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*RESEARCH ARTICLE*

# Trends in modern women development

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The objective is to study trends in modern women development using the anthropometric technique. The obtained results are evidence of the increase in longitudinal (body and leg length) and the decrease in transverse (transverse diameter of a thorax, shoulders and a pelvis) body size in women born from 1942 to 1999. Somatotypes distribution according to the Rees-Eysenck classification shows the increased percentage of asthenic-type people. Triple increase in the percentage of young people referred to an andromorphic somatotype is indicative of women's acquisition of opposite sex (andromorphic) features.
**Keywords:** women; physical development; the Rees-Eysenck index; the Tanner index; industrial city

The study of morphological indicators of body structure is a convenient and informative reference point to judge the profile of individual development (Prahin et al., 1997). The works devoted to the peculiarities of physical development in the context of epochal variability, or secular trend are widely presented in Russian and world literature (Shilova, 2011). Traditionally, the epochal changes of the human species meant the achievement of large body size, the acceleration of the pace of physical and sexual development compared to previous generations. Global trends of epochal variability of physical development demonstrate multidirectional processes: from the continuation of acceleration to its stopping (Shilova, 2011). In the last decade of the twentieth and the beginning of the twenty-first centuries there were a lot of publications indicating a slowdown in the acceleration process and the appearance of the opposite phenomenon – retardation of physical and sexual development (Shilova, 2011). In this connection, the purpose of our work is to study trends in modern women development.

## Materials and methods

We conducted a cross-sectional study of 323 females from 17 to 73 years old - residents of Barnaul. The data were grouped by age periods in accordance with the "Scheme of age periodization of human ontogenesis", adopted at the VII All-Union Conference on Age Morphology, Physiology and Biochemistry of the USSR Academy of Pedagogical Sciences (Moscow, 1965): adolescence - 16–20 years; adulthood: I period - 21–35 years, II period - 36–60 years; old age - 56–74 years. The testees were representatives of European ethnicity lived in the city of Barnaul, Altai Territory. All participants of the research agreed to participate in the study. The age characteristic of the groups is presented in table 1.

**Table 1.** Age statistics of the testees

| | Old age | IIperiod of adulthood | Iperiod of adulthood | Adolescence |
|---|---|---|---|---|
| N | 82 | 71 | 85 | 85 |
| Average age (M±SE) | 63.5±0.53 | 49.6±0.66 | 27.2±0.33 | 19.3±0.47 |
| Age (Min–Max) | 56 – 73 | 36 – 55 | 21 – 35 | 16 – 20 |
| Average year of birth | 1952 | 1965 | 1988 | 1996 |
| Year of birth (Min–Max) | 1942 – 1959 | 1960 – 1980 | 1981 – 1994 | 1995 – 1999 |

During anthropometric studies we were guided by the rules set out in the work of B.A. Nikitjuk, N. A. Kornetov (1998). A small anthropometric program includes the determination of longitudinal, transverse and girth dimensions: body length, cm (BL), circumference of a thorax (upper), cm (CTu), shoulders width, cm (SW) and pelvis width, cm (PW). These parameters, according to WHO experts, describe 80% of human morphological variability, which is representative for diagnosing the overall body dimension and body type (Shershneva et al., 2004). In addition, we determined leg length, cm (LL), transverse diameter of a thorax, cm (TDT) to solve the problems. Standard anthropometric instruments: height meter, medical scales, large compass, plastic measuring tapewere used.

The somatic type assessment was carried out according to the Rees-Eysenck scheme using the Rees-Eysenck index (IRA) according to the formula: IRA = (BL * 100) / (TDT * 6) (<96 – pyknic-type people, 96–106 – normosthenic-type people,> 106 – asthenic-type peopleamong women (Nikitjuk, Kornetov, 1998)). To characterize the proportions of the body, a number of physical development indices were calculated: the J. Tanner index (IT) (Nikitjuk, Kornetov, 1998) using the formula: IT = SW * 3 – PW, which allows to determine the degree of somatic sexual differentiation (>81 – andromorphy, 75-81 – mesomorphism, <75 – gynecomorphia).

