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Fitness of five-year-olds with different levels of motor skills

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Sprawność fizyczna pięciolatków o odmiennych umiejętnościach motorycznych

Streszczenie

Mimo że obserwujemy systematyczny wzrost zainteresowania rozwojem dzieci w wieku przedszkolnym, to wciąż niewiele jest badań poświęconych ocenie związku między nabytą sprawnością motoryczną przedszkolaków a ich poziomem sprawności fizycznej. Stąd celem pracy była ocena związku między poziomem sprawności fizycznej a umiejętnościami motorycznymi pięciolatków. W badaniu wzięło udział 435 pięcioletnich dzieci. Sprawność fizyczna (PF) została oceniona testem Sekity dla przedszkolaków. Natomiast do oceny umiejętności motorycznych zastosowano test dużej motoryki (TGMD II). Dzieci podzielono na grupy o niskiej sprawności fizycznej (PFI), średniej sprawności fizycznej (PFII) oraz wysokiej sprawność fizycznej (PFIII). Analiza sprawności fizycznej

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wykazała istotne różnice między dziewczętami i chłopcami w próbach oceniających szybkość i zwinność biegu. Ponadto wyższy poziom umiejętności motorycznych odnotowano u dziewcząt w porównaniu z chłopcami, na co wpływ miały głównie umiejętności lokomocyjne. W umiejętności panowania nad przyrządami podobne wyniki zaobserwowano u obu płci. Jednak w poszczególnych ćwiczeniach wystąpiły znaczne różnice. Ponieważ u pięcioletnich dziewcząt i chłopców charakteryzujących się różnym poziomem sprawności fizycznej nie odnotowano znaczących dysproporcji w umiejętnościach lokomocyjnych i kontroli nad przyrządami, należy przyjąć, że 5 rok życia to jeszcze zbyt wczesny okres w ontogenezie do oceny tego typu zależności.

Słowa kluczowe: przedszkolaki, sprawność fizyczna, duża motoryka.

Abstract

Although we are observing a systematic increase in interest in the development of preschoolers, there are still few studies devoted to the assessment of the relationship between the acquired motor skills of preschoolers and their level of physical fitness. Hence, the aim of the study was to assess the relationship between the level of physical abilities and motor skills of five-year-olds. 435 five-year-old children participated in the study. Physical fitness (PF) was assessed according to the Polish Physical Fitness Test for preschoolers. The Gross Motor Skills Test (TGMD II) was used to assess motor skills. Children were divided into the following groups: low physical fitness (PFI), average physical fitness (PFII), high physical fitness (PFIII). The analysis of fitness abilities revealed significant differences between girls and boys in trials assessing running speed and agility. Among the five-year-olds, a higher level of gross motor skills was noted in girls compared to boys, which was mainly influenced by the results of locomotor skills. In the ability to control sports equipment, similar results were observed in both sexes. However, there were significant differences in the individual exercises. Since no significant disproportions in locomotor skills and control of instruments were noted in five-year-old girls and boys characterized by different levels of physical fitness, it should be assumed that the 5th year of life is still too early a period in ontogenesis to look for such relationships.

Keywords: preschoolers, physical fitness, gross motor skills.

Introduction

An increasing number of observations is being carried out on the physical fitness and motor skills of preschool children. In professional literature, there are studies showing the interrelationships between motor skills or physical fitness and other factors. Some of the factors which have been analyzed are racial differences [12, 28] and dimorphic differences in motor abilities [18]. Moreover, researchers have observed a negative influence of excessive weight and obesity on motor skills of preschoolers [4, 11, 14, 17] and no influence of body weight on gross motor skills [12]. Children's motor skills were also assessed against the background of other reference groups [2, 16, 25, 27]. It was noted that children's motor skills were positively related to their physical activity, but inversely related to the time spent in front of a TV or computer screen [8, 28].

Although we are observing a systematic increase in interest in the development of this age group, there are still few studies devoted to the assessment of the relationship between the acquired motor skills of preschoolers and their level of physical fitness. It has been observed around the world that athletes start specializing in particular sports at an increasingly early age, which means that coaches need the necessary information for recruitment purposes, as it is very important to learn about the factors conditioning motor skills so that children have the best opportunities for their development. Hence, the aim of the study was to assess the relationship between the motor skills of 5-year-olds and their level of physical fitness.

