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DOMINANT DETERMINANTS IN CARDIO-RESPIRATORY ENDURANCE IN 13 YEARS OLD BOYS AND GIRLS

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Abstract

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Aim of the study: The purpose of the research was to establish correlations between cardio-respiratory endurance (C-RE) and biological maturity rate (retarded, normal and accelerated), body height, body mass, sum of five skinfolds, frequency of undertaking physical activity (PA), and onset of menarche (in girls).

Methods: Research has been carried out in the selected schools in Poznań City and included 237 girls (13.3 y.o. SD 0.24) and 231 boys (13.2 y.o. SD 0.32). The 20m shuttle run test (the endurance run), from the battery of the Eurofit test, has been used to assess C-RE, accordingly to the protocol. The 20m shuttle run test results have been introduced as results of C-RE level. Selected morphological characteristics (body height, body mass and five skinfolds) have been measured.

Results of the statistical complete linkage analysis (furthest neighbor rule) are similar in girls and boys and show two major gatherings of variables. Results of C-RE indicate that only normally mature girls have achieved significant relations between scores of the 20m shuttle run and body mass ($r=-0.16$; $p\leq0.05$). Both in the case of girls and boys there is a significant relation between scores of the 20m shuttle run and sum of skinfolds (for girls $r=-0.28$; for boys $r=-0.21$; $p\leq0.05$). Similarly, the more frequent PA of girls and boys declared in their leisure time the better results they have gained in the 20m shuttle run test (for girls $r=0.24$; for boys $r=0.21$; $p\leq0.05$). The sum of skinfolds influences on the results of endurance run the most strongly only in accelerated girls ($r=-0.44$). Boys with thicker layer of subcutaneous fat have gained worse results in the 20m endurance run. Results of the endurance run together with frequency of undertaking PA are associated with the biological stages of development.

Conclusions: There is a low dimorphic differentiation of 13 y.o. girls and boys, not significant, due to the relatively high homogeneity of the examined groups.

Key words: *Adolescents, girls, boys, cardio-respiratory endurance, physical activity*

Introduction

The period of puberty is associated with changes in body stature and body composition, and influences on physical and motor fitness. Exercises of adequate intensity and duration of stimulating cardio-respiratory fitness seem to be an essential part of human development. Ara et al. (1) have observed that active prepubertal children (9.5 y.o.) attain better results in aerobic fitness than non-active, and additionally their $\dot{V}O_2max$ has shown negative correlation with fat mass. An increased PA over a long period of time already results in improved physical fitness in younger (5-6 y.o.) children (2). On the other hand obesity among children and youth increases with sedentary behaviour (3). Hence, a review of empirical studies about TV, video, computer consumption and body fatness and PA suggests small relationships between those variables (4).

It can be possible that correlation between the level of activity, fitness and fatness depends on differentiation in biological age. It has been reported that maturation is directly related to growth and exercise performance characteristics (5). Children at the same age can present different levels of physical fitness due to their individually different maturity rates (6). Thus it is difficult to specify determinants of aerobic fitness.

The important determinant which can play a crucial role in fitness is gender, especially among pubertal and older boys and girls. Sexual dimorphism differentiates metabolic processes, body composition and level of motor abilities (7–10). However, Saar and Jürimäe (11) have proved that in 13-15 y.o. girls anthropometric parameters have been only in 10-20% of the total variance of motor ability tests. Not only body building differentiates boys from girls. In traditional subsistence populations the workload must be shared among all family members, and thus strict division of tasks is present accordingly to age and sex (12). Males are generally in charge of high-energy-demanding muscular task (13). There are also differences according

to age and maturation. Less mature females are more active than more mature ones (14).

The aim of the research is to establish correlations between C-RE (measured as scores of the 20m shuttle run test) and such determinants as: biological maturity rate, body height, body mass, sum of five skinfolds, frequency of undertaking PA, and onset of menarche (in girls).

Material and Methods

Research has been carried out in the selected schools in Poznań City and included 237 girls (13.3 y.o. SD 0.24) and 231 boys (13.2 y.o. SD 0.32). The 20m shuttle run test, from the battery of the Eurofit test, has been used to assess C-RE endurance, accordingly to the protocol (15). The 20m shuttle run test results have been introduced as results of C-RE level. Selected morphological characteristics (body height, body mass and five skinfolds of biceps, triceps, subscapular, suprailiac, and calf) have been measured. The each gender group is divided into three developmental stages: retarded, normal and accelerated in regard to S. Pavilonis's method (16) based on indices of the developmental stages of forehead and pubic hair, growth of breasts, type of body building and presence of menstruation in girls (Tab. 1). A pupil in the normal stage of development is within the score -20 to +20 of Biological Maturity Rate, the retarded stage - below the score -20, and accelerated above the score +20. Examination has been carried out by a qualified physician. A Self-Evaluation Physical Activity questionnaire has been developed in this work by Bronikowski to evaluate the frequency of individual PA.

