

# ENVIRONMENTAL DIVERSITY IN SOMATIC DEVELOPMENT AND PHYSICAL FITNESS OF SIX-YEAR-OLD CHILDREN

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## Abstract

**Introduction.** In the auxologic literature numerous publications confirming the importance of environmental factors for the biological processes of growth and development of motor skills of children and adolescents can be found. The aim of the study was a comparative assessment of the level of somatic development and physical fitness of six-year-old children in urban and rural areas. **Material and methods.** The study was conducted in 2011-2013. A total of 1,057 children, including the 371 boys and girls from the Warsaw agglomeration and 147 boys and 168 girls from the rural environment in the Lublin region were subjects of the study. The average age was 5.87 ( $\pm 0.30$ ) years. In order to determine the status of somatic development the following features were measured: height and weight, 3 circumferences (shoulder, chest and waist), and 5 skinfolds (above the biceps and triceps, subscapular, on the stomach and on the calf). To assess the motor level the fitness test was used, consisting of the 5 following tests: seated forward bend, shuttle run 10x5 m, standing long jump, sitting-up for 30 s, and 1 kg medicine ball throw with both hands above the head forward. In the mathematical analysis of numerical data the selected techniques of descriptive statistics and Student's t-test and chisquare test were used. **Results.** Average values of height and weight, and body circumferences were higher in the rural areas (in these measurements of boys' body weight and broad parameters differed significantly). In environments differing in the degree of urbanization of place of residence a similar level of fatness was reported. In the most tests of physical fitness better results were achieved by rural children. This dominance was found especially in the 10x5 m shuttle run and the medicine ball throw. In these tests, there were significant differences in both sex groups. In addition, rural boys achieved significantly better results in the standing long jump and girls – in forward bend. **Conclusions.** The presence of signaled in the literature urbanization gradients in the rates of somatic development in favor of the urban population was not confirmed. In terms of selected anthropometric parameters (body circumferences) even a significant advantage of six-year-old children in rural areas against the peers in the city was noted. Dominance of the respondents from the rural environment has also been found in the image of their physical fitness. Higher levels of somatic-motor school readiness of six-year-old children from rural areas as compared with urban peers were shown.

**Key words:** somatic development, fitness, six-year-old children

## Introduction

In the auxologic literature numerous publications confirming the importance of environmental factors for the biological processes of growth and development of motor skills of children and adolescents can be found [1-11]. In particular, the level of somatic development, expressed by the size of anthropometric parameters, is widely recognized as a sensitive indicator of conditions internal and external to the family. The so-called social variables include mainly the number of children in the family, education of mother and father, the material conditions and the degree of urbanization of the place of residence. In view of the available literature, the rank of the abovementioned modifiers of developmental processes is evaluated ambiguously [1-11]. However, it seems that there prevails the view indicating that the size of the agglomeration inhabited differentiates the status of somatic development more clearly than intra-familial factors [11]. This is evidenced by, among others, quite radical opinions drawn from selected anthropological works. The results of years of auxologic research conducted by Nowicki [12] in the region of Bydgoszcz confirm the presence of an urbanization gradient in

the indicators of physical development to the benefit of the urban population. The author suggests that in many areas there still persist "backwardness of the Polish rural areas", which in his opinion "is the result of social neglect of the state not providing the younger generation with the proper development". Burzynski [13], analyzing the issue of social stratification in terms of some of the autotelic values (including those related to sport, competition, care of the body, physical activity and aesthetics of movement), talks about the deprivation of the development of children and youth from rural areas (understood as the denial or uneven access to material or spiritual goods, causing inability to meet the individual or group specific needs). Also Bielicki et al. [14] confirmed that the rural environment is for some reason "worse by itself" for the physical development of the young generation. This condition has been called the "biological manifestation of impaired civilization still ongoing in the Polish rural areas" [15].

The level of physical fitness in environments with different degree of urbanization of the place of residence does not show as unidirectional and unambiguous differentiation as the status of somatic development. For example, in the studies of Sekita [16]

from the 80s of the last century the advantage of urban children in preschool age over their peers from rural areas was demonstrated, in terms of arm and trunk strength. The author justified the result obtained by favorable anthropometric parameters of girls and boys living in conditions of the urban agglomeration (Wrocław). In later studies of six-year-old children in urban and rural areas, in the same physical tests quite the opposite result was reported, despite the continuing trend of urbanization in somatic development. Dominance of the respondents from rural areas over their city peers in terms of strength predispositions was explained by the specificity of movement stimuli specific to the rural environment [17]. It seems, therefore, that a more clear indicator of social stratification are gradients in the development of morphological features [18].

