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Health-Related Physical Fitness, BMI, physical activity and time spent at a computer screen in 6 and 7-year-old children from rural areas in Poland

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Abstract

The objective of the study was determination of the effect of various forms of physical activity, BMI, and time devoted to computer games on the level of Health-Related Physical Fitness (H-RF) in 6–7-year-old children from Polish rural areas. The study covered 25,816 children aged 6–7: 12,693 girls and 13,123 boys. The evaluations included body height and weight, and 4 H-RF fitness components (trunk strength, explosive leg power, arm strength and flexibility). The BMI was calculated for each child. The Questionnaire directed to parents was designed to collect information concerning the time devoted by children to computer games, spontaneous and additional physical activity. The strength of the relationships between dependent and independent variables was determined using the Spearman's rank correlation (R_{sp}), and the relationship by using the regression analysis. The BMI negatively affected the level of all the H-RF components analysed (p=0.000). The negative effect of computer games revealed itself only with respect to flexibility (p=0.000), explosive leg power (p=0.000) and trunk muscle strength (p=0.000). A positive effect of spontaneous activity was observed for flexibility (p=0.047), explosive leg power (p=0.000), and arm strength (p=0.000). Additional activity showed a positive relationship with trunk muscles strength (p=0.000), and explosive leg power (p=0.000). The results of studies suggest that it is necessary to pay attention to the prevention of diseases related with the risk of obesity and overweight among Polish rural children as early as at pre-school age. There is also a need during education for shaping in these children the awareness of concern about own body, and the need for active participation in various forms of physical activity.

Key words

Health-Related Physical Fitness, physical activity, sedentary behaviours, child development

INTRODUCTION

According to the AAHEPERED assumptions [1984], physical fitness is identified with the concept of human health, for it allows an efficient functioning during the day, as well as undertaking various forms of physical activity during free time. Adaptation in unexpected or critical situations is also important from the aspect of the further functioning of an individual. Hence, the Health-Related Fitness (H-RF) components include: cardiovascular endurance, muscle strength, endurance, flexibility and body composition [1].

The level of physical fitness (H-RF), similar to other elements of life style, including physical activity and inactive behaviours, is engaged in the etiology and occurrence of many non-infectious general diseases, such as: cardiovascular diseases, diabetes, selected types of cancer, and is also among the risk factors for arterial hypertension or obesity [2, 3, 4]. Although the majority of these alarming states concern adults, some of them – overweight and obesity – occur already from the youngest age [5, 6]. Hence, at present, a greater emphasis is placed on the monitoring of the H-RF level in the groups of children and adolescents. Preventive actions also concern the implementation into practice the recommendations for an everyday, moderate physical activity for at least 60 minutes daily [6], limitation of passively spent time [7], as well as making parents and their children aware of the importance of adequate nutrition [8] and skilful shaping of the psychomotor potential as early as from the youngest age [6].

Many epidemiological and intervention studies emphasize that strong relationships between the level of H-RF, physical activity, BMI, and sedentary forms of leisure are observed already in childhood [9]. Inactive forms of leisure (watching television, computer games, etc.) are responsible for the reduction in the level of physical activity and, together with inadequate nutrition, constitute an important predictor of increased frequency of overweight and obese children, and decreased physical activity [7]. In turn, a high level of physical activity considerably reduces body weight and unfavourable height-weight ratio, limits the time devoted to sedentary behaviours, and favours the attaining of an optimum physical fitness, its general indicators and individual components [10]. The relationships observed are the cause of changes in the shaping of the future image of the health of society; therefore, negative relationships evoke justifiable concerns, and cause not only instant, but also long-term health and psycho-social consequences [11].

The scope of problems identified most often refer to cardiovascular fitness, whereas other components are more

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rarely examined. Apart from this, the majority of scientific reports available concern children and adolescents at the age of puberty, as well as adults. The reports concerning pre-school children are scarce, and the varied methodology of research does not allow a more comprehensive view of the phenomenon discussed. Also, it is not known at which moment of ontogenesis of a child a tendency towards body fatness may reveal itself, and a decrease in positive indicators of health as a result of inhibition of spontaneous physical activity and increased importance of sedentary behaviours. The problem undertaken is interesting, especially with respect to the rural environment.