Materials and Methods

Participants

435 five-year-old children participated in the study, including 180 girls and 255 boys from Biała Podlaska. The results were collected in April and May 2016. The legal guardians of the children gave their consent for participation in the research. The study was preceded by a medical examination during which children's health was assessed. The research was carried out in accordance with the principles of the Helsinki Declaration and received a positive opinion of the Senate Committee on Ethics of Scientific Research.

Measurements

Physical fitness (PF) was assessed according to the Polish Physical Fitness Test for preschoolers [19]. It consisted of four trials: 20m dash (20mR); standing broad jump (SBJ); 4 × 5 m shuttle run with carrying blocks (4 × 5 mSR); throwing a 1 kg medicine ball with both hands from above the head (1 kgTB).

The Gross Motor Skills Test (TGMD II) [26] was used to assess motor skills, in which the examiner rated the technique of performed exercises. This test allows the assessment of mobility capabilities with the help of 6 tests

— run (8 points)
— forward gallop and forward delivery steps (8 points)
— jumping on one leg (10 points)
— jumping over an obstacle (8 points)
— slides – side-loading steps (8 points)
— long jump from place (8 points)

Six trials with the use of sports equipment were carried out:

— hitting the ball in place (10 points)
— dribbling in place (8 points)
— catching the ball (6 points)

— kicking the ball (8 points)
— throwing the ball with a swing (8 points)
— ball rolling on the floor (8 points)

Statistical analysis

Statistica 13.0 software was used for statistical-data processing. In the sex groups, descriptive statistical parameters (mean, standard deviation) were calculated.

Taking into account the criterion $\bar{x} \pm 0{,}5$ SD from all the points obtained in the Gross Motor Skills Test (TGMD II) and considering locomotor skills and the ability to control sports equipment, the following groups were selected:
Group I – low physical fitness (PFI) up to ($\bar{x} - 0{,}5$ SD);
Group II – average physical fitness (PFII) of ($\bar{x} - 0{,}5$ SD) to ($\bar{x} + 0{,}5$ SD);
Group III – high physical fitness (PFIII) above ($\bar{x} + 0{,}5$ SD).

Next, the individual results of 4 physical fitness trials (PF) were converted into points on the T scale. In order to standardize the units, the individual results of girls and boys were normalized on the T scale to the mean and statistical dispersion of all subjects using the formula:

$$T = \left(\frac{x_i - \bar{x}}{SD}\right) \times 10 + 50$$

T – number of points;
x_i – measurement result;
$\bar{x}$ – sample mean;
SD – standard deviation.

The mean score from all test trials assesses general fitness (GF). The point values for each group are presented in Table 1.

Table 1. Point criteria according to the groups

	Locomotor abilities	**Control over sports equipment**	**Gross Motor**
Girls			
Group I	30.54	27.57	59.45
Group II	30.55 – 37.45	27.58 – 33.32	59.46 – 69.44
Group III	37.46	33.33	69.45
Boys			
Group I	29.32	29.69	60.05
Group II	29.33 – 37.36	29.68 – 36.75	60.06 – 73.10
Group III	37.37	36.76	73.11

Source: own research.

The statistical significance of differences between the above-mentioned groups was assessed by the ANOVA analysis of variance and the Newman Keuls test, and the dimorphic differences were assessed by the t-Student test for independent data.

Results

Table 2 shows the absolute values of the results of the physical fitness test and the Gross Motor Skills Test for the boys and girls. These comparisons show that statistically significantly better results were obtained by the boys compared to the girls in the trials of the 4 × 5 m shuttle run while carrying blocks (by 0.50 s, $p \leq 0.01$) and the 20 m dash (by 0.45 s, $p \leq 0.01$). In the remaining parts of the physical fitness test, the differences between genders were small. They only indicate slightly better results in the long jump from place for the boys (by 2.49 cm) and in throwing a medicine ball with both hands from above the head for the girls (by 0.56 cm). On the other hand, when assessing the dimorphic differences in the locomotor skills of the five-year-olds, it was observed that the girls obtained statistically significantly better results in all trials ($p \leq 0.01$).

