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ORIGINAL ARTICLE

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Respiratory System Parameters and Other Somatic Indicators of Fitness in Primary School Pupils Exemplified in the Pomeranian Province

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A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection

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Abstract

Background: *Functional parameters of the respiratory system, the level of fatty tissue and connected with it the weight/growth index constitute important information attesting health condition of the population. The purpose of the study is to compare somatic features and determine the degree of correlation between these features taking into consideration different ecological conditions of the place of residence.*

Material/Methods: *A total of 114 children aged 13 (56 boys) and 12 (58 girls), representatives of the urban and country school population participated in the research. A city school was represented by a group of 30 boys and 27 girls. 26 boys and 31 girls were representatives of a village school. Research on physical development concerned body height and weight, thickness of the fatty tissue and functional parameters of the respiratory system.*
The arithmetic mean and standard deviation were assessed. The importance of difference of the arithmetic means in town and village groups of both sexes was tested by the Student t-test, and the correlation coefficient was assessed. The level of significance alpha = 0.05 was accepted. The assessment was made by means of Statistica 9 programme. The tests were taken in spring 2008.

Results: *Research findings present significant relationships between the thickness of the fatty tissue and the body mass. The relationships between the remaining somatic features, for example lung ventilation parameters, are less essential.*

Conclusions: *The assumption that the place of residence and associated with it different ecological conditions influence the biological development indicators seems to be untrue with reference to the tested group of pupils.*

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Introduction

Physical development and physical fitness are created under the influence of many factors which undergo various changes; therefore, there is a need of continuous monitoring of their both positive and negative effects. By development in the natural conditions we understand the process of changes which the matter undergoes leading to a permanent creation of new forms. The process of developmental changes happening in human life can be examined in the aspect of physical, motor or mental development. Physical or biological development means the entirety of irreversible biological processes taking place in the developing organism from the moment of conception until the moment of transforming the individual into a mature organism. Physical development is also a biological process influencing quantitative and qualitative changes in human organism as far as many factors, both exterior and interior, are concerned. Multiple tests indicated [1, 2, 3, 4, 5] that physical development and physical fitness are mutually interdependent, they do not occur in a parallel way, and their level is conditioned by the following factors: endogenous genetic factors – determinants of development, endogenous paragenetic factors – stimulators of development and exogenous factors – modifiers of development. Among the latter ones one can distinguish: cultural-social factors, character of the environment, the level of education, the amount of earnings, traditions, customs and style of life which is connected both with genetic and environmental conditionings. The second group of modifiers are biogeographical factors, connected with the place of residence: fauna, flora, climate, mineral resources and also air pollution, an analysis of which in the context of progress and physical fitness has been extensively described in literature [6–14].

The aim of this paper is to evaluate the respiratory system parameters and other somatic indicators in primary school pupils exemplified in the Pomeranian province in view of the place of residence. The study has been conducted on the basis of a comparative analysis of chosen indicators of biological development of the groups of youth of primary schools form towns and villages of the Pomerania region which are comparable in numbers.

Fast and dynamic development of physical education has resulted in a continuous increase in the number of studies concerning this topic. By this analysis the authors intend to broaden the knowledge on the problem of ecological conditionings of biological development.

Material and Methods

114 children, including 56 twelve-year-old boys and 58 thirteen-year-old girls were tested. They are representatives of 2 primary schools from the Pomeranian region, one group is from a big town (Gdynia) and the other one from a village (Luzino) The town school was represented by 30 boys and 27 girls. As to the rural school, however, there were 26 boys and 31 girls. The tests of physical development in these groups included an analysis of the following parameters: body height and mass, fatty tissue and lung ventilation characteristics. The following research tools were applied: a measuring tape, medical scales, skin fold caliper Fat Tester and KoKo spirometer. Basic ventilation parameters were subject to statistical assessment: FVC (Forced Vital Capacity), FEV1 (Forced Expiratory Volume in one second), FEF 25-75% (Forced Expiratory Flow) and PERF (Peak Expiratory Flow Rate) as well as body height and weight, the BMI index and the sum of skin folds according to the British method (sum of calf and triceps fat) [15]. Thearithmetic mean and standard variation were assessed. The significance of difference of the arithmetic means in town and village groups of both sexes was tested by the Student t-test, and the correlation coefficient was assessed. The level of significance alpha = 0.05 was accepted. The assessment was made by means of Statistica 9 programme. The tests were taken in spring 2008.

