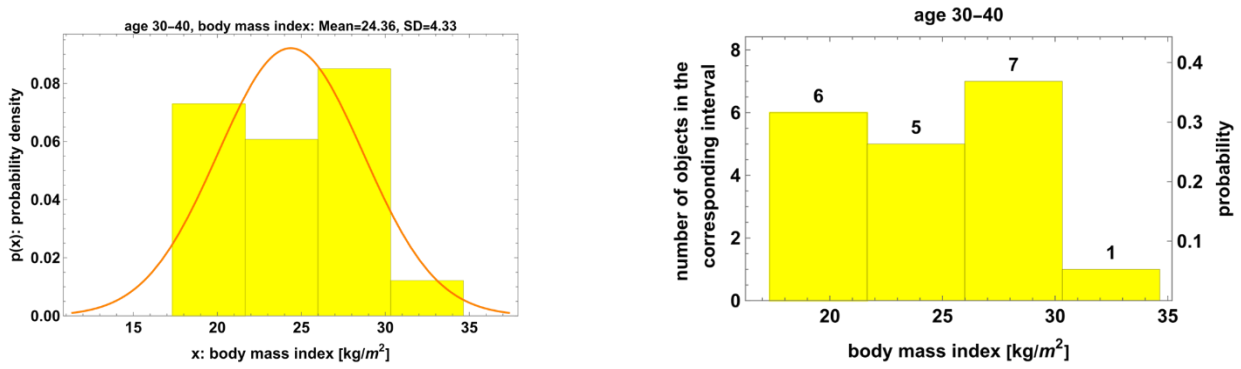
(a) (b)

Fig. 7. Probability density function (a) and histogram (b) for the height of the group 30-40 years.



(a) (b)

Fig. 8. Probability density function (a) and histogram (b) for the weight of the group 30-40 years.



(a) (b)

Fig. 9. Probability density function (a) and histogram (b)for the body mass index of the group 30-40 years.

3. Discussion and Conclusion

It is very difficult to delineate the trends and dynamics in distinctions with the age of stature and weight as a function of all possible factors influencing them. Some scientists speculate, e.g., that it is not just genetics that reflects human stature and that there is a relationship between the stature of humans and the economic development of the society in a given period with a better economic status claimed to lead to an increase in stature. Economic cataclysms then are expected to lead to a decrease in stature, while prosperity and a high standard of living to an increase in stature. Based on Bulgaria we can say that this hypothesis is supported – there are two maxima of the stature of the Bulgarians - in 1940 and 1980, (see

Ref. [16-24]) corresponding to a relative economic growth in the decade preceding them.

The inspection of the results shows a small increase in individual height, by about 1 cm, in the range "female aged 25 – 30" and "female aged 30 – 40" in comparison with "female aged 18 – 25". One concludes that, due to the acceleration, the height of the body quickly reaches its maximum. At the same time, however, the weight change is more significant– the average weight of a "female aged 30-40" is about 8 kg heavier than that of the average "female aged 18-25". Compared with the group of 30-40 years old measured about 35 years ago living in the area of Sofia, we observe an increase in the average height by 5 cm and a decrease in the average weight about 3 kg (see Table 2).

From the results for women belonging to the same age group ("female aged 30 – 40") but who leaved in different historical time periods, one can conclude that in the XXI century the stature of Bulgarian women increased by about 5 centimeters compared to women who lived in the XX century. The conclusion to be made is that in the present century, there is a tendency of increasing women's height.

In terms of the weight for the same age group, it can be seen that the average weight of women in the current century has decreased by 3 kilograms compared to that of the last century

Finally, let us recall that the results from one representative anthropological investigation of the human body can be applied in industry, ergonomics, sport, health care, etc., with the investigation of mass parameters being necessary for the analysis of human movement and many biomechanical activities. In the current study, we have observed some substantial differences between the basic parameters characterizing the average Bulgarian woman from the city of Sofia. On a practical level, such differences have to be known to the industry when planning products aimed at the market of the corresponding geographical regions.

Acknowledgements

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