Statistical processing of the material was carried out using software products SPSS 21.0. Quantitative attributes with a normal distribution are presented as arithmetic mean (M), standard deviation (SD), standard error (SE), 95% confidence interval (95% CI); values with a non-normal distribution - in the form of a median (Me) and percentile ranking (25 and 75 percentile). The data samples were checked for normal distribution, for which the Kolmogorov-Smirnov test at a level of significance $p < 0.05$ was used. For comparison of three independent groups with a normal distribution, we used single-factor analysis of variance. To compare two independent groups with an abnormal distribution, two-sample Mann-Whitney test was used. Differences in the studied parameters were considered statistically significant at the 95% probability threshold ($p < 0.05$), at the level of pronounced tendency at the 90% probability threshold ($p < 0.1$), at the trend level at 80% probability threshold ($p < 0, 2$). To determine the statistical significance of the differences between the parts, the Pearson Chi-square test ($\chi^2$) was used.

## Results

During the study of physical development of women of different ages living in the Altai Territory, average values of anthropometric parameters, the nature of the distribution of which partially corresponded to the normal type were obtained. The increase in body length was accompanied by a restructuring of the body, which is manifested by narrow thorax (Table 2) - at the level of a pronounced tendency, the index of the transverse diameter of a thorax decreased, by narrow shoulders (Table 2) and narrow pelvis (Table 2). According to L.N. Vasileva (2011), the normal pelvis of an adult woman has the following dimensions: Distantiacristarum 28-29 cm. The data we obtained for girls of 19 years in terms of the pelvis width (D. cristarum) correspond to the uniformly narrowed pelvis of an adult woman (Vasileva, 2011). A longitudinal study can answer more accurately on the question of whether the pelvis is generally evenly characteristic of young people, or whether it has not yet been formed in the age category we have considered.