Results

When elementary developmental parameters of boys and girls from both environments where compared, in most cases no statistically significant differences between them were stated. The difference between urban and rural girls' body height was an exception ($p<0.01$) – Tables 1 and 2.

Another group of parameters of biological development that underwent measurements were breathing indicators of lungs. The spirometric test did not indicate statistically significant differences in both sexes taking into consideration different as far as ecological conditions places of residence (Tab. 3 and 4).

The statistical analysis also concerned determining coefficients of correlation between all the analysed parameters in the case of all 4 groups subject to tests (Tables 5–8).

Tab.1. Elementary indicators of biological development in urban and rural groups of boys

Feature	unit	Town (n=30)		Village (n=26)		t
		x	±s	x	±s	
Body height	cm	155.33	8.80	150.75	9.11	1.83
Body mass	kg	44.75	10.92	44.07	11.98	0.21
Fatty tissue	mm	29.54	11.54	28.42	13.81	0.31

Tab. 2. Elementary indicators of biological development in urban and rural groups of girls **p<0.01

Feature	unit	Town (n=27)		Village (n=31)		t
		x	±s	x	±s	
Body height	cm	160.17	4.94	154.73	9.20	2.25**
Body mass	kg	51.41	7.29	53.00	16.46	-0.37
Fatty tissue	mm	35.29	9.82	36.36	14.34	-0.27

Tab. 3. Volume and flow values characteristic of the respiratory system in urban and rural groups of boys

Feature (in % of normal values)	Town (n=30)		Village (n=26)		t
	x	±s	x	±s	
FVC (%)	95.66	12.65	98.28	10.01	-0.83
FEV1 (%)	92.37	12.48	95.42	10.21	-0.96
FEV1/FVC (%)	103.41	6.54	103.50	6.30	-0.04
FEF 25-75% (%)	91.20	17.54	92.78	16.29	-0.33
PEFR (%)	74.25	12.44	69.96	13.49	1.18

Tab. 4. Volume and flow values characteristic of the respiratory system in urban and rural groups of girls

Feature (in % of normal values)	Town (n=27)		Village (n=31)		t
	x	±s	x	±s	
FVC (%)	101.76	14.89	102.33	14.84	-0.12
FEV1 (%)	92.88	9.69	96.83	13.66	-1.04
FEV1/FVC (%)	102.00	5.66	104.96	6.43	-1.58
FEF 25-75% (%)	92.00	9.28	96.16	17.11	-0.92
PEFR (%)	79.17	14.37	64.60	11.63	3.78**

Tab. 5. Correlation coefficient between chosen parameters of biological development in the group of boys from urban areas *p<0.05

Feature	Body height	Body mass	Sum of fat folds	FVC	FEV1	FEV1/FVC	FEF 25-75%	PEFR
Body height	1.00	0.72*	0.51*	0.04	-0.09	-0.16	0.06	0.06
Body mass	0.72*	1.00	0.75*	0.25	0.06	-0.32	-0.06	0.01
Sum of fat folds	0.51*	0.75*	1.00	-0.06	-0.10	-0.02	-0.01	-0.13
FVC	0.04	0.25	-0.06	1.00	0.88*	-0.24	0.37	0.69*
FEV1	-0.09	0.06	-0.10	0.88*	1.00	0.23	0.71*	0.71*
FEV1/FVC	-0.16	-0.32	-0.02	-0.24	0.23	1.00	0.73*	0.03
FEF 25-75%	0.06	-0.06	-0.01	0.37	0.71*	0.73*	1.00	0.41*
PEFR	0.06	0.01	-0.13	0.69*	0.71*	0.03	0.41*	1.00

Tab. 6. Correlation coefficient between chosen parameters of biological development in the group of boys from rural areas *p<0.05

Feature	Body height	Body mass	Sum of fat folds	FVC	FEV1	FEV1 /FVC	FEF 25-75%	PEFR
Body height	1.00	0.67*	0.41*	-0.24	-0.39*	-0.14	-0.05	-0.05
Body mass	0.67*	1.00	0.83*	-0.18	-0.32	-0.13	-0.05	-0.10
Sum of fat folds	0.41*	0.83*	1.00	-0.29	-0.32	-0.01	-0.06	-0.09
FVC	-0.24	-0.18	-0.29	1.00	0.81*	-0.26	0.20	0.04
FEV1	-0.39*	-0.32	-0.32	0.81*	1.00	0.34	0.68*	0.20
FEV1/FVC	-0.14	-0.13	-0.01	-0.26	0.34	1.00	0.84*	0.19
FEF 25-75%	-0.05	-0.05	-0.06	0.20	0.68*	0.84*	1.00	0.24
PEFR	-0.05	-0.10	-0.09	0.04	0.20	0.19	0.24	1.00

