

Changes in the body build of students of the Maritime University of Szczecin in the years 1969–2007

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ABSTRACT

Background: Changes in the human body build over the last century refer to greater and greater body height but also to the “plague” of obesity in the period of the last 30 years. The secular trend and excessive weight gain being observed in societies of rich and developing countries is global in nature. Students of academies that traditionally prepare for working at sea on ships have been required until recently to be of very good health and physical fitness. Changes in the body build, particularly obesity, may interfere with the selection of candidates for the profession of seaman in the near future.

Aim: The aim of this study is to characterise the body build of students of the Maritime University of Szczecin. The results of the author’s own research from 2006 and 2007 were compared with those of similar anthropometric studies being published in the literature from previous years (1969–2007).

Materials and methods: The author’s own research material consisted of a group of students of the Maritime University of Szczecin ($n = 171$). Anthropometric measurements (body height, body weight, and waist, hip, and arm circumferences) were made in 2006 and 2007. Based on these anthropometric data, the body mass index and the Rohrer’s index were calculated. Arithmetic means, standard deviations, and range of variation (min–max) were calculated for all anthropometric measurements and somatic indices and compared with the results from previous years (1969–2007).

Results and Conclusions: During the analysed years 1969–2007, the examined students of the Maritime University of Szczecin showed increasing body height and, worryingly, rising body weight and waist and hip circumferences. This is evidence of visceral fatness, which is dangerous for health and increases the risk of cardiovascular diseases. One of the reasons for the changes in the body build is decreasing motor activity. The increases in the traits being analysed were not steady over time; larger increases in body height occurred in the years of the more stable socio-economic situation in Poland.

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Key words: body build, seaman, Maritime University, body mass index, Rohrer’s index

INTRODUCTION

Human body build is an important piece of information about the biological value of individuals. In highly developed countries, two worrying biological processes have been observed: ageing and obesity. These two processes have been problems in rich countries for more than 30 years, but obesity has increased and covers more and more poor and developing countries [1]. Excessive ageing of societies and obesity involving health problems may bring on, in the near future, a deficit of candidates for difficult professions

that require good health. These professions include the profession of seaman.

It is important to monitor information on the physical development of candidates and students in any field of studies burdening a young organism not only with learning but also with the physical work connected with such practical vocational training [2]. This knowledge will allow the young people to be focused in terms of their fitness, psyche, and health or, where justified, enable the candidates to change their profession well in advance. Verification of such young



people and their preparation for difficult professional work is an attractive subject for medical specialists, anthropologists, or psychologists. The condition and the biological value of prospective students who wish to train for trades that require physical fitness and are psyche burdening, e.g. with large occupational stress, family separation, or disability risk, have been checked for generations. Selection for this type of university studies has been carried out to choose individuals as best biologically and mentally predisposed to difficult professions as possible. In Polish universities there are still fields of study in which recruits are required to present not only a matriculation certificate but also results of a basic medical examination and show their physical fitness and good health.

Socio-economic and cultural transformations influence the biological development and shape the “biological quality” of future employees. Intergenerational changes are being defined in scientific literature as the secular trend or long-term tendencies towards changes. In the 20th century a process of increasing average body height in young people has occurred in industrialised countries of the Euro-American civilisation circle. An explanation of this secular trend is seen in the improvement of socio-economic status. This is explained by nutrition level improvement and better medical care [3, 4].

The study of variation in somatic build and motor fitness of university students in Poland [4] shows that a clear trend towards increasing body height of students over the 1946–2003 period. The tendency towards changes in their body weight is shaped differently. Low average body weight was characteristic for the students in the 1960s (with the lowest body weight in 1967), whereas in subsequent years this trend was upward in nature. Our society has become increasingly tall and heavy. The proportion of body weight in relation to body height is well illustrated by the body mass index (BMI), which, according to Czarny [5], amounted to 23.3 for young studying males at beginning of the 21st century. This result is within the normal range, but the increase in body weight has shown a worrying intensification in recent years in all age and occupational groups among Poles. Society over-nutrition has become not only a medical, social, and cultural problem, creating serious health threats, but has also given rise to completely new problems connected with the performance of some professions [3].