The concept of this work – primarily including social determinants of development processes – also refers to the implemented since 2009 a highly controversial education reform, which involves lowering the age of undertaking the student duties. The analysis concerns the comparison of selected aspects of the biological condition of six-year-old children in urban and rural areas. These components are located in the formula of school readiness, defined by Wilgocka-Okoń [19] as a set of psychophysical features, formed in the course of development, allowing the child to meet the school demands. The present work falls within the realm of environmental studies and refers to previous publications of diagnostic nature, concerning the so-called positive measures of health. A new aspect of this analysis can be defined as the reference to the educational reform, where the motto – according to the position represented by the Ministry of Education – is equal educational opportunities. Therefore, the aim of the study is the comparative assessment of the level of somatic development and physical fitness of six-year-old children in urban and rural areas.

### Material and methods

The study was conducted in the years 2011, 2012, 2013 – each time in the spring months. In subsequent editions, it covered children born in 2005, 2006 and 2007. In 2011-12 the survey was carried out in the Warsaw agglomeration, and in 2013 in small-town and rural environment (Parczew, the Lublin region and its surroundings). The study involved a total of 1,057 boys and girls, whose average age was  $5.87 (\pm 0.30)$  years. Particularized characteristics of the study group have been presented in Table 1 and Figures 1-4.

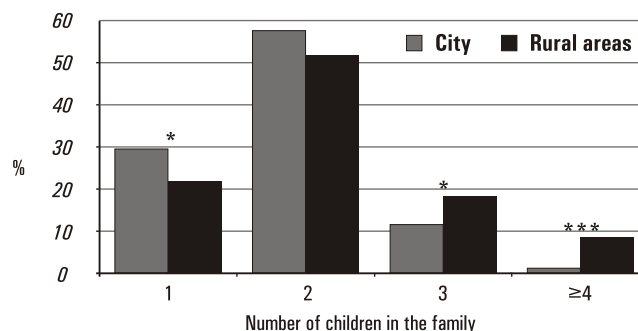
**Table 1.** Numerical characteristics of the study group by gender and environmental

	Boys (N=518)		Girls (N=539)	
	city	rural area	city	rural area
N <sub>i</sub>	371	147	371	168
Age (years)	5.85±0.30	5.95±0.29	5.83±0.31	5.91±0.29

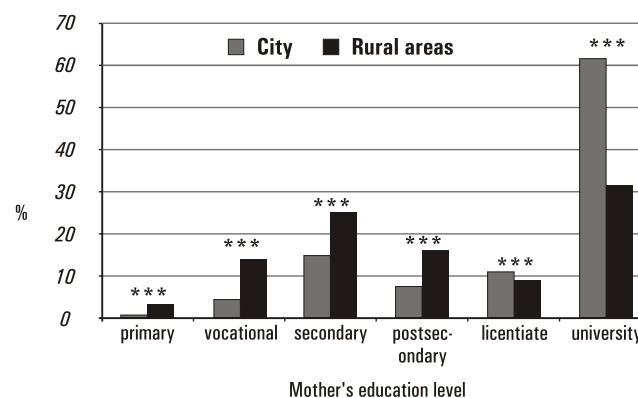
According to the information contained in Table 1, the arithmetic average age of the respondents was similar in both environments, and in both sexes. About 2.5 times the size of the subgroups of boys and girls in urban compared to rural peers result from the overall concept and stage division of the research projects (DS.139 and DM.8), on the basis of which this article was prepared.