Tab. 7. Correlation coefficient between chosen parameters of biological development in the group of girls from urban areas *p<0.05

Feature	Body height	Body mass	Sum of fat folds	FVC	FEV1	FEV1 /FVC	FEF 25-75%	PEFR
Body height	1.00	0.55*	0.24	-0.33	-0.39	0.23	-0.31	-0.17
Body mass	0.55*	1.00	0.50*	0.18	0.07	-0.26	-0.27	-0.15
Sum of fat folds	0.24	0.50*	1.00	0.10	-0.07	-0.24	-0.42	0.10
FVC	-0.33	0.18	0.10	1.00	0.94*	-0.79*	-0.07	0.04
FEV1	-0.39	0.07	-0.07	0.94*	1.00	-0.55*	0.21	0.23
FEV1/FVC	0.23	-0.26	-0.24	-0.79*	-0.55*	1.00	0.50	0.40
FEF 25-75%	-0.31	-0.27	-0.42	-0.07	0.21	0.50*	1.00	0.70*
PEFR	-0.17	-0.15	0.10	0.04	0.23	0.40	0.70*	1.00

Tab. 8. Correlation coefficient between chosen parameters of biological development in the group of girls from rural areas *p<0.05

Feature	Body height	Body mass	Sum of fat folds	FVC	FEV1	FEV1 /FVC	FEF 25-75%	PEFR
Body height	1.00	0.64*	0.53	-0.36	-0.50*	-0.16	-0.30	-0.17
Body mass	0.64*	1.00	0.90*	-0.01	-0.05	0.01	0.04	-0.06
Sum of fat folds	0.53*	0.90*	1.00	-0.02	-0.06	-0.01	0.02	-0.16
FVC	-0.36	-0.01	-0.02	1.00	0.90*	-0.38*	0.49*	0.48*
FEV1	-0.50*	-0.05	-0.06	0.90*	1.00	0.04	0.77*	0.61*
FEV1/FVC	-0.16	0.01	-0.01	-0.38*	0.04	1.00	0.52*	0.18
FEF 25-75%	-0.30	0.04	0.02	0.49*	0.77*	0.52*	1.00	0.63*
PEFR	-0.17	-0.06	-0.16	0.48*	0.61*	0.18	0.63*	1.00

Discussion

When elementary developmental parameters of boys and girls from both environments were compared, in most cases no statistically significant differences between them were stated. This confirms numerous earlier reports [16, 17]. But according others opinion, physical development depends on the place of residence [18].

In the case of height, body mass and fat tissue, boys from the city achieved slightly higher values than their peers from the countryside. The reverse situation occurred in the case of groups of girls, where advantage in two of these parameters (body mass and fat tissue) was achieved by girls from the countryside. In all cases, however, those differences were statistically insignificant. Minimum differentiation was also observed in male groups when applying measurements of body mass. In the case of body height, statistical difference was found only between girls from urban and rural environments, with advantage urban girls ($p<0.01$).

Another group of parameters of biological development that was measured were breathing indicators of lungs, closely described in literature [19, 20, 21]. The analysis included forced vital capacity (FVC), forced expiratory volume during the first second of expiration (FEV1), ratio of FEV1 to FVC, forced expiratory flow at 25%-75% of FVC (FEF 25%-75%) and the indicator of peak expiratory flow rate (PEFR). The results presented in the tables constitute reference values resulting from the weight–height and age index specific for each tested person. The spirometric test did not indicate statistically significant differences in both sexes, and it was confirmed for children less than 14 years of age [21, 22] (with the exception of girls PEFR - $p<0.01$) taking into consideration different as far as ecological conditions places of residence. However, in the group of girls and boys almost all indicators were slightly better in the rural group. Earlier data analyse this issue in the aspect of air pollutants and show limits of fitness indicators in time of exercise in polluted air [23, 24]. But there is an opposite assumption when contaminants result in a kind of negative adaptation, and people from urban areas have better ventilation parameters [25, 26].