Universities, through all their activities, should stimulate development of generations and selection of the most suitable individuals to exercise a specific type of profession.

The aim of this study is to characterise the body build of students of the Maritime University of Szczecin based on the author's own research from 2006 and 2007 and compare it with the data from previous years, obtained in the former Merchant Marine Academy in Szczecin.

MATERIALS AND METHODS

The author's own research material consisted of a group of young male students of the Maritime University of Szczecin ($n = 171$). The examinations that became the basis of this study were made in April and May of 2006 and 2007. The examined males were 20 to 24 years old ($\bar{x} = 21.89$). Anthropometric measurements and survey data were collected during physical education classes at a swimming pool with the permission from the then University authorities. Examinations were completely voluntary and non-invasive; a student refusal was not connected with any consequences. During the studies at the Maritime University (former Merchant Marine Academy), the students of this university were required (and are still required) to wear a seaman uniform.

Body measurements were made with anthropometric instruments according the principles being adopted in anthropometry. The following measurements were taken in the study: body height (B-v), body weight, waist circumference, hip circumference, and arm circumference. Body height measurements were taken with an anthropometer to the nearest 0.1 cm; body weight was examined with scales to the nearest 100 g; body circumferences were measured with a metric tape to the nearest 0.5 cm.

Based on the anthropometric data, two somatic indices were calculated (i.e. BMI and Rohrer's index) which are used in the characteristics of human body build, both in an individual and between populations.

The BMI (i.e. $\text{body weight [kg]/(B-v)}^2 \text{ [m]}$) was interpreted based on the WHO classification. Interpretation of results: BMI < 16.00 – 3° slenderness, BMI 16.00–16.99 – 2° slenderness, BMI 17.00–18.49 – 1° slenderness, BMI 18.50–24.99 – normal variation, BMI 25.00–29.99 – 1° overweight, BMI 30.00–39.99 – 2° overweight (obesity), BMI > 40.00 – 3° overweight (massive obesity) [6]. Classification of Rohrer's index ($\text{body weight [g]/(B-v)}^3 \text{ [cm]} \times 100$) for 22-year-old males is as follows: ≤ 1.34 slender figure, $1.35 \geq$ stout figure.

Arithmetic means (\bar{x}), standard deviations (SD), and range of variation (min–max) were calculated for all anthropometric measurements and somatic indices being estimated. Statistical calculations were made using Statistica 10.0 PL computer software.

The literature data referring to the body build of students of the Maritime University of Szczecin, who had been repeatedly examined anthropologically [2, 7–10], was compared with the author's own research material (Table 1). The statistical significance of differences in measurement results between specific study years was determined (for $p < 0.05$).

RESULTS

As a result of the performed analysis, it is possible to state that body height measurements of the students of the

Table 1. Numerical characteristics of body measurements and body mass index (BMI) and Rohrer's index in students of the Maritime University of Szczecin (1969–2007)