It is known that during the period of political transition in Poland, civilisation changes took place which, to this day, brought undesirable health effects exclusively among inhabitants of large city agglomerations. This alarming state is enhanced by the fact that Polish rural areas are not prepared for the compensation of hazards resulting from civilisation changes. In addition, the report concerning the level of maturity of children aged 6 shows that approximately 90% of pre-school rural children play computer games for various amount of time; about 80% of them do not participate in any additional physical exercises, and 60% show intensive spontaneous physical activity during the day. Additionally, the level of fitness of rural children is lower [12]. The above-mentioned facts inclined the authors to deal with the problem of physical fitness, approached according to the H-RF concept, and its conditioning in children living in the rural environment.

Objective. The primary goal of the presented study was evaluation of the effect of various types of physical activity and ways of spending leisure time by Polish rural children aged 6–7 on their health indicators. It is noteworthy that to-date no such report has been found with respect to 6–7-year olds from the rural regions of Poland.

MATERIALS AND METHOD

The research material were results concerning 25,816 children aged 6–7 – 12,693 girls and 13,123 boys from Polish rural areas. The representative study was conducted in 2006 during April-June and September-November. Approximately 10% of the population of children born in 1999 and 2000 were examined. The procedure of stratified sampling was used developed according to the Educational Information System programme and up-dated by the Main Statistical Office. This procedure covered the division into administrative regions, type of educational facility, and place of residence. In this way, approximately 10% of the population of Polish children born in 1999 and 2000 were selected for the study. The anthropometric and physical fitness measurements were performed using a battery of EUROFIT tests. Only components related to the Health Related Fitness concept were selected for analysis [1]: flexibility, explosive leg power, and trunk muscle strength and functional arm strength. In the case of arm and shoulder strength, an abbreviated version of the trial was applied [12].

Information concerning sedentary behaviours and the level of children's physical activity were collected by means of a diagnostic survey conducted among parents of the children in the study, with the use of a questionnaire form in which the parents declared the time devoted by their children to computer games, daily spontaneous activity, and organized activity during the week. Categorized replies were used and supplemented with time values (minutes and hours). In the case of categorization of the BMI, a centile level was adopted with cut-off points of 5, 85 and 95 centile.

Basic statistical characteristics were calculated in the selected age groups. The strength of the relationships was assessed using the non-parametric χ^2 test and Spearman's rank correlation. The relationship between independent (forms of physical activity) and dependent (H-RF fitness components) variables were determined based on backward elimination analysis of regression. The significance of the strength of correlations was verified using t°-Student test and Snedecor's F-test in accordance with the number of groups compared. The p values $p \leq 0.05$ were considered statistically significant. The calculations were performed by means of statistical package SPSS 12.0.

RESULTS

Based on percentile point values for the BMI, 4 groups of children were selected: normal weight (76%-boys, 68.2%-girls), underweight (8.5%-boys, 13.0%-girls), overweight (11.4%-boys, 10.6%-girls) and obese (9.4%-boys, 8.2%-girls). A significant relationship was observed between gender and the BMI ($p \leq 0.000$). A higher percentage of girls than boys were underweight, while boys were overweight and obese more often than girls (Tab.1). Also, the time devoted to computer games was significantly related with the respondents' gender ($p \leq 0.000$). Among children who did not play computer games, the percentage of girls was slightly higher, whereas boys dominated in the group of children who played for longer

Table 1. Basic characteristics of 6–7-year-old children from Polish rural areas

VARIABLES	Boys		Girls		
	$\bar{x}$	s_d	$\bar{x}$	s_d	
Age	6.56	0.42	6.56	0.42	
BMI	Boys		Girls		
	N	%	N	%	
underweight	1,198	8.5	1,750	13.00	χ^2=149.903 (df=3) p=0.000
2 – normal weight	9,902	70.6	9,168	68.2	
3 – overweight	1,594	11.4	1,424	10.6	
4 – obese	1,322	9.4	1,098	8.2	
Computer games					
Not at all	368	2.8	438	3.6	χ^2=19.445 (df=3) p=0.000
A few minutes a day	768	5.9	761	5.9	
An hour a day	5,078	38.7	5,106	40.2	
More than an hour a day	6,909	52.6	6,388	50.3	
Spontaneous physical activity					
Inactive	2,028	16.7	2,514	21.5	χ^2=143.060 (df=2) p=0.000
An hour a day	7,097	58.5	6,908	59.0	
Active all the time	3,005	24.8	2,293	19.5	
Additional physical activity					
Not at all	11,349	87.6	10,798	12.7	χ^2=33.942 (df=2) p=0.000
Twice a week	1,398	10.8	1,589	12.7	
More than twice a week	205	1.6	133	1.1	