Girls have represented higher values than boys in % of normal values. This fact has already been noticed by a Polish author [27]. Characteristic is the fact that, excluding the ratio of FEV1/FVC and female FVC, all the tested groups achieved results below reference values in the case of all parameters.

Statistical analysis also concerned determining coefficients of correlation between all the analysed parameters in the case of all 4 groups subject to tests (boys from the town and village and girls from town and village). In all the groups essential statistical correlations were observed between the height and body mass and the thickness of the fatty tissue, as was the case in earlier research on youth from urban environment [28].

In the group of town and village children there was no correlation noted between body weight, the fatty tissue and respiratory indicators of lungs. In numerous cases a correlation between particular respiratory indicators was observed. In the case of boys and girls from the village, a correlation between body height and indicator FEV1 was indicated. A correlation between body height and ventilation parameters has been discovered by many authors [29, 30, 31]. Other researchers confirmed that body mass and fatty tissue do not correlate with parameters of the ventilatory system [32, 33, 34].

Conclusions

The results of tests incline to drawing the following conclusions. The assumption that the place of residence and associated with it different ecological conditions influence biological development indicators seems to be untrue with reference to the tested group of pupils. In the tested groups only one essential statistical difference was determined concerning body height of town and country girls. Opinions established in many years that citizens of large towns prefer a sitting style of life in comparison to country dwellers and that there are differences in fat deposition resulting from it do not find confirmation in these tests. In the present studycase, these are country girls who prove to have a higher level of fat deposition in comparison with their city peers. Lack of any statistically essential differences within elementary ventilation parameters of the respiratory system makes us reject the assumption drawn from numerous foreign sources that the sanitary conditions of air in the place of residence substantially modify respiratory parameters. The tests have also indicated the existence of close correlations between the height, body mass and thickness of fatty tissue, but few relationships between these parameters and particular respiratory indicators of lungs. Respiratory indicators, however, frequently find themselves in close correlations, but these correlations are more numerous in groups of girls, which would indicate that they are conditioned by sex to a greater extent than the environment in which they live.

References

1. De Toia D, Klein D, Weber S, et al. Relationship between anthropometry and motor abilities at pre-school age. *Obes Facts* 2009;2(4):221-225.
2. Graf C, Koch B, Kretschmann-Kandel E, et al. Correlation between BMI, leisure habits and motor abilities in childhood (CHILT-project). *Int J Obes Relat Metab Disord* 2004;28(1):22-26.
3. D'Hondt E, Deforche B, Vaeyens R, et al. Gross motor coordination in relation to weight status and age in 5- to 12-year-old boys and girls: a cross-sectional study. *Int J Pediatr Obes* 2011;6(2-2):556-564.
4. Lopes VP, Stodden DF, Bianchi MM, Maia JA, Rodrigues LP. Correlation between BMI and motor coordination in children. *J Sci Med Sport* 2011 Aug 8 [Epub ahead of print].