Parameters	1969 (Piesiakowski, 1980)		1975 (Zajaczkowski, 1980)		1978 (Zajaczkowski, 1980)		1979 (Szczotka et al. 1992)		1988 (Szczotka et al. 1992)		1990 (Szczotka et al. 1992)		2006 and 2007 (own research)	
	$\bar{X} \pm SD$	min-max	$\bar{X} \pm SD$	min-max	$\bar{X} \pm SD$	min-max	$\bar{X} \pm SD$	min-max	$\bar{X} \pm SD$	min-max	$\bar{X} \pm SD$	min-max	$\bar{X} \pm SD$	min-max
Body height (B-v) [cm]	174.77 ± 5.87	155.5–191.4	176.32 ± 6.37	158–195	176.91 ± 6.36	158–196	177.7 ± 5.65	NA	178.1 ± 6.30	NA	179.8 ± 6.16	NA	179.64 ± 6.31	165.1–197
Body weight [kg]	69.62 ± 7.06	48.9–94.0	69.50 ± 7.95	54–99	71.16 ± 8.61	52–99	7.10 ± 7.28	NA	73.4 ± 8.62	NA	77.8 ± 9.84	NA	79.95 ± 11.62	55.2–118.7
Waist circum- ference	76.75 ± 4.76	64.2–93.5	NA	NA	NA	NA	78.5 ± 5.22	NA	77.8 ± 5.89	NA	82.2 ± 6.89	NA	87.24 ± 7.40	74–113
Hip circum- ference	92.48 ± 4.21	78.0–106.0	NA	NA	NA	NA	94.2 ± 4.25	NA	95.7 ± 5.26	NA	97.8 ± 5.60	NA	98.79 ± 6.69	86–124
Upper arm circumference	29.22 ± 1.99	21.2–36.6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	33.11 ± 3.33	25–43
BMI	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	24.74 ± 3.11	18.75–35.25
Rohrer's index	1.3 ± 0.11	1.06–1.73	1.26 ± 0.12	1.02–1.72	1.2700 ± 0.13	0.98–1.69	NA	NA	1.39 ± 0.83	0.93–1.85	NA	NA	1.37 ± 0.18	1.06–1.93

NA – not available

Maritime University of Szczecin changed with an upward trend during the thirty-eight years being analysed. The average body height of the young people being examined in 1969 amounted to $\bar{x} = 174.8$ cm, but a regular increase was observed during the subsequent studies. A comparison of the average body height measurements over the period 1969–2007 is presented in Figure 1. The results of the author’s own research referring to the body height of Maritime University students are on average 0.16 cm smaller than those from the beginning of the 1990s.

A fairly proportional increase, in relation to body height, in average body weight was observed between 1969 and 1988. A clear increase in body weight was recorded between 1988 and 1990, when average body weight increased by 4.4 kg, with an average increase in body height amounting to merely 1.7 cm, and this difference is statistically significant. An even greater difference in body weight increase was observed in the studies between 1990 and 2007. The increase in average body weight among the examined students amounted up to 2.25 kg with a simultaneously small decrease ($\bar{x} = 0.2$ cm) in body height in relation to similar earlier studies (Fig. 2).

Waist circumference among the examined students of the Maritime University of Szczecin increased on average by an alarming 10.5 cm during thirty-eight years. The fatness of the examined students may be concluded from waist circumference information. The mean value of waist circumference in the author’s own research is within the normal range, only slightly diverging from the accepted standards at the extreme values. This is evidence of dangerous visceral obesity. Excessive fatness is an undesirable phenomenon bearing in mind the future work on ships. Changes over the 1969–2007 period being analysed are presented in Figure 3.

Additionally, hip circumference increased together with the changes in body height and weight and waist circumference of the Maritime University students. A great difference was recorded in the studies performed between 1988 and 1990 during which time an increase in hip circumference of 2.1 cm was observed. Differences in successive measurements over the years were statistically significant in relation to the earlier ones. Changes over the 1969–2007 period being analysed are presented in Figure 3.

The last parameter included in the tabular summary is arm circumference. In the case of this measurement, comparison of the results of the author’s own research was possible with the measurements from 1969 only. Over these years, student arm circumference measurements increased on average by 3.9 cm, which was also a significant difference.

The BMI has become a popular diagnostic tool for determining the proper body mass due to its uncomplicated way of calculation (Table 1). In the author’s own research,

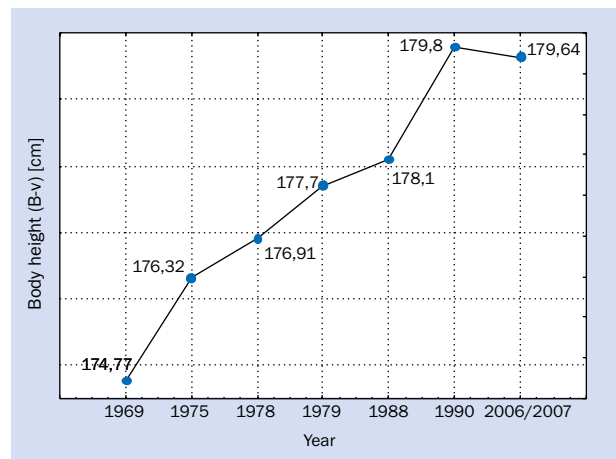


Figure 1. Changes in the body height (B-v) of Maritime University students in 1969–2007

