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INTERGENERATIONAL DIFFERENCES IN THE BODY BUILD OF WOMEN

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A – study design, **B** – data collection, **C** – statistical analysis, **D** – interpretation of data, **E** – manuscript preparation, **F** – literature review, **G** – sourcing of funding

ABSTRACT

Background: This study analyzed generational differences in body build of woman.

Aim of the study: The aim of the study was to examine the intergenerational differences in the body build of women.

Material and methods: 90 women (30 female physiotherapy students, their mothers and grandmothers) were examined. Their heights, weights, waist circumferences, and waist and hip circumferences were measured. Their *Body mass index* (BMI) and *Waist to Hip Ratio* (WHR) were calculated. Their frequency of underweight, overweight and obesity were estimated. WHO criteria were applied. The results were subjected to statistical analysis. Descriptive statistics were calculated. The Shapiro-Wilk test for testing the normal distribution was used. The Kruskal-Wallis test and post-hoc test were used. A significance level alpha of 0.05 was assumed. Statistica 13.1 was used for calculations.

Results: The median body height of the female students was 166.8 cm, their mothers 160.8 cm, and grandmothers 158.0 cm. Their median body masses were, respectively: 59.4 kg, 70.1 kg and 72.5 kg. Their median BMIs were 21.4 kg/m^2, 26.3 kg/m^2, and 29.2 kg/ m^2, and their WHRs were 0.80, 0.86, and 0.87, respectively. Underweight was only seen in students (13%). The prevalence of overweight female students (BMI ≥30) was 10%, their mothers 33% and their 13% grandmothers, whereas obesity was 7%, 30% and 50%, respectively.

Conclusions: There were intergenerational differences in the body structure of women. In subsequent generations, the size of the body increased, and height of the body decreased. There were differences between mothers and offspring. From an early age, body growth should be monitored to prevent obesity development with age.

KEYWORDS: intergenerational differences, women, body build

Background

Changes occur to a person's body throughout their lifespan. These changes affect all organs, their composition and proportions. At different life stages, height, body mass, and adipose tissue change. In females, body fat increases, particularly around the hips, buttocks and thighs, varying depending on physical activity, diet and genetic predisposition up to approximately 60–70 years of age [1]. Relative stabilization in adipose tissue can be observed in adults.

Aging is a physiological process influenced by environmental and genetic factors. The aging process is inextricably linked to changes in body fat, its distribution and lean body mass, reduction in body height, and altered proportions, declining muscle strength, balance and metabolism, as well as dysfunction in internal organs [2–4].

Obesity is becoming a global epidemic. According to the World Health Organization (WHO), 1.6 billion people have elevated body mass index, while 522 million people are obese. The number of obese adolescents has tripled in recent years, and 400,000 new cases among children and adolescents are reported annually. In Poland, excessive body mass among children is trending upward. Also, based on research published in 2005, over 20% of adults suffer from obesity [1,5].

Obesity relates to high levels of body fat (in men, over 25%, in women over 30%). Overweight and obesity

contribute to impaired body function, development of chronic diseases and, as a consequence of these, a significant decrease in life quality [5–7]. It is also associated with increased risk of premature death, heart disease, stroke and disability. However, research conducted among the elderly population is not always unambiguous. Epidemiological data suggests that overweight and first-degree obesity are associated with a minimal risk of seniors' death, and underweight increases mortality risk for older people [8,9]. The currently recommended values of body mass index, waist circumference and obesity threshold for the general adult population may be inappropriate for older people [10].

BMI has been shown to be the best predictor of total adipose tissue content and distribution [11–13]. Besides BMI, WHR is another indicator that describes obesity type and illustrates fat distribution [1,14].

Aim of the study

Our aim is to examine the intergenerational differences in women's body build.

Material and methods

Participants: 90 women, including 30 physiotherapy students in Opole Medical School, their mothers and grandmothers were examined. The mean of the female students' age was 21.9 ± 0.89 years, their mothers' was 48.4 ± 5.40 years, and their grandmothers' was 73.2 ± 6.32 years.

Prior to the study, all subjects were informed of the principles and purpose and expressed written consent to participate. The Bioethical Commission at the Opole Medical School in Opole approved of the study, and the Dean of the Faculty of Physiotherapy gave permission.