When analyzing the results of control over sports equipment, it was found out that the girls achieved statistically significantly better results compared to the boys. These included: dribbling the ball (by 0.53 points, $p \leq 0.05$), catching the ball (by 0.71 points, $p \leq 0.01$) and rolling the ball (by 0.52 points, $p \leq 0.01$). On the other hand, the girls obtained worse results in kicking the ball (by 0.61 points $p \leq 0.01$). Small, statistically insignificant differences between the groups of the girls and boys were noted in hitting the ball (by 0.30 points) and throwing the ball with a swing (by 0.20 points).

In terms of the sum of all points obtained in locomotor abilities, the girls obtained statistically significant, higher results than the boys (by 4.40 points, $p \leq 0.01$). However, in the control of sports equipment, a similar level of skill was observed, with the difference being 1.04 points. The mean of the points obtained from all the gross motor skills trials was higher in the girls than in the boys (by 5.44 points, $p \leq 0.01$).

In the analysis of the influence of motor skills (TGMD II) on the physical fitness of 5-year-olds, it was found out that both in the girls (Table 3) and in the boys (Table 4) the differences in the level of fitness abilities between the discussed teams were small and statistically insignificant. However, even in this group of calendar age certain trends can be observed. Taking into account motor skills, it was observed that the girls from the PFIII group, whose general fitness was 51.32 points, were characterized by the highest level of fitness. This was influenced by the results obtained from all fitness abilities. The lowest level of

fitness was recorded in their peers from the PFI group (48.90 points), who obtained the worst results in the 20 m run, the standing long jump, and throwing a medicine ball with both hands.

Table 2. Results of physical fitness (PF) and motor skills (TGMD II) of five-year-olds from Biała Podlaska and t-Student index values calculated

Test attempts	Girls (n 186)	Boys (n 255)	Value of the t-Student
	$\overline{x}$ ± SD	$\overline{x}$ ± SD	
Physical fitness			
4 × 5 mSR	10.93 ± 1.54	10.43 ± 1.24	3.77**
1 kg TB	206.10 ± 63.71	205.54 ± 55.77	0.10
20 mR	6.33 ± 0.87	5.88 ± 0.81	5.58**
SBJ	90.24 ± 22.23	92.73 ± 22.87	1.14
PF	201.37 ± 29.19	198.95 ± 30.25	0.84
Locomotor abilities			
run	7.03 ± 2.01	6.41 ± 2.01	3.47**
gallop	5.89 ± 2.26	5.18 ± 2.26	3.21**
jumping on	6.96 ± 2.61	5.51 ± 2.61	6.17**
jumping over	5.18 ± 1.49	4.76 ± 1.49	2.94**
long jump	6.62 ± 2.28	5.95 ± 2.28	3.11**
slides	6.07 ± 2.09	5.54 ± 2.09	2.62**
total	37.75 ± 6.92	33.35 ± 8.05	6.01**
Control over sports equipment			
hitting the ball	7.27 ± 2.13	7.57 ± 2.13	1.45
dribbling	4.62 ± 2.93	4.09 ± 2.93	1.94*
catching	5.11 ± 1.47	4.40 ± 1.47	5.08**
kicking	5.83 ± 1.64	6.44 ± 1.64	3.64**
throwing	6.08 ± 1.60	5.88 ± 1.60	1.32
ball rolling	5.36 ± 1.77	4.84 ± 1.77	3.12**
total	34.27 ± 5.76	33.23 ± 7.07	1.65

* statistically significant differences at $p \leq 0.05$
** statistically significant differences at $p \leq 0.01$

Source: own research.

Among the boys, the best results in physical fitness were also recorded in the PFIII group (50.48 points), which was influenced by the results of throwing a medicine ball with both hands and the standing long jump. On the other hand, the worst results were observed in the PFI group (49.70 points), where the poorest results were observed in the 4 × 5 m run while carrying a block and the standing long jump.

After comparing the results of the physical fitness test of the girls qualified for groups with different locomotor skills and control of sports equipment, small, statistically insignificant differences were also observed. However, there are also some trends here. Taking into account locomotor skills, it was observed that the subjects from the PFIII group (50.86 points) had the highest level of fitness, and the lowest level was observed in the PFI group (49.12 points). This was influenced by the results obtained in the 20 m run and the standing long jump by the girls with high point values in locomotor skills and in the 4 × 5 m run while carrying a block and throwing a medicine ball with both hands by the subjects with the lowest locomotor skills.