**Table 2.** Statistical indicators of the anthropometric parameters of women of different ages

| Indicators | Groups | M | SD | SE | 95% CI | | Min | Max | p |
|---|---|---|---|---|---|---|---|---|---|
| BL | 1 | 160.6 | 6.06 | 0.67 | 159.2 – 161.9 | | 142.0 | 174.0 | $p_{1-2} = 0.042$ |
| | 2 | 162.6 | 5.94 | 0.71 | 161.2 – 164.0 | | 148.0 | 177.0 | $p_{1-3.4} < 0.001$ |
| | 3 | 165.5 | 6.10 | 0.66 | 164.2 – 166.8 | | 154.0 | 178.0 | $p_{2-3.4} \leq 0.001$ |
| | 4 | 165.8 | 6.06 | 0.66 | 165.1 – 167.8 | | 148.0 | 182.0 | |
| LL | 1 | 83.7 | 4.07 | 0.45 | 82.8 – 84.6 | | 74.0 | 96.0 | $p_{1-2} = 0.116$ |
| | 2 | 84.9 | 3.24 | 0.38 | 84.1 – 85.7 | | 78.0 | 93.0 | $p_{1-3.4} < 0.001$ |
| | 3 | 88.6 | 4.72 | 0.51 | 87.6 – 89.6 | | 77.0 | 100.0 | $p_{2-3.4} \leq 0.001$ |
| | 4 | 88.1 | 5.80 | 0.63 | 86.1 – 88.6 | | 70.0 | 107.0 | $p_{3-4} = 0.038$ |
| CTu | 1 | 94.8 | 10.37 | 1.15 | 92.5 – 97.0 | | 72.0 | 144.0 | $p_{1-3.4} < 0.001$ |
| | 2 | 94.0 | 9.16 | 1.09 | 91.8 – 96.2 | | 77.0 | 114.0 | $p_{2-3.4} < 0.001$ |
| | | Me | | | $Q_{25}$ | $Q_{75}$ | | | $p_{3-4} = 0.037$ |
| | 3 | 87.0 | | | 80.0 | 90.0 | 58.0 | 112.0 | |
| | 4 | 85.8 | 6.30 | 0.68 | 83.5 – 86.2 | | 70.0 | 102.0 | |
| TDT | 1 | 25.0 | 2.35 | 0.26 | 24.5 – 25.5 | | 20.0 | 30.5 | $p_{1-2} = 0.294$ |
| | 2 | 24.8 | 2.21 | 0.26 | 24.3 – 25.3 | | 20.0 | 30.0 | $p_{1-3} = 0.077$ |
| | 3 | 24.4 | 2.25 | 0.27 | 23.9 – 25.0 | | 19.0 | 29.0 | $p_{1-4} = 0.073$ |
| | 4 | 24.2 | 2.35 | 0.26 | 23.7 – 24.7 | | 19.0 | 29.0 | $p_{2-3} = 0.198$ |
| SW | 1 | 36.7 | 1.91 | 0.21 | 36.3 – 37.2 | | 32.0 | 41.0 | $p_{2-4} = 0.190$ |
| | | Me | | | $Q_{25}$ | $Q_{75}$ | | | $p_{1-3.4} < 0.001$ |
| | 2 | 37.0 | | | 36.0 | 39.0 | 32.0 | 40.5 | $p_{2-3.4} < 0.001$ |
| | 3 | 31.0 | | | 28.0 | 33.0 | 26.0 | 38.0 | $p_{3-4} = 0.043$ |
| | 4 | 30.0 | | | 29.0 | 33.0 | 26.0 | 41.0 | |
| PW | 1 | 31.5 | 3.08 | 0.34 | 30.8 – 32.1 | | 24.0 | 37.0 | $p_{1-2} = 0.072$ |
| | 2 | 30.1 | 4.18 | 0.50 | 29.1 – 31.1 | | 23.0 | 37.0 | $p_{1-4} < 0.001$ |
| | | Me | | | $Q_{25}$ | $Q_{75}$ | | | $p_{2-3} = 0.070$ |
| | 3 | 30.0 | | | 27.0 | 33.0 | 22.0 | 37.0 | $p_{2-4} < 0.001$ |
| | 4 | 25.0 | | | 24.0 | 27.0 | 22.0 | 35.0 | $p_{3-4} < 0.001$ |

Note: groups 1 – old age, 2 – second period of adulthood, 3 – first period of adulthood, 4 – adolescence.

These features are characteristic of leptosome proportions of the body; therefore, a shift in their direction can be indicated as leptosomization. Leptosome (elongated) proportions of the body are combined with reduced fat deposition, "dry" type musculature with high specific force. According to many authors, a decrease in body massiveness and transverse dimensions of the head and face allows us to see in leptosomization one of the manifestations of gracialization, i.e. reduce the massiveness of the skeleton (Shilova, 2011).

Leptosomization testifies to the disharmony of the acceleration of development: the activation of body growth in length is accompanied by a shortfall in transverse and girth dimensions of the body. That was confirmed in our work. The distribution of somatotypes according to the Rees-Eysenck classification showed an increase in the percentage of individuals with asthenic-type physique at the level of a pronounced tendency (Fig. 1).