Techniques and measurements: using standard anthropometric techniques, the following were measured: body height (B-v) measured with the Martin technique, height measured with an anthropometer to an accuracy of 0.1 cm, with the subject standing upright, upper limbs lowered along the torso, lower limbs upright, compact, with head set in the Frankfurt plane. Height was the determined distance between the points basis (B) and vertex (v). Weight was measured on an electronic scale with an accuracy of 0.1 kg. Waist circumference was measured with a metric tape to the nearest 0.1 cm, midway between the lower rib margin and the iliac crest, with the participant asked to breathe normally. The reading was taken at the end of light exhalation. Hip circumference was measured with a metric tape to the nearest 0.1 cm, with a tape placed around the point with the maximum circumference over the buttocks below the ala of ilium. All measurements were carried out on the same weekday (Monday), in the morning, with the participant dressed in underwear and without shoes.

The BMI (*Body Mass Index*) was calculated as body mass in kilograms divided by the square of body height in meters. The WHR (*Waist to Hip Ratio*) was calculated as waist circumference divided by the hip circumference. Frequency of underweight, overweight and obesity among the examined women was estimated. WHO criteria were applied [5,15].

According to the *World Health Organization* (WHO), a healthy WHR is 0.85 or less for women. In both men and women, a WHR of 1.0 or higher increases the risk of heart disease and other conditions associated with being overweight.

Statistical methods

The results were subjected to statistical analysis. The Shapiro-Wilk test determines if a random sample comes from a normal distribution. When the results were significant, it implied the distribution was non-normal. Descriptive statistics (median, standard deviation, coefficient of variation, minimum and maximum value) were calculated. In later analysis, we used the Kruskal-Wallis post-hoc test. A significance level of alpha 0.05 was assumed. Statistica 13.1 was used for calculations.

Results

The median of body height (BH) of female students (s) was 166.8 ± 6.0 cm, their mothers (m) 160.8 ± 7.4 cm, and grandmothers (b) 158.0 ± 6.3 cm (fig. 1). The students had the highest median height, and their grandmothers had the shortest. Differences were statistically significant between students and their grandmothers (p=0.000151).

The median of body weight increased with each older generation. The median body mass of female students was 59.4 ± 12.1 kg, their mothers 70.1 ± 11.6 kg, and their grandmothers 72.5 ± 15.5 kg (fig. 2). As with body height, statistically significant differences in body mass were noted between students and their mothers (p=0.003658), and between students and their grandmothers (p=0.002646).

The median BMI of female students is 21.4 ± 3.9 kg/m^2, mothers (BMI=26.3 ± 3.6 kg/m^2) and grandmothers (BMI=29.2 ± 5.5 kg/m^2). With age, the percentage of women with a normal BMI decreases (fig. 3). Statistically significant differences occur between female students and their mothers (p=0.000137) as well as between students and their grandmothers (p=0.000001)

The median waist circumference tended to increase in subsequent generations (fig. 4). In the students, the median was 71.5 ± 10.8 cm, the mothers was 87.2 ± 10.3 cm, and grandmothers was 92.5 ± 13.9 cm. Statistically significant differences were found for all groups of women (mother-student p=0.000066, student-grandmother p=0.000001, mother-grandmother p=0.000385).

The median hip circumference of female students was 91.0 ± 11.2 cm, the mothers' was 101.5 ± 10.5 cm, and the grandmothers' was 105.8±14.1 cm (fig. 5). Sta-

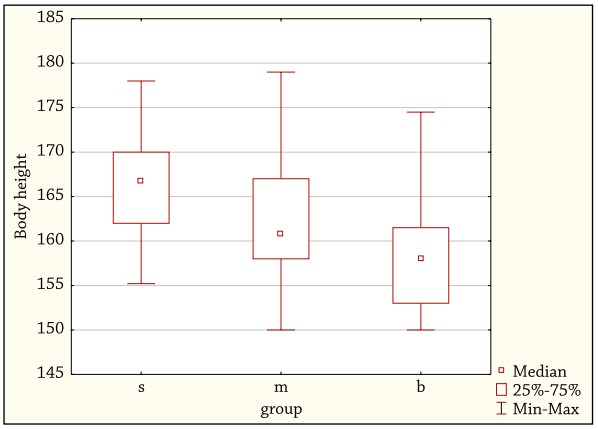

Figure 1. Body height (BH) – intergenerational differences [cm]