Table 3. The results of the fitness abilities of the girls in groups with different motor skills as well as the ANOVA values and the Newmann-Keuls test calculated for the differences between the groups

Test attempts	Group I	Group II	Group III	ANOVA	I–II	I–III	II–III
	$\bar{x}$ ± SD	$\bar{x}$ ± SD	$\bar{x}$ ± SD				
Locomotor abilities							
n	51	64	65				
4 × 5 mSR	10.65 ± 1.43	10.16 ± 0.82	10.45 ± 1.22	1.70	2.51	1.18	1.94
1 kg TB	207.10 ± 54.63	211.64 ± 54.82	210.17 ± 63.55	0.05	0.46	0.35	0.19
20 mR	5.77 ± 0.56	5.73 ± 0.68	5.54 ± 0.81	1.72	0.32	2.14	2.02
SBJ	91.33 ± 16.40	89.53 ± 24.51	94.13 ± 20.62	0.80	0.52	0.92	1.72
PF	49.12 ± 6.82	50.34 ± 6.19	50.86 ± 7.89	0.13	0.03	0.61	0.50
Control over sports equipment							
n	53	69	58				
4 × 5 mSR	10.38 ± 1.41	10.55 ± 1.06	10.29 ± 1.09	0.80	1.11	0.57	1.75
1 kg TB	209.12 ± 67.10	199.90 ± 46.30	224.11 ± 65.12	5.65	1.20	1.88	3.24
20 mR	5.68 ± 0.81	5.77 ± 0.78	5.69 ± 0.63	0.28	0.94	0.10	0.85
SBJ	90.75 ± 22.42	89.67 ± 22.71	94.26 ± 17.08	0.80	0.40	1.25	1.74
PF	50.43 ± 8.16	49.26 ± 7.01	51.65 ± 6.70	1.70	1.25	1.25	2.61
Motor skills (TGMD II)							
n	49	73	58				
4 × 5 mSR	10.46 ± 1.30	10.43 ± 1.18	10.34 ± 1.09	0.16	0.19	0.74	0.61
1 kg TB	208.86 ± 62.60	208.51 ± 55.95	213.57 ± 62.81	0.13	0.04	0.57	0.68
20 mR	5.74 ± 0.57	5.78 ± 0.91	5.60 ± 0.62	1.00	0.41	1.37	1.95
SBJ	90.33 ± 17.64	89.80 ± 25.14	94.95 ± 17.37	1.15	0.20	1.65	2.02
PF	50.10 ± 6.67	48.90 ± 8.14	51.32 ± 6.69	0.84	0.15	1.42	1.72

4 × 5 mSR – 4 × 5 m shuttle run with carrying blocks; 20 mR – 20 m dash; SBJ – standing broad jump; 1 kgTB – throwing a 1 kg medicine ball with both hands from above the head; PF – physical fitness.

Source: own research.

The girls from the PFIII group also obtained the best results from all the teams for different sports equipment control skills, as evidenced by the results of general fitness (51.65 points). They obtained the best results in the 4 × 5 m race while carrying a block, the standing long jump, and throwing a medicine ball with both hands. The subjects from the PFII group (49.26 points) were characterized by the lowest fitness, they obtained the poorest results in all the tested samples of the test.

Table 4. The results of the fitness abilities of the boys in groups with different motor skills as well as the ANOVA values and the Newmann-Keuls test calculated for the differences between the groups