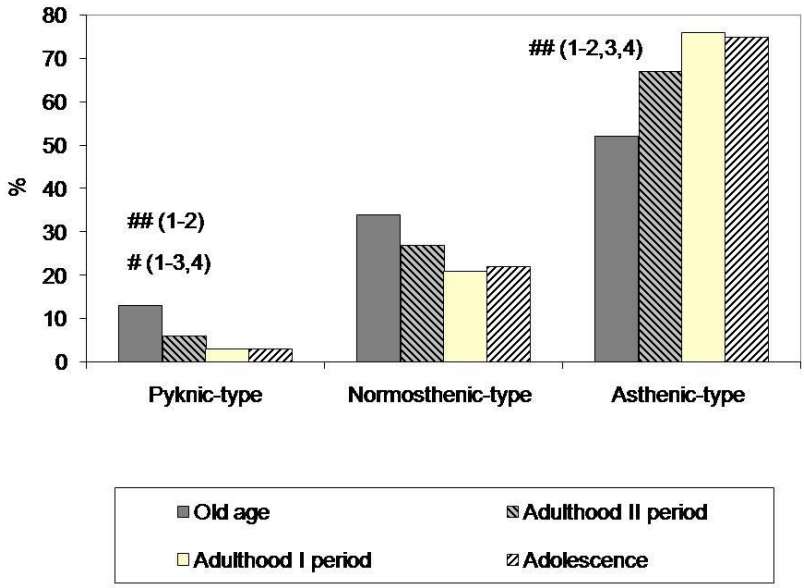


**Figure 1.** Distribution of somatotypes according to the Rees-Eysenck classification of groups of the testees of different age.
Note: Differences between groups at the level of pronounced trend ## – P <0.1, at the level of trend # – P <0.2.

**Table 3.** The results of the comparison of the difference in the groups of the testees with different somatotypes according to the Rees-Eysenck classification (to Fig. 1)

| Compared groups | Pyknic somatotype | | | Compared groups | Asthenic somatotype | | |
|---|---|---|---|---|---|---|---|
| | $\chi^2$ | df | P | | $\chi^2$ | df | p |
| 1–2 | 2.24 | 1 | 0.134 | 1–2 | 2.87 | 1 | 0.090 |
| 1–3 | 3.13 | 2 | 0.208 | 1–3 | 5.49 | 2 | 0.064 |
| 1–4 | 5.15 | 3 | 0.161 | 1–4 | 5.54 | 2 | 0.060 |

Note: groups 1 – old age, 2 – 1 period of adulthood, 3 – 2 period of adulthood, 4 – adolescence.

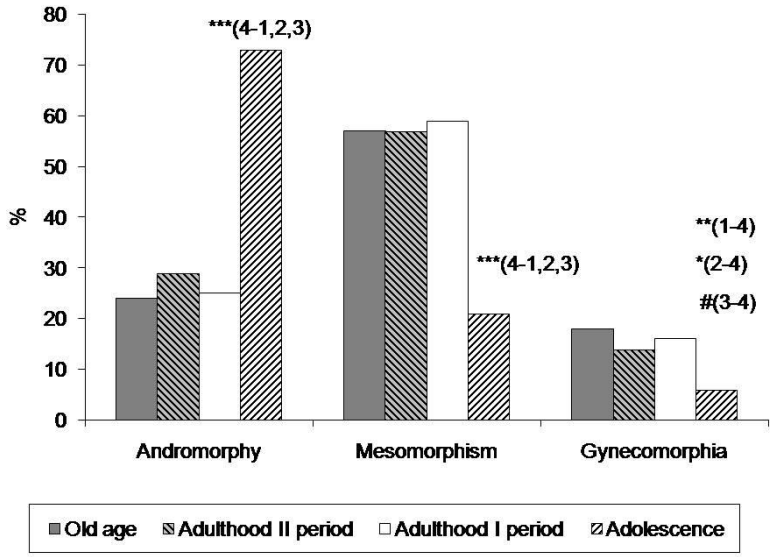


**Figure 2.** Distribution of somatotypes according to the J. Tanner classification of groups of the testees of different age. Notes: Statistically significant differences between groups: * – P <0,05, ** – P <0,01, *** – P <0,001. Differences between groups at the trend level # – P <0,2.

The study of somatic sexual differentiation of the body revealed the prevalence of the testees of the andromorphic somatotype in adolescence (Fig. 2). This is due to the low value of the pelvis width (Table 2).