Examined subgroups of children in urban and rural areas were different in terms of components of socio-economic status and education of their families, as shown in Figures 1-4. Urban families had a smaller number of children, the higher level of education of mother and father and favorable financial condi-

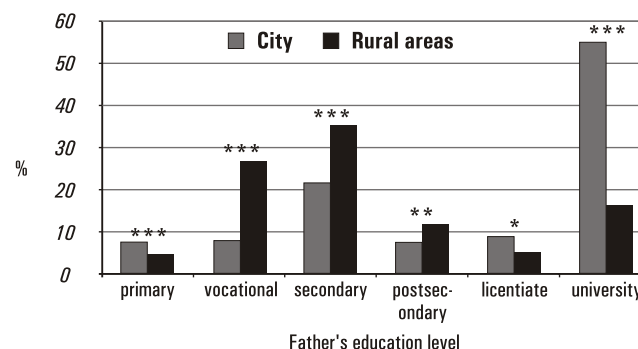
tions of development. Detailed information about the diversity in the area of the aforementioned social variables has been marked on Figures 1-4 in the form of percentage (supplemented by an assessment of statistical significance).



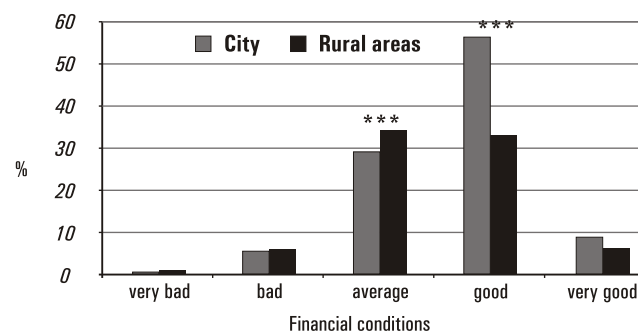
**Figure 1.** Fractions (%) of the studied children families separated due to the number of children in the family



**Figure 2.** Fractions (%) of the studied children families separated due to the mother's education level



**Figure 3.** Fractions (%) of the studied children families separated due to the father's education level



**Figure 4.** Fractions (%) of the studied children families separated due to the financial conditions

**Table 2.** The average values ( $\pm$ SD) of anthropometric parameters in the studied group by gender and environment, together with the differences marking

Anthropometric parameters		Boys			Girls		
		city	rural area	difference	city	rural area	difference
Height and weight	height (cm)	117.44 $\pm$ 5.17	118.39 $\pm$ 5.66	-0.95	116.54 $\pm$ 5.33	116.91 $\pm$ 5.37	-0.37
	weight (kg)	21.72 $\pm$ 3.70	22.60 $\pm$ 4.48	-0.88*	21.54 $\pm$ 3.94	22.16 $\pm$ 4.39	-0.62
Circumferences (cm)	arm	17.84 $\pm$ 1.88	18.41 $\pm$ 2.15	-0.57**	18.27 $\pm$ 3.03	18.51 $\pm$ 2.06	-0.24
	chest	56.84 $\pm$ 3.74	59.32 $\pm$ 4.90	-2.48***	55.56 $\pm$ 4.20	58.40 $\pm$ 5.08	-2.84***
	waist	54.65 $\pm$ 4.40	55.63 $\pm$ 5.25	-0.98*	53.34 $\pm$ 4.26	54.52 $\pm$ 5.26	-1.18**
Skinfolds (mm)	over biceps	6.92 $\pm$ 2.58	6.96 $\pm$ 2.86	-0.04	8.14 $\pm$ 2.75	8.19 $\pm$ 2.95	-0.05
	over triceps	9.53 $\pm$ 2.92	8.93 $\pm$ 3.48	0.60*	10.94 $\pm$ 3.00	10.40 $\pm$ 3.14	0.54
	under shoulder blade	6.89 $\pm$ 2.94	6.68 $\pm$ 3.74	0.21	7.70 $\pm$ 3.03	7.79 $\pm$ 3.75	-0.09
	on the belly	5.49 $\pm$ 3.19	5.74 $\pm$ 3.71	-0.25	6.42 $\pm$ 3.23	6.69 $\pm$ 3.53	-0.27
	on the calf	10.47 $\pm$ 3.98	9.68 $\pm$ 4.68	0.79	12.06 $\pm$ 4.03	11.75 $\pm$ 4.47	0.31
	sum of 5 folds	39.14 $\pm$ 14.05	38.07 $\pm$ 17.21	1.07	44.48 $\pm$ 15.05	44.81 $\pm$ 16.37	-0.33