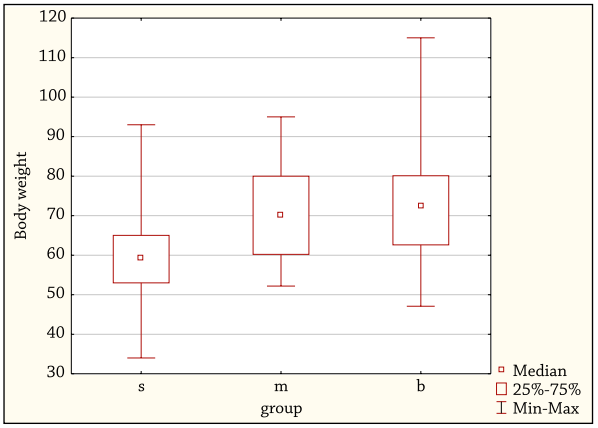

Figure 2. Body Weight (BW) – intergenerational differences [kg].

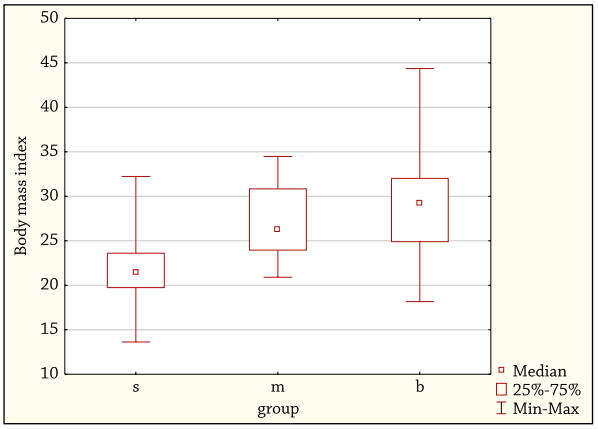

Figure 3. Body mass Index (BMI) – intergenerational differences [kg/m2]

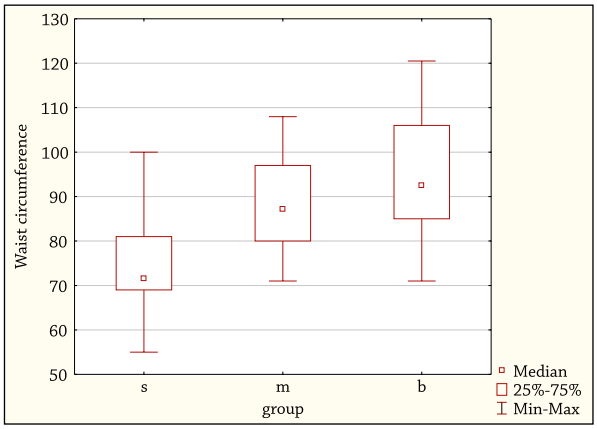

Figure 4. Waist circumference – intergenerational differences [cm]

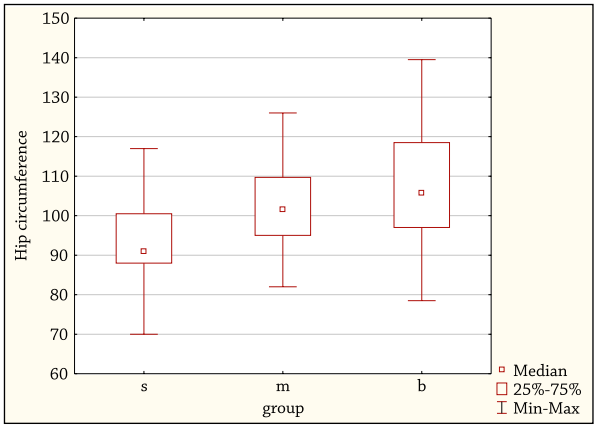

Figure 5. Hip circumference – intergenerational differences [cm]

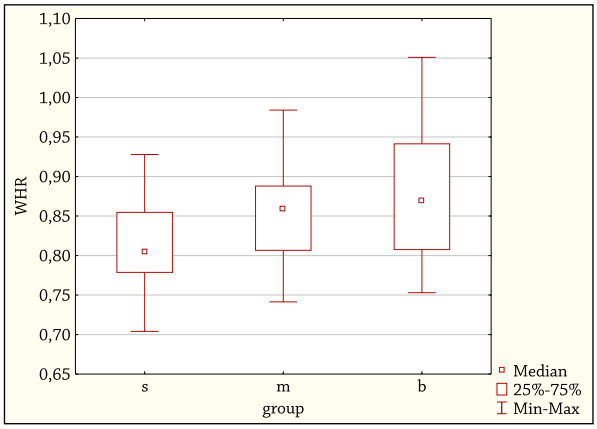

Figure 6. WHR - intergenerational differences

tistically significant results were found between female students and their mothers (p=0.03853), and students with their grandmothers (p=0.000049).