Test attempts	Group I	Group II	Group III	ANOVA	I–II	I–III	II–III
	$\bar{x}$ ± SD	$\bar{x}$ ± SD	$\bar{x}$ ± SD				
Locomotor abilities							
n	64	96	95				
4 × 5 mSR	10.47 ± 1.21	10.46 ± 1.34	10.38 ± 1.16	0.13	0.10	0.63	0.59
1 kg TB	202.89 ± 52.72	200.79 ± 55.02	209.99 ± 61.68	0.67	1.09	0.32	1.57
20 mR	5.89 ± 0.79	5.93 ± 0.79	5.82 ± 0.84	0.45	0.82	0.36	1.31
SBJ	92.70 ± 26.15	91.76 ± 22.81	93.72 ± 20.65	0.17	0.39	0.35	0.83
PF	49.79 ± 7.34	49.52 ± 7.77	50.62 ± 7.55	0.31	0.80	0.14	1.04
Control over sports equipment							
n	72	99	84				
4 × 5 mSR	10.68 ± 1.34	10.36 ± 1.05	10.27 ± 1.34	2.63	0.66	2.26	3.14
1 kg TB	202.92 ± 56.19	200.59 ± 59.59	212.71 ± 54.43	1.01	1.94	1.51	0.39
20 mR	5.93 ± 0.76	5.84 ± 0.80	5.87 ± 0.86	0.28	0.37	0.62	1.02
SBJ	89.26 ± 21.95	95.67 ± 23.47	92.76 ± 22.70	1.79	1.16	1.36	2.68
SO	48.88 ± 7.85	50.40 ± 6.98	50.69 ± 7.92	1.45	0.12	1.92	2.21
Motor skills (TGMD II)							
n	69	98	88				
4 × 5 mSR	10.56 ± 1.37	10.32 ± 1.25	10.42 ± 1.12	0.91	0.74	1.01	1.90
1 kg TB	203.56 ± 54.40	202.14 ± 55.31	210.09 ± 61.01	0.42	1.25	1.00	0.24
20 mR	5.84 ± 0.81	5.91 ± 0.80	5.87 ± 0.82	0.17	0.51	0.80	0.24
SBJ	92.01 ± 21.79	92.10 ± 25.80	94.57 ± 20.23	0.30	0.97	0.98	0.04
PF	49.70 ± 7.82	49.93 ± 7.76	50.48 ± 7.20	0.22	0.66	0.93	0.30

4 × 5 mSR – 4 × 5 m shuttle run with carrying blocks; 20 mR – 20 m dash; SBJ – standing broad jump; 1 kgTB – throwing a 1 kg medicine ball with both hands from above the head; PF – physical fitness.

Source: own research.

On the other hand, when assessing the results of the fitness test in the groups of the boys classified into individual teams with different levels of loco-

motor skills and control of sports equipment, it was observed that the physical fitness results were at a similar level, because no statistically significant differences were found. Despite the lack of greater discrepancies, it was observed that among the teams with different levels of locomotor skills, in all trials of the test and in general fitness, the best results were obtained by the boys from the PFIII group (50.62 points). The worst results were recorded in their peers from the PFII group (49.52), which were influenced mainly by the results in the 20 m run, the standing long jump, and throwing a medicine ball with both hands.

Taking into account the ability to control sports equipment, it was found out that the boys from the PFIII group (50.69 points) had the highest level of general fitness, while the boys from the PFI group had the lowest level (48.88 points). The PFIII group achieved the best results in the 4 × 5 m race while carrying a block and in throwing a medicine ball with both hands. The boys with the lowest level of the ability to control sports equipment had the worst results in the 4 × 5 m race while carrying a block, in the 20 m run, and in the standing long jump.

Discussion

The analysis of the processes taking place in the body with the simultaneous monitoring of individual aspects of a child's life may support its psychophysical development. Directing the child correctly during this period may contribute to better functioning later in life [9, 21].

In studies on the motor skills of preschoolers, different conclusions can be reached regarding the impact of gender dimorphism on fitness. There are studies in which the authors confirm the above-mentioned relationships, but there are also those that contradict them. According to Ruzbarska and Piątkowska [18], the boys in selected tests of physical fitness obtain significantly better results in comparison with the girls. According to the aforesaid authors, this is a manifestation of what will be more clearly observed in adulthood, when men, due to a higher content of androgens in the body (e.g. testosterone), will achieve much better results [10]. On the other hand, differences in physical fitness between girls and boys at preschool age were not found by Kokštejn et al. [13].