**Table 4.** The results of the comparison of the difference in the groups of the testees with different somatotypes according to the J. Tanner classification (to Fig. 2)

| Compared groups | Andromorphic somatotype | | | Compared groups | Mesomorphicsomatotype | | | Compared groups | Gyneco-morphicsomatotype | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\chi^2$ | df | p | | $\chi^2$ | df | p | | $\chi^2$ | df | p |
| 1–4 | 81.57 | 3 | <0.001 | 1–4 | 79.8 | 3 | <0.001 | 1–4 | 12.5 | 3 | 0.006 |
| 2–4 | 75.5 | 2 | <0.001 | 2–4 | 65.4 | 2 | <0.001 | 2–4 | 8.26 | 2 | 0.016 |
| 3–4 | 75.5 | 1 | <0.001 | 3–4 | 11.86 | 1 | ≤0.001 | 3–4 | 2.07 | 1 | 0.150 |

groups 1 – old age, 2 - 1 period of adulthood, 3 - 2 period of adulthood, 4 – adolescence.

The earliest anthropometric data in the available literature refer to 1935 (Shilova, 2011). The body length at that time was 155.8 cm. It can be seen from table 5 that the body length continued to increase over time. Although over the period we studied, the body length increased by 5 cm (Table 3), the increase in body length was due to an increase of leg length (Table 2).

**Table 5.** Comparison of arithmetic mean values of the body length of females who have reached the end of growth processes, according to the results of different years of survey

| Our data | | Literature data | | |
|---|---|---|---|---|
| Average year of completion of growth processes | Body length, cm | Year | Body length, cm | References (by Shilova, 2011) |
| | | 1935 | 155,8 | Aron,1940 |
| 1969 | 160.6±0.67 | 1969 | 160.8 | Vlastovsky, 1976 |
| 1982 | 162.6±0.71 | 1982 | 162.2±0.5 | Shilova, 1982 |
| 2005 | 165.5±0.52 | 2003 | 165.3±0.4 | Andreeva et al, 2007 |
| 2013 | 165.8±0.62 | 2009 | 165.6±0.6 | Sukhanova,, 2009 |

## Discussion

The purpose of this work was to study trends in modern women development – residents of Barnaul, Altai Territory. Our data are consistent with the results of E.Z. Godina (2001), who studied the physical and sexual development of teenagers and young people with an interval of 20 years in different territories of Russia. She showed that in 30 years of research the greatest changes in children of both sexes occurred in leg length and arm length. This is confirmed by the well-known fact in auxology that secular changes in body length are mainly due to leg length (Godina, 2001).

The increase in the percentage of persons with asthenic physique at the level of a pronounced tendency (Fig. 1) indicates the process of asthenia or deceleration of the physical development of girls compared with older women. Our data on the reduction of the lateral diameter of a thorax are consistent with data from other authors. E.Z. Godina (2001) showed negative changes in the transverse diameter of a thorax in the study of the 70s - 90s, which is also interpreted as a tendency to asthenia physique, especially pronounced in girls. Our results are consistent with the data of E. N. Sizova et al. (2010). Based on the study, the authors came to the conclusion that the process of asthenization or deceleration of the physical development of 17–18-year-old girls of the Kirov region, established at the end of the 20th century, continues at the beginning of the 21st century.

A number of authors point out the acquisition of the structural features of the opposite sex (andromorphism) by women (qtd. in Shilova, 2011). This was confirmed in our work – a study of the somatic sexual differentiation of the body revealed an increase in the percentage of individuals of the andromorphic somatotype 3 times in the group of adolescence.

## Conclusion

A study of females from 1942 to 1999 years of birth revealed an increase in longitudinal (body length, leg length) and a decrease in transverse (shoulders and pelvis) body size.

The distribution of somatotypes according to the Rees-Eysenck classification showed an increase in the percentage of individuals with asthenic physique at the level of pronounced tendency.

An increase in the percentage of people of the andromorphic somatotype by 3 times in the group of adolescence indicates that women acquire the structure features of the opposite sex (andromorphism).

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