The median WHR value of female students was 0.80 ± 0.1, mothers was 0.86 ± 0.1, and grandmothers was 0.87 ± 0.1 (fig. 6). Mothers and grandmothers exceeded the norm. Statistically significant results were found for students and their grandmothers (p=0.004730).

About 2/3 of students have normal weight, >12% were underweight, 10% overweight and 7% obese. 37% of their mothers had normal weight, 33% were overweight and 30% obese. For the grandmothers, only 37% of respondents had normal weight, 13% were overweight, and half were obese. None of the mothers or grandmothers were underweight. The number of overweight and obese women increased with each generation. In other words, fewer grandmothers have normal weight proportions and none of them are underweight. Statistically significant results were seen for students and their grandmothers (p=0.00012).

Table 1. Frequency of underweight, normal, overweight and obesity.

Category	numbers/ percent	Students	Mothers	Grandmothers
underweight	n	4	0	0
	%	13.33%	0.00%	0.00%
normal	n	21*	11*	11*
	%	70.00%*	36.67%*	36.67%*
overweight	n	3	10	4
	%	10.00%	33.33%	13.33%
obesity	n	2	9	15*
	%	6.67%	30.00%	50.00%*
Total	n	30	30	30

*Chi^2 Pearson: Chi^2 =27.47922, df=6, p=0.00012

Discussion

In recent years, many scientific researchers from different countries have studied the somatic features of people due to increasing BMIs and WHRs and their associated diseases. Obesity and overweight have become very common, and this trend is evident in all age groups. Overweight is caused by a combination of environmental factors such as poor diet and genetic factors.

On the basis of the BMI index, by means of which the weight-increase norms are estimated, one can compare differences in body structure between particular age groups. The female students had a median BMI of 21.4 kg/m^2 in the normal range. However, their mothers and grandmothers had elevated median BMIs of 26.3 kg/m^2 and 29.2 kg/m^2 respectively. These median results of mothers and grandmothers were in the overweight range.

Skrzek *et al.* found that seniors from Lower Silesia had average BMI results in the overweight range, 28.26 kg/m^2 for women who do not participate in the study at the University of the Third Age (UTW) and 27.63 kg/m^2 for UTW members. The examined women had lower WHR rates of 0.85 and 0.84, respectively [16]. The average BMI of a cohort of Brazilian women aged 60–79 was also in the overweight range [17].

We found similar increases in BMI index with age. We examined people aged <40 years, 40–60 years and> 60 years. In the youngest group, almost half of the respondents had normal body mass. In this group, the smallest percentage of people with obesity was recorded—around 25%. In the group aged 40–60, about one third of the respondents had a normal BMI, while the percentage of people with obesity increased to about 40%. In the oldest group, only about 25% of respondents had normal BMI, and half of the subjects were obese [15].

Some researchers consider that calculating the BMI index for older people using body height is misleading. Yilmaz *et al.* propose that arm length should be used instead [18]. Others have published similar BMIs to those described here. The average BMI for Poznań students in 2012 was 21.7 kg/m^2. 13% were underweight, 7% overweight, and 1.5% obese [19]. Girls studying medicine in Radom, in 2014 showed an average body mass index of 21.8 kg/m^2 [3]. In Sweden, 27% of women were overweight, and 11% were obese. In Switzerland, 21% were overweight and 8% obese. Based on these results, Poland has among the highest BMIs in Europe [10].

Conclusions

We found intergenerational differences in women's body structures. With each generation, body size increased, and height decreased. Differences were seen between mother and offspring. A more detailed analysis of data over three generations is warranted to understand the nature of the differences. From an early age, body growth should be monitored to prevent the occurrence of overweight and obesity in adulthood and old age.

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