\* ( $p<0.05$ ), \*\* ( $p<0.01$ ), \*\*\* ( $p<0.001$ ) – significantly different from the result obtained by the respondents from the second level of urbanization

**Table 3.** The average values ( $\pm$ SD) of fitness tests in the studied group by gender and environment, together with the differences marking

Physical fitness test	Boys			Girls		
	city	rural area	difference	city	rural area	difference
Seated forward bend (cm)	2.20 $\pm$ 5.07	3.13 $\pm$ 4.62	-0.93	3.76 $\pm$ 4.83	4.66 $\pm$ 4.81	-0.9*
Standing long jump (cm)	95.66 $\pm$ 17.41	100.05 $\pm$ 18.03	-4.39**	89.69 $\pm$ 17.22	92.05 $\pm$ 16.79	-2.36
Sitting up in 30 s	6.27 $\pm$ 5.04	6.53 $\pm$ 4.70	-0.26	5.83 $\pm$ 5.24	5.56 $\pm$ 4.32	0.27
10x5 m shuttle run (s)	28.54 $\pm$ 2.86	27.10 $\pm$ 2.44	1.44***	29.21 $\pm$ 3.10	28.54 $\pm$ 2.67	0.67**
1 kg medicine ball throw (cm)	263.78 $\pm$ 56.85	277.67 $\pm$ 56.21	-13.89*	236.62 $\pm$ 48.33	248.46 $\pm$ 50.18	-11.84**

\* ( $p<0.05$ ), \*\* ( $p<0.01$ ), \*\*\* ( $p<0.001$ ) – significantly different from the result obtained by the respondents from the second level of urbanization

In order to determine the status of somatic development the following features were measured: height and weight, 3 circumferences (shoulder, chest and waist), and 5 skinfolds (above the biceps and triceps, subscapular, on the stomach and on the calf). The measurements were taken in accordance with the guidelines generally accepted in anthropology [20].

To assess the motor level the fitness test was used, consisting of the following tests: seated forward bend, shuttle run 10x5 m, standing long jump, sitting-up for 30 s, and 1 kg medicine ball throw with both hands above the head forward. Four of them were taken from Eurofit, the last of the following tests is derived from Wrocław test of physical fitness for preschool children by Bożena Sekita [21].

Additionally – for the characterization of socio-economic and educational status of the tested children's families – a diagnostic survey method was used. Survey questions addressed to the parents related to the number of children in the family, the educational level of the mother and father, and the financial conditions of growing up.

In the mathematical analysis of the resulting figures the selected techniques of descriptive statistics were used (average values, percentage and standard deviations were calculated). To assess the significance of differences between the average values in the two subgroups (urban and rural) Student's *t* test was used. However, in order to determine the significance of differences between the socio-economic and educational status of families the chi-square test in logarithmic form was used (Fig. 1-4). Standard significance levels were adopted:  $p<0.001$  (\*\*\*),  $p<0.01$  (\*\*),  $p<0.05$  (\*) [22].

## Results

In accordance with the title of this work and its concept and purpose outlined in the introduction, in the presentation of the results attention was paid mainly to exposing the differences between urban and rural children in the values of selected anthropometric parameters and the results of physical fitness tests. The results of tests have been shown in Tables 2 and 3.

Both girls and boys from the rural areas obtained higher height and weight values than their peers from the city. These differences, expressed as an absolute numerical value occurred with greater severity in the male subgroup of patients. Weight of rural boys was significantly higher (by nearly 0.9 kg,  $p<0.05$ ) than in urban areas. In terms of circumferences a clear predominance of children growing up in an environment with a low urbanization degree of the place of residence was demonstrated. Differences in circumferences of chest and waist to the advantage of children in rural areas have proved to be significant in both sexes, and of the arm – in boys. The average values of skinfolds in the tested environments were similar. Of the 5 measurements assessing body fat only in one case the difference showed signs of statistical significance (0.6 mm thicker folds over the triceps in urban boys –  $p<0.05$ ) (Tab. 2). The standard deviation in subgroups of subjects from comparable levels of urbanization suggest a similar status of inter-personal differentiation (Tab. 2).

Results' layout in physical fitness is regular. In the majority of tests (with the exception of abdominal muscle strength in the subgroup of girls) better results were achieved by rural children.