5. Cruz C, Sequeira S, Gomes H, Pinto D, Marques A. Relationship between physical fitness, physical activity and body mass index of adolescents. *Br J Sports Med* 2011;45(15):8-9.
6. Jethon Z. Subclinical heavy metal intoxication changes the ability to physical effort. In: *XII Weltkongress für Arbeitsschutz*. Hamburg; 1990, 132.
7. Joens-Matre RR. Welk GJ, Calabro MA, Russell DW, Nicklay E, Hensley LD. Rural-urban differences in physical activity, physical fitness, and overweight prevalence of children. *J Rural Health* 2008;24(1):49-54.
8. Liu J, Bennett KJ, Harun N, Probst JC. Urban-rural differences in overweight status and physical inactivity among US children aged 10-17 years. *J Rural Health* 2008;24(4):407-15.
9. Peacock JL. Acute effects of winter air pollution on respiratory function in schoolchildren in southern England. *Occup Environ Med* 2003;60:82-89.
10. Pyżuk M. Rozwój dziecka a wrażliwość na czynniki środowiska [in Polish] [The development of a child and sensitivity to environmental factors]. Warszawa: PWN; 1974.
11. Shepard RJ. Athletic performance and urban air pollution. *Can Med Assoc J* 1984;131(2):105-109.
12. Plotnikoff RC, Bercovitz K, Loucaides CA. Physical activity, smoking, and obesity among Canadian school youth. Comparison between urban and rural schools. *Can J Public Health* 2004;95(6):413-8.
13. Bruner MW, Lawson J, Pickett W, Boyce W, Janssen I. Rural Canadian adolescents are more likely to be obese compared with urban adolescents. *Int J Pediatr Obes* 2008;3(4):205-11.
14. Schwela D. Air pollution and health in urban areas. *Res Environ Health* 2000;15(1-2):13-42.
15. Lohman TG. The use of skinfolds to estimate body fatness in children and youth. *J Physical Educ Recr Dance* 1987;58(9):98-102.
16. Domaradzki J, Ignasiak Z. Disparity in the development level of somatic and functional traits in children living in areas of different pollution level. *Human Movement* 2002;1(5):14-20.
17. Bocheńska Z. Rozwój fizyczny dziecka w środowisku przemysłowym [in Polish] [Physical development of a child in industrial environment]. *Zeszyty Naukowe AWF Kraków* 1984:31.
18. Reyes ME, Tan SK, Malina RM. Urban-rural contrasts in the growth status of school children in Oaxaca, Mexico. Ann Hum Biol 2003;30(6):693-713.
19. Glew RH, Kassam H, Vandert Voort J, Agaba PA, Harkins M, VanderJagt DJ. Comparison of pulmonary function between children living in rural and urban areas in northern Nigeria. *J Trop Pediatr* 2004;50(4): 209-216.
20. Asgari MM, DuBois A, Asgari M, Gent J, Beckett WS. Association of ambient air quality with children's lung function in urban and rural Iran. *Arch Environ Health* 1998;53(3):222-230.
21. Armstrong N, Kirby BJ, McManus AM, Welsman JR. Prepubescents' ventilatory responses to exercise with reference to sex and body size. *Chest* 1997;112(6):1554-1560.
22. Doherty M, Dimitriou L. Comparison of lung volume in Greek swimmers, land based athletes, and sedentary controls using allometric scaling. *Br J Sports Med* 1997;31(4):337-341.
23. Carlisle A, Sharp N. Exercise and outdoor ambient pollution. *Br J Sp Med* 2001;35:214-222.
24. Folinsbee LJ. Pulmonary function changes after 1 h continuous heavy exercise in 0.21 ppm ozone. *J Appl Physiol* 1984;57(4):984-988.
25. Hazucha MJ. Relationship between ozone exposure and pulmonary function changes. *J Appl Physiol* 1987;62(4):1671-1680.
26. Kopp MV, Ulmer C, Ihorst G, et al. Upper airway inflammation in children exposed to ambient ozone and potential signs of adaptation. *Eur Respir J* 1999;14(4):854-861.
27. Rożek K. Wybrane parametry wentylacyjne płuc w aspekcie poziomu zdolności motorycznych dzieci i młodzieży [in Polish] [Chosen lung ventilation parameters in context of children and young people's motor abilities]. Monografie AWF Wrocław; 2006, 84.
28. Antal M, Péter S, Biró L, et al. Prevalence of underweight, overweight and obesity on the basis of body mass index and body fat percentage in Hungarian schoolchildren: representative survey in metropolitan elementary schools. *Ann Nutr Metab* 2009;54(3):171-176.
29. Burrows B, Cline MG, Knudson RJ, Taussig LM, Lebowitz MD. A descriptive analysis of the growth and decline of the FVC and FEV1. *Chest* 1983;83(5):717-724.
30. Quanjer PH, Stocks J, Polgar G, Wise M, Karlberg J, Borsboom G. Compilation of reference values for lung function measurements in children. *Eur Respir J Suppl* 1989;4:184-261.
31. Malina RM, Bouchard C, Bar-Or O. Growth, maturation and physical activity. Champaign IL: Human Kinetics Books; 2004.
32. Arkinstall W, Nirmel K, Klissouras V, Milic-Emili J. Genetic differences in the ventilatory response to inhaled CO_2. *J Appl Physiol* 1974;36:6-11.
33. Bouchard C, Malina RM. Genetics of physiological fitness and motor performance. *Exerc Sport Sci Rev* 1983;11:306-339.
34. Lewitter F, Tager I, McGue M, Tishler P, Speizer F. Genetic and environmental determinants of level of pulmonary function. *Am J Epidemiol* 1984;120(4):518-530.