In our observations on fitness abilities, statistically significantly better results were noted in the boys in two out of four test trials. On the other hand, in the Gross Motor Skills Test, the results for both sexes were at a similar level. Thus, at this stage of ontogenesis, the reasons for the above-mentioned differences should be sought in genetic conditions, and not in the level of acquired skills. Better results for the boys were recorded in the 20 m dash and the 4 × 5 m run, i.e. in trials considered anaerobic. It should be remembered that motor

skills are directly related to the genotype we inherit, but also indirectly to the body composition and dimorphic differences, which are a manifestation of the phenotype [20]. Szopa [23] documented high heritability rates of maximal anaerobic power, which is under strong genetic control of the muscle structure, i.e. the ratio of fast-twitch to slow-twitch fibres. The phosphagen-non-lactic acid component is genetically controlled to a degree similar to the height of the body, which is a trait commonly considered to be strongly genetically determined. Also Sklad [22], when examining twins aged 8 to 15 years in terms of fitness abilities, showed that in relation to speed heritability the correlation was 0.62 to 0.9.

There is also no unanimity in the literature regarding the dimorphic differences in the gross motor skills of preschoolers. Aye et al. [1, 2], when studying five-year-olds in Myanmar and Japan, observed that girls had much better locomotor skills, while boys had much better control over sports equipment. Similar relationships were found in preschoolers from Finland [16]. Among US children, Kit et al. [12] reported a higher level of locomotor skills only in girls. On the other hand, no significant dimorphic differences were found in the control of sports equipment. This is contradicted by the results of British observations [15] and Belgian observations [3], according to which boys had a higher level of control skills. On the other hand, in terms of locomotion skills, no differences were found between girls and boys. However, Morano et al. [14] focusing on southern Italian boys and girls, Jiang et al. [11] studying Chinese preschoolers, and Tomaz et al. [24] based on African studies, found no differences in test results.

In the presented study of five-year-olds, the mean score obtained in all trials of the TGMDII test was higher in the girls than in the boys. It was mainly influenced by the results of locomotor skills tests. In the control of sports equipment, a similar number of points was observed in both sexes. However, significant differences in individual exercises could be observed. The results of locomotor skills we have described are consistent with the results of research presented above by other authors. Therefore, it can be assumed that girls, compared to boys, have a genetically better predisposition to natural movement. However, as described above, there is no such unanimity in the control of sports equipment. Therefore, we should look for other factors which could affect these aspects of children's gross motor skills. The search for further modifiers requires more research.

Since a five-year-old child is at the beginning of its path when it comes to motor development, the differences in motor skills between particular skill groups may be small. Hence, both in the boys and girls, there were no significant differences in the level of physical fitness between the groups with different levels of motor skills. Freitas et al. [7], on the basis of studies of American children aged 3-6 years, documented links with motor skills for only some fitness abilities. However, these relationships differed between boys and girls. One should

bear in mind that the evaluation of the results of fitness abilities takes into account the absolute value of the result obtained in a motor task, without assessing the manner of its execution. On the other hand, in TGMDII the technique of performing the exercise is assessed, and not the absolute value of the obtained result. It should be emphasized that all the children we studied were inhabitants of cities. Aye et al. [2] and Niemistö et al. [16] found out that children from the countryside achieved better results in gross motor skills compared to those from the cities. Similar observations were presented by Trzcińska et al. [25] describing the differences in fitness abilities. According to the quoted authors, preschoolers from the countryside, apart from compulsory classes in kindergarten, spent more time outdoors, while children from urban areas limited themselves to participating in organized sports activities whose time was restricted. The assessed five-year-olds are not sports-active children. 41.75% of the girls and 30.71% of the boys participate in additional physical activities outside the compulsory program in kindergarten. These children spend a lot of free time in front of the TV or computer, especially in the autumn and winter period [6]. Therefore, it can be assumed that the motor skills of the five-year-olds we assessed are still at a low level and do not affect their future motor skills.

Conclusions

1. The analysis of fitness abilities revealed significant differences between the girls and boys in trials assessing running speed and agility. On the other hand, such relationships were not noted in the strength of the arms and the power of the lower limbs.
2. Among the assessed five-year-olds, a higher level of gross motor skills was noted in the girls compared to the boys, which was mainly influenced by the results of their locomotor skills tests. As for the ability to control sports equipment, similar results were observed in both sexes. However, there were significant differences in the individual exercises.
3. As for both the boys and girls, there were no significant differences (statistically significant) in the level of physical fitness between the groups with different levels of motor skills.

DECLARATION OF CONFLICTING INTERESTS

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