The Pearson's correlation method has been applied to establish relations between C-RE and selected determinants. Then, in turn, a complete linkage analysis has been used to differentiate subgroups and cluster objects based on the maximum distance between them. This method has been employed to get a picture of possible connections.

Results

C-RE evaluated by the 20m shuttle run test has been previously estimated and reported by Bronikowski et al. (17) as a good example to measure the level of aerobic endurance in adolescents.

Results of the complete linkage analysis are similar in 13 y.o. girls and boys and show (Fig. 1) two major gatherings of variables. In girls in the first gathering results of an endurance run (C-RE) together with the frequency of undertaking PA (frequency of PA) join biological maturity rate (Tanner' stage) and onset of menarche (menarcheal age). In the second gathering body mass is associated with the sum of skinfolds. Re-

Table 1. *Anthropometric characteristics, frequency of P A and results of the 20m shuttle run test (level of endurance) in girls and boys*

		Girls N=237			Boys N=231		
		retarded	normal	accelerated	retarded	normal	accelerated
body height [cm]	M	159.9	160.7	165.5	153.3	161.7	164.3
	SD	10.08	6.23	11.43	8.82	7.13	11.62
body mass [kg]	M	46.4	48.3	54.6	40.3	48.7	53.9
	SD	13.01	8.01	13.24	7.33	8.97	20.28
sum of five skinfolds [mm]	M	66.3	65.2	71.7	42.3	51.5	62.7
	SD	31.77	20.87	31.79	15.47	18.68	27.89
level of PA [frequency per week]	M	1 x per week	2 x per week	1 x per week	3-4 x per week	3-4 x per week	2 x per week
	SD	1.66	1.74	1.96	1.97	1.74	1.52
level of endurance [minutes of run]	M	3.7	4.8	4.3	6.1	6.0	4.7
	SD	1.46	1.89	1.84	2.32	2.22	1.85

M – mean; SD – standard deviation

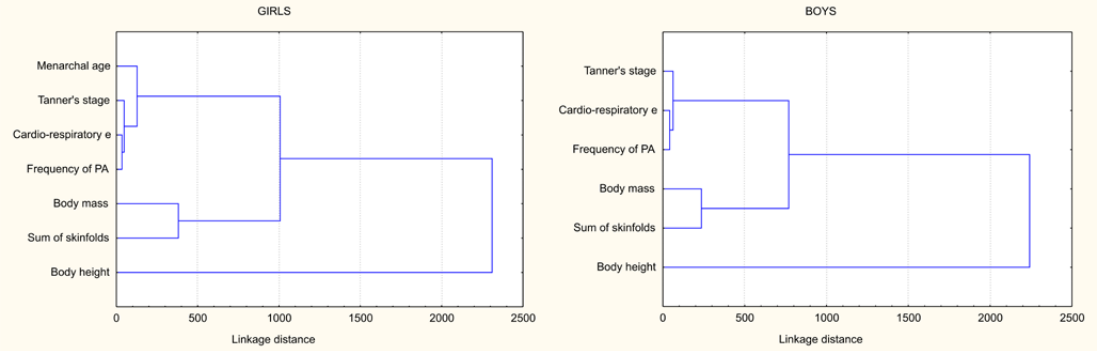

Fig.1. *Results of the complete linkage analysis in 13 y.o. girls and boys*

Table 2. *Values of Pearson's coefficient correlation in girls and boys between C-RE as dependent variable and selected determinants as independent variables*

	Girls N=237			Boys N=231		
developmental stages	retarded	normal	accelerated	retarded	normal	accelerated
age of menarche	-0.26	0.13	-0.13	--	--	--
body height	0.27	-0.05	-0.11	0.08	-0.07	0.07
body mass	0.02	-0.16*	-0.30	-0.12	-0.06	0.26
sum of skinfolds	-0.43	-0.28*	-0.44*	-0.21	-0.21*	-0.27
frequency of PA	0.33	0.24*	0.25	0.08	0.21*	-0.24

* $p \leq 0.05$

sults of the endurance run together with frequency of undertaking PA are associated with biological stages of development (Tanner's stages). The second gathering involves body mass and the sum of skinfolds, too.