than an hour: (52.6% vs. 50.3%) (Tab. 1). The child's gender was also significantly related with spontaneous activity (p=0.000). In the group of physically inactive children there were more girls (16.7% vs. 21.5%), whereas boys prevailed in the category of active all the time (24.8% vs. 19.5%). It is an alarming fact that nearly 90% of the total number of respondents (boys -87.6%, girls – 86.2%) from rural areas did not participate in any additional (paid) physical education classes. Parents of girls more frequently than those of boys cared for the participation of their daughters in additional forms of physical activity (p=0.000) (Tab. 1).

Significant differences in the level of the H-RF components examined were observed by gender (Tab. 2). Boys attained better results in trunk muscles strength (p=0.000), arm strength (p=0.000), and explosive leg power (p=0.000); however, compared to girls, they obtained a lower level of body flexibility (p=0.000).

Table 2. BMI and Physical Health-Related Fitness of 6–7-year-old Polish children

PF*	Boys (N=13960)		Girls (N=13413)		p
	$\bar{x}$	s_d	$\bar{x}$	s_d	
BMI	16.06	2.304	15.78	2.27	0.000
F	0.45	5.266	1.84	5.131	0.000
ELP	97.20	20.223	90.44	18.40	0.000
TS	8.51	5.376	8.08	5.233	0.000
FSA	29.83	22.088	26.24	19.83	0.000

*PF – physical fitness; BMI – body mass index; F – flexibility; ELP – explosive leg power; TS – trunk strength; FSA – functional strength of arm.

Table 3 demonstrates the values of Spearman's R correlation for the H-RF components analyzed, BMI, time devoted to computer games and 2 distinguished manifestations of physical activity. In all gender groups and the total sample, significant relationships were found between the BMI and explosive leg power (Spearman's R from -0.076 -0.057), trunk muscles strength (Spearman's R values from -0.18 -0.022), and arms strength (from -0.151 -0.167). The direction of the correlations obtained was negative and the values relatively low. No relationship was noted between the BMI and body flexibility.

Correlations between time devoted to computer games and H-RF components were also negative. In the total study group and in boys, statistically significant relationships were observed with respect to flexibility (r=-0.22 – total number of children and -0.022 – boys), and trunk muscles strength (boys: r=-0.024, total r=-0.024). Among girls, a relationship was noted only between computer games and trunk muscles strength (r=-0.037).

The distinguished manifestations of physical activity showed a positive, although inconsistent effect on H-RF components. In the total group of children in the study and among girls, spontaneous activity significantly affected explosive leg power (r=0.027 and r=0.024, respectively). In addition, in the total group and in boys, a significant relationship was found between spontaneous activity and arms strength (r=0.017 and r=0.023, respectively), and flexibility in boys (r=0.020). The differences according to additional physical activity were noted only for 2 strength components: explosive leg power (values within the range r=0.035: boys –0.050: girls), and trunk muscle strength (values within the range from r=0.018: girls – r=0.026: boys).

In order to specify the strength of the effect of the above-mentioned characteristics on the level of H-RF, multiple regression analysis was performed by the method of backward elimination (Tab. 4). This method allowed selection of the ultimate models of variables for each of the fitness components which were statistically significant: flexibility: F=130.350, p=0.000, explosive leg power: F=760.620, p=0.000, trunk muscle strength: F=610.754, p=0.000 strength of arms and shoulder girdle: F=2630.434, p=0.000. The predictors selected explained jointly from 0.2% (flexibility) to 2.2% (explosive leg power) of common variability of the H-RF components analyzed. Only for explosive leg power all the independent variables examined were significant. Two of them, BMI (p=0.000) and time devoted to computer games