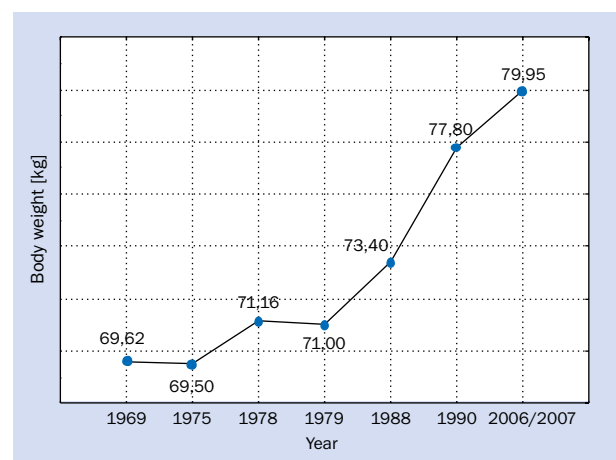


Figure 2. Changes in the body weight of Maritime University students in 1969–2007

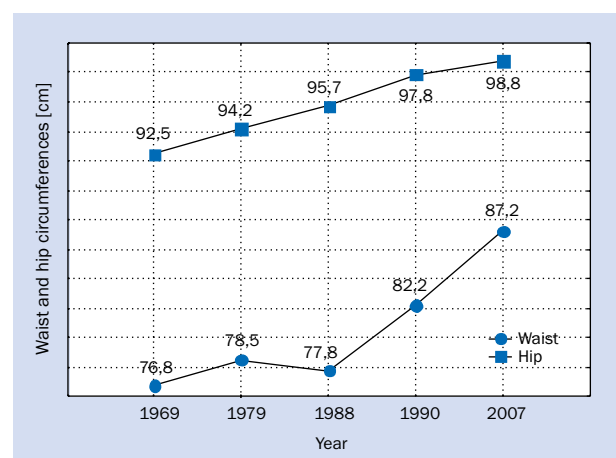


Figure 3. Changes in the waist and hip circumferences of Maritime University students in 1969–2007

the following BMI values were obtained: students with 2° slenderness constituted 4.7% of the study population (n = 8); while students with 1° slenderness constituted 35.7% (n = 61). The majority of subjects, i.e. 59.6% (n = 102), were within the BMI classification interval corresponding to proper body mass range.

Rohrer's index (Table 1) classifies the body build into two types: either slender or stout. In light of this index, in 2006 and 2007, 45% of students (n = 77) showed a slender figure, while 55% (n = 94) showed a stout one. Based on this index, it is possible to generally conclude that males were slender until 1988. Based on the author's own research from 2006 and 2007, the students were classified according to the arithmetic mean of this index as having a stout figure. The minimum value of Rohrer's index was observed in 1988 (min = 0.93), while the maximum occurred in 2006 and 2007 (max = 1.93).

DISCUSSION

The students of the Maritime University of Szczecin are burdened with relatively intense sports activities during their studies when compared to those of other types of universities, as well as maintaining physical fitness during practical work on shore and during practical placements (sea trips). This is a specific group of young people who see an opportunity for future employment in the maritime industry by choosing such a field of study. The character of the work in this profession requires good health and mental strength [11].

In the light of contemporary knowledge about the development of human body proportions, the role of hereditary factors is not questioned. Body height is a trait that seems to be the product of individual, genetically programmed growth potential and environmental influences, such as: quantitative and qualitative deficiencies in nutrition, excessive energy expenditures, lack of rest, past diseases, or stress [4]. Secular changes, or a tendency towards changes, are one of the manifestations of long-term biological rhythm. For more than fifty years the direction of changes has manifested in greater and greater final body measurements being reached by successive generations due to the improvement in living conditions [1, 12, 13].