Results of C-RE (Tab. 2) indicate that only normally mature girls have achieved significant relations between scores of the 20m shuttle run and body mass ($r=-0.16$; $p \leq 0.05$). Both in the case of girls and boys there is a significant relation between scores of the 20m shuttle run and sum of skinfolds (for girls $r=-0.28$; for boys $r=-0.21$; $p \leq 0.05$). Similarly, the more frequent PA of girls and boys declared in their leisure time the better results they have gained in the 20m shuttle run test (for girls $r=0.24$; for boys $r=0.21$; $p \leq 0.05$). The sum of skinfolds influences on endurance the most strongly only in accelerated girls ($r=-0.44$). Boys with thicker layer of subcutaneous fat have gained worse results in the 20m endurance run. Results of the endurance run together with frequency of undertaking PA are associated with the biological stages of development. There is a low, statistically insignificant dimorphic differentiation of 13 y.o. girls and boys, probably due to the high homogeneity of the examined groups.

In case of 13 y.o. boys results of C-RE positively correlate with frequency of PA ($r=0.21$; $p \leq 0.05$), and negatively with sum of skinfold thickness ($r=-0.21$, $p \leq 0.05$). Boys with thicker layer of subcutaneous fat have gained worse results in the 20m endurance run (Tab. 2).

Discussion

The introduced study shows difficulties in the simple clear-cut determination of the most essential determinants of C-RE, in particular stages of development: retarded, normal, and accelerated. Biological age is the determinant "disturbing" a value of correlation's coefficient between C-RE and frequency of PA. Garnier and Benefice (14) have observed that less mature girls are more active than more mature ones. Our study indicates that this relation is statistically significant only in normally mature girls and boys. Additionally, an increase of fat mass with age and a decrease with age of muscle mass in girls has also been reported (18,19).

In both groups of 13 y.o. girls and boys a statistically significant ($p \leq 0.05$) relation between the result of the 20m shuttle run test (C-RE), body mass, sum of five skinfolds, and level of activity (frequency of PA) have been noticed (Tab. 2). Only in a stage of normal development sum of skinfolds and frequency of PA indicate significance for the endurance level. In normally developed girls it has been also body mass stressed (Tab. 2). It is worth underlying in regard to their declared frequency of PA because this frequency is almost accordant to the level of PA really represented by them. It proves the role and potential effectiveness of education in the increase of their responsibility for own health and also introduction of ability in body care and health monitoring. It gives also a hope to achieve a success in improvement of youth's scan health. In retarded and accelerated stages of development the lack of statistical significance (in the case of relatively high values) can show probably too less number of subjects within examined groups (about 20-25 subjects). Hence, a tendency of this influence can be observed – frequency of PA seems to be an important predictor of a determinant of C-RE. It is shown in our study (Tab. 2) and also reported in other reports mentioned earlier (1–4). In any case active adolescent girls and boys have higher values of $\dot{V}O_2max$ than their less active peers and the decline of aerobic fitness in both genders is mainly caused by the decrease of daily level of PA (9). However, it is necessary to add that some researches show only small relationships between those variables (4).

In our study very similar relations observed between C-RE and other determinants as independent variables can lead to the conclusion of the relatively low dimorphic differentiation of 13 y.o. girls and boys in examined groups. It is expressed only at the beginning of the stage of puberty while Maciaszek (20) in his earlier study shows the different formula of relationship (linear versus non-linear) between C-RE and other variables can be different among boys and girls at the same age, particularly around the age of 14.

The weak relationship between C-RE and frequency of PA in both genders (Tab. 2) supports the conclusions inclosed earlier in other research (8 – 10) that physical fitness is determined by genetic factors as much as by environmental and cultural ones. In the examined age category of 12-14 y.o. adolescents, in the case of endurance, it is also due to the change of structure and functional capacity of lungs and respiratory system at this age (21).

Thus, the level of biological development in association with an adequate level of PA is a condition of related level of aerobic endurance. Additionally, there is already a correlation between the level of physical fitness and a thickness of skinfolds in children (10). Body mass appears to be one of the determinants modulating power and mutual correlation of the introduced determinants. Such a tendency is also reflected here in results of Pearson's linear correlation but only for girls (Tab. 2). C-RE also proves its relation to sum of skinfolds in both genders (Tab. 2). In regard to the idea of health related-fitness (22) it needs to be taken under the consideration while planning the amount and the level of PA sufficient for stimulation of biological development in youth.

Conclusions

1. Menarcheal age in girls and body height in both genders have no influence on the level of endurance.
2. Body mass influences on the level of endurance only in girls.
3. Results of the endurance run together with sum of five skinfolds and frequency of undertaking PA are associated with the biological stages of development.
4. There is a low dimorphic differentiation of 13 y.o. girls and boys in the examined group.

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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