Table 3. Spearman's correlation between H-RF components and BMI – time devoted to computer games and physical activity

PF	BMI	Computer games	Spontaneous PA	Organized PA
Total				
Flexibility	-0.006	-0.022**	0.006	0.003
Explosive leg power	-0.057**	-0.008	0.027**	0.038**
Trunk strength	-0.018**	-0.030**	-0.012	0.021**
Functional strength of arm	-0.151**	-0.004	0.017**	-0.003
Girls				
Flexibility	0.009	-0.013	0.014	0.008
Explosive leg power	-0.064**	-0.002	0.024**	0.050**
Trunk strength	-0.022*	-0.037**	-0.018	0.018**
Functional strength of arm	-0.167**	-0.005	0.000	0.002
Boys				
Flexibility	-0.003	-0.024**	0.020**	-0.008
Explosive leg power	-0.076**	-0.017	0.006	0.035**
Trunk strength	-0.020**	-0.024**	-0.007	0.026**
Functional strength of arm	-0.151**	-0.006	0.023**	-0.006

*p≤0.05; **p≤0.01

Table 4. Regression analysis (backward elimination procedure) for physical fitness components in 6–7-year-old children

Predictors	B	β	SE	P	R	R^2
Flexibility						
Computer games	–0.243	–0.034	0.047	0.000	0.041	0.002
Spontaneous Physical Activity	0.109	0.013	0.055	0.047		
BMI	–0.165	–0.023	0.047	0.000		
Explosive leg power						
Computer Games	–0.802	–0.030	0.177	0.000	0.114	0.013
Spontaneous Physical Activity	0.888	0.028	0.206	0.000		
Additional Physical Activity	1.957	0.038	0.336	0.000		
BMI	–2.724	–0.101	0.177	0.000		
Trunk strength						
Computer Games	–0.406	–0.056	0.047	0.000	0.089	0.008
Additional Physical Activity	0.322	0.023	0.090	0.000		
BMI	–0.454	–0.062	0.048	0.000		
Strength of arm						
Spontaneous Physical Activity	0.640	0.019	0.220	0.000	0.149	0.022
BMI	–4.365	–0.149	0.191	0.000		

(p=0.000), had a negative direction, whereas spontaneous activity (p=0.000) and organized activity (p=0.000) a positive direction. In the remaining cases, the models were simplified. For flexibility, the significant factors were time devoted to computer games and the BMI (p=0.000), as well as spontaneous physical activity (p=0.000). In turn, trunk muscles strength depended on the BMI (p=0.000), computer games (p=0.000), and organized activity (p=0.000). The greatest differences in arms strength were noted according to the BMI (p=0.000) and spontaneous activity (p=0.004).

DISCUSSION

The study showed that the BMI and sedentary behaviours were the factors which, to a small degree, limited the normal level of H-RF components. However, due to the sample size, for the majority of the relationships the correlation coefficients were statistically significant.

Spontaneous physical activity showed a positive effect on 3 fitness components, while organized activity – only on 2 from among 4 components analyzed. Both manifestations of activity were observed in the case of explosive leg power. The effect of the remaining H-RF components varied. The calculated corrected R^2 values also showed at this age a small contribution of selected factors to the explanation of total variability of the characteristics analyzed. Hence, it is highly probable that other predictors, such as environment of place of residence or SES of the family play an important role. At a younger age a child learns patterns of physical activity and sedentary forms of playing and leisure from the closest environment. Not only contacts with peers are important, but primarily the family, siblings, and grandparents [13]. The cultural environment in which a child grows up, the economic situation of the family [14], or the region of residence are also of importance [15, 16]. It is noteworthy that despite the blurring of the differences in the level of biological development of children and adolescents from various environments, differences between rural and urban areas are still observed with respect to economic status and the sports-recreational infrastructure [17].