Their biggest advantage – of high level of significance and confirmed in both sexes – was reported in the 10x5 m shuttle run. Significant differences – reaching almost 14 cm in boys ( $p < 0.05$ ) and nearly 12 cm in girls ( $p < 0.01$ ) – also occurred in the medicine ball throw and were also noted in the female subgroup in seated forward bend ( $p < 0.05$ ) and in boys – in the standing long jump ( $p < 0.01$ ) (Tab. 3).

### Discussion

Given the opinions and suggestions, contained in the introduction, about the favorable development conditions of children from urban environments compared to boys and girls living in rural areas [12, 13, 14, 15], the results obtained in this study should be considered surprising. Their outline was regular and quite clearly showed the dominance of the respondents from the rural areas. We would like to emphasize that the average height and weight and especially body circumferences were larger in rural children. At the same time in environments different in terms of the degree of urbanization of the place of residence a similar level of fatness was reported. In addition, in the vast majority of physical fitness tests rural children obtained better results.

Comparing observed in the present study results of anthropometric measurements with analogous, population-wide measurements, one can talk about reverse trends. In the cross-sectional diagnosis “Six-year-old children in Poland” – in both series (fall and spring), and in both trials (random and purposive) – a higher level of growth, weight, width, and thickness of fatty layer parameters was demonstrated in a population of urban children [23]. The discrepancy in the results outline between a group of children covered by own research and a Poland-wide test has also been noted in relation to physical fitness. In the cross-sectional diagnosis – depending on the edition (at the beginning or end of the school year), of gender and assessed motor skills – results obtained showed both the advantages of urban children and rural children [24]. In the study of Nowicki [25] regarding a group of more than 500 girls and boys at the threshold undertake their school duties, the rural six-year-old children in average presented lower levels of physical fitness, manual efficiency and hand-eye coordination than their peers from the city.

In the literature, however, can be also found the opinions indicating little relevance of the size of the agglomeration inhabited to the physical growth processes. Based on studies of six-year-old children from the rural, small-town and urban areas in Świętokrzyskie Voivodeship, it was concluded that the level of urbanization is a minor factor differentiating the status of somatic and motor development [3]. The publication undertaking similar issues, concerning the re-population of Świętokrzyskie region, reported similar values of selected anthropometric parameters in children from rural areas against the voivodeship population of peers. It has been shown, however, that the level of motor development only slightly differs from the results for the entire region [5].

Some of the reasons for the lack of dominance of urban over the rural children in terms of somatic features can be found in Charzewski [2] of more than 30 years ago. It was already then that the author of the monograph entitled “Social determinants of physical development of children in Warsaw”, published in 1981, formulated the notion of proximity of expiration of the tall-growth trend in the Warsaw environment. In this work, it can be read that the children of the intelligentsia from Warsaw downtown are close to making full use of “growth potential”, which is determined genetically.

Demonstrated diversity in the level of motor abilities could be caused by selected intra-family conditions. In the literature,

a higher number of children in the family is considered to be a factor encouraging the development of physical fitness due to the greater number and variety of movement stimuli in everyday life [26].

Probably the unusual trends observed in own studies constitute a symptom of effacing of the social stratification biological effects. In the Nordic countries known for their high standard of living, this phenomenon has already been observed in previous decades [27, 28, 29]. Similar manifestations were found in the earlier analysis, undertaken by the authors of this work. The publication was devoted to the importance of intra-family development processes and conditions concerning only the urban subgroup of six-year-olds. There has been a relatively low number and small intensity of differences in the somatic development and physical fitness among groups with high, medium and low socio-economic and educational status [30].

### Conclusions

Based on the survey the following conclusions can be formulated:

1. The presence of signaled in the literature gradients of urbanization in the rates of somatic development in favor of the urban population was not confirmed. In the terms of selected anthropometric parameters (body circumferences), a significant advantage of six-year-old children in rural areas over their peers in the city has been indicated.
2. Dominance of the respondents from the rural environment has also been found in their physical fitness. This advantage occurred mainly in 10x5 m shuttle run and the medicine ball throw.
3. Despite the less favorable urbanization, socio-economic and educational conditions of six-year-old children growing up in rural environment, demonstrated a higher level of their somatic – motor school readiness was shown, as compared with the urban peers.

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