Research on the issue of secular changes is one of the main topics of physical anthropology. Observations in this regard show that the trend of changes in height and body mass concern not only the Polish population, but virtually all European countries. This issue has been widely described in many studies [1, 14].

Changes, in particular somatic traits, are not uniform. The increase in body height at the end of the 19th century was estimated to 0.3 cm per decade; in the beginning of the 20th century this increment amounted to 1–3 cm per decade. The traits with weaker genetic determination are

subject to acceleration to a greater extent; therefore, the main reasons for this phenomenon lie in the changes of external factors [15]. The most important indicators related to secular changes include the general progress of civilisation and a rise in living standards. In addition, studies indicate an important role of many other socio-economic factors. The most important include: membership of a social class, family size, level of education, urbanisation, place of residence, level of nutrition, medical history, etc. The periodic decrease in the average body mass and height, which relates to certain populations, is often associated with the deterioration of living conditions, malnutrition, and stress in various forms [16].

Based on the study of conscripts, it is known that the average body height of 19-year-old males in Poland increased from 170.5 cm to 176.9 cm, i.e. by 6.4 cm, during the 30-year period (1965–1995). This was a huge increment, being equal approximately to the unit of standard deviation for this trait in the population. With the assumption that the trend towards tall stature was induced in Poland mainly by the improvement of standard of living, it should be considered as supporting a considerable civilisation advancement in the Polish population in the post-war period. The rate of increase in average body height in the 1965–1995 period amounted on average to 2.1 cm per decade and was not uniform over the whole 30-year period [4, 12, 13, 15]. The results of the author's own research from 2006 and 2007 show that the students have greater body measurements than their older colleagues from 20 or 30 years before. That they have greater body weight is evidence of the secular trend and development acceleration.

Analysis of the family status of the young people being examined is not the subject of this study. However, the study of the same author's own research material expanded with other anthropological data showed a strong correlation between body height and father's education. This relation may be explained by the fact that the better the father's education, the higher the family status is, and consequently the better the biological development. Body height in childhood and adolescence is strongly related to environmental conditions, family wealth, rational nutrition, active recreation, education, and access to medical care [17].

The group being examined may be considered as a representative group of typical student communities in Poland. The specific process of selection at the recruitment stage at the Maritime University disqualifies the males being examined as standard academic representatives. An increasingly worrying phenomenon observed among the examined students is the tendency towards excessive body weight in relation to body height and excessive fat accumulation in the waist and hip region.

Body weight that is appropriate in childhood and adolescence usually does not induce overweight in adulthood if the organism is not overfed. Studies also confirm that a relatively sudden gain in body weight takes place between 45 and 50 years of age, compared to the previous period. At the age of 45 years, the average body weight of women and men is frequently 20% higher than 20 years before [18]. This means that individuals characterised by normal BMI frequently reach one of the obesity degrees within a few years. This increasingly refers to individuals who have already been classified as an obese person in adolescence. Studies on seamen and ship personnel show that individuals with higher BMI are characterised by lower working ability [19].

The results of this analysis show that measurements of the somatic traits of students of the Maritime University of Szczecin were higher when compared to similar measurements of the students of University of Szczecin [10], which confirms the thesis mentioned above regarding the directional selection of young people when choosing the type of studies.

The suggestion of Szczotkova [20] from more than 40 years ago refers to detailed examination of future and young seamen. This author in her study of that date depicted the troubles with profession selection and health consequences after heavy occupational burnout. Detailed medical and anthropological examinations among marine industry employees being professionally active would allow tracking physiological and morphological changes in the organism. Such monitoring of health status would prevent seaman from leaving their job prematurely.

CONCLUSIONS

1. The body build of Maritime University students over the analysed years 1969–2007 underwent changes, which can be explained by the secular trend.
2. The measures of somatic indices do not show worrying values referring to emaciation. However, the increasingly frequently observed waist and hip fatness is noteworthy.
3. During the thirty-eight years that were analysed, waist and hip circumferences of the students of the Maritime University of Szczecin increased considerably. This is evidence of visceral body fatness, which is dangerous for health and increases the risk of cardiovascular diseases.

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