While evaluating in detail the effect of individual behavioural characteristics and the BMI on the level of physical fitness of the population examined, according to the American concept of Health Related Fitness (H-RF), it should be mentioned that among the children in the study low, although statistically significant relationships were observed between the BMI and all fitness components. Based on a smaller number of observations carried out in various countries worldwide, mainly in the urban environment, a similar strength of relationships was found [18, 19]. It is noteworthy that the BMI is the measure of weight-height ratio, but not fatness. Lean body mass is of great importance for the development of the musculoskeletal H-RF component. Intensive developmental processes taking place in puberty lead not only to disorders in the ratio between the 2 body weight components (fat mass and lean body mass), but also weaken the muscular corset. In consequence, this decreases the fitness of the child. In addition, other external factors (inactive forms of spending leisure time/physical activity) may fix the negative effects of excessive body weight or will counteract these effects by the compensatory-corrective mechanism of physical activity [18].

It is difficult to evaluate the weak inversely proportional relationship found in the presented study between the level of physical fitness investigated according to the concept of health, and time devoted to computer games, because the incomparable criteria for determination of the scope of sedentary behaviours do not allow the performance of comparable analysis of the material collected. It is noteworthy that using the survey technique, and consideration of even longer (up to several hours) periods of watching television programmes by children, the results were similar to those obtained in own studies [20, 21]. It is especially important that physically weaker and obese children are more willing and devote more of their leisure time to this form of activity [22]. However, the above-mentioned problem should be approached with great caution. Marshall et al. [23], based on meta-analysis found that the effect of individual forms of sedentary behaviours on increase in overweight and obesity, and decrease in the level of children's interest in physical activity, may be overestimated [23]. Their effect on the state of health is generally small and has no clinical importance. In such a situation, from the pedagogic and medical aspects, the proposal to establish the allowable daily limit for watching television programmes by children on the level of 2 hours daily, and encouraging them to longer and slightly more intense physical activity, seems to be justified [24].

The results of studies suggest that in the majority of pre-school children, in most of the relationships there occurred a positive, weak direction of correlation between the level of physical activity and H-RF components. Based on the number of statistically significant relationships, it may be presumed that among spontaneous forms of physical activity in girls dominated those which shaped the development of leg power, while among boys – arms and legs strength. Additional classes exerted a positive effect on the strengthening of explosive leg power and trunk strength.

Although the majority of the results of the presented study confirmed the well-documented positive effect of physical activity on children's health condition before starting school education [22, 24], the strength of the relationships shows that this effect is far from that expected. In order to increase the effectiveness of using by children of the postulated limit of 60 minutes of additional physical exercise classes, it is proposed, based on the experiments conducted, to intensify the physical load in spontaneous and organized forms of physical activity [24].

Despite low correlations and corrected R^2 coefficients, the relationships observed between physical fitness and the BMI, activity, and sedentary forms of leisure, indicate that the problem of shaping physical fitness from early childhood should be approached with more concern. In addition, the tests applied, which are easy to use in conditions of school or nursery school, should be performed as the means for promoting active forms of spending free time, and also to identify possible health problems, including overweight and obesity.

CONCLUSIONS

Differences were observed in the level of HR-F fitness according to the BMI, time devoted to inactive computer games, and physical activity. Significantly higher parameters in the level of fitness were attained by rural children who had a normal

BMI, did not use a computer, and were more physically active. The calculated R^2 coefficients are low, which rather suggests that there are other factors of considerable importance for the development of HR-F components at this age. Hence, there is a need for the creation of a social policy in Polish rural areas in order to solve problems related with disturbed height-weight ratio in children prior to school education. In addition, considering the scale of sedentary behaviours and rather low level of the respondents' additional activity, attention should be paid to physical exercise classes at nursery schools, as well as classes proposed outside the educational facility. The limitation of obligatory physical exercise classes in Polish nursery schools seems to be inexplicable, as well as the limitation of access to other active forms of spending leisure time, especially in the rural environment. The neglect in these spheres should be considered as non-educational, and enhancing sedentary behaviour habits.

Pre-school age is the period of extraordinary sensitivity and preference in acquiring proper experiences and adequate patterns of behaviour. Hence, it is justifiable to undertake early interventions in the groups of children with overweight and obesity, and skilful use of other health behaviours, including physical activity. The rationality of such conduct suggests that in the situation where children are susceptible to the suggestions of others, and the plasticity of their brain is high, the creation of a health promoting life-style biased towards physical activity would bring about measurable benefits in the future.

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