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Assessment of the influence of physical activity and screen time on somatic features and physical fitness in 6 to 7-year-old girls

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Abstract: Aim of the study is to assess the relationship between screen time, physical activity and physical fitness among girls 6–7 years-old.
21,528 girls aged 6 and 7 from Poland were assessed in terms of physical fitness. Arm strength, abdominal strength and explosive strength of the lower limbs were measured using the EUROFIT test. Basic somatic features were measured and BMI and WHtR indices were calculated. Spontaneous and organized physical activities as well screen time were assessed by the parents utilizing a questionnaire. The multiple logistic regression method was used to evaluate the influence of screen time and spontaneous physical activity on various components of physical fitness.
Physically active (PA) girls (≥1h/day) and those who participated in additional physical activities (APA) during the week had significantly higher height, weight, and BMI ($p<0.001$), but not WHtR. They had a higher level of flexibility, explosive strength of the lower limbs and arm strength ($p<0.001$). With an increase in screen time, the BMI, WHtR increased significantly and explosive strength of the lower limbs, abdominal strength and arm strength were lower. Regression analysis showed that more frequent participation in extracurricular activities increased the values of BMI and WHtR in quartile 4 (Q4), and strength components: Q2–Q4 ($p<0.05$). Spontaneous physical activity was positively related to the values of BMI, WHtR (both: Q4; $p<0.05$), explosive force of lower limbs (Q3–Q4; $p=0.001$), and negatively related to arm strength (Q2; $p=0.001$). Screen time (≥2hrs/day) increased odds for higher BMI values ($p<0.05$). Each screen time category decreased the odds of achieving abdominal muscle strength related to the quartiles: Q2–Q4 ($p<0.05$), arm strength (Q4: $p<0.05$). ST (1 <2hrs/day) decreased arm strength (Q3; $p=0.045$).
Our research has shown that screen time-related sedentary behavior and physical activity affect overweight and obesity indices (especially BMI) and strength abilities. The observed associations more often affected girls with a higher level of fitness The results observed in girls aged 6-7 indicate a need for early intervention aimed at limiting time spent watching TV and computer use, as well as to encourage both spontaneous and organized physical activities.

Key words: preschool children, fitness, leisure time

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Introduction

Pre-school children are considered to be the most active population group (Fang et al. 2017). This is due to the interdependence between a number of developing biological structures, functional capabilities and factors of the external environment (Schmutz et al. 2020). The harmonious development of the structures of the nervous, muscular and circulatory systems, seems to be particularly important as it ensure readiness to take on new challenges by experiencing movements in the undertaken functional activities and everyday play. Moreover, natural physical activity, as well as readiness at this age to react to the surrounding external stimuli allow for continuous improvement and shaping of features related to physical fitness. Particularly important aspects of physical fitness from the point of view of the child's development in the subsequent stages of ontogenesis include cardiopulmonary fitness, strength, and flexibility (Ortega et al. 2015).

According to the Health-Related Fitness (HR-F) concept, body composition is considered one of the components of physical fitness. In younger children, the Body Mass Index (BMI) is the most frequently used indicator to assess general obesity (de Onis et al. 2010). However, BMI does not always give a true picture of overweight or obesity. Children with more muscle mass may have an increased BMI. WHtR has an advantage over BMI, which does not provide any information on the distribution of adipose tissue, especially around the abdomen (Santomauro et al. 2017). BMI and WHtR are correlated with, however, a significant percentage of children with a normal BMI may have high WHtR values (Schröder et al. 2014). Hence the proposal to take both of these indicators into account when assessing overweight and obesity in children (Kuba et al. 2013).

In the latest research by Małtosz et al. (2021) in children 5–6 years old, the percentage of overweight and obese girls based on BMI is 11.1%, and the total percentage in the study group is 11.7%. Abdominal obesity is present in 12.7% of the children, including 14.9% of girls. There are no current data on overweight and obesity in 7-year-old children. However, recent studies by Fijałkowska et al. (2017) showed that in 8-year-olds, this percentage is 22.3%, of which 23.7% in girls.

Physical fitness and body composition depend on many factors. The important factors, apart from genetic ones, are the process of urbanization, environmental pollution, socio-cultural changes and the related changes in lifestyle, especially physical activity and screen time (Drabik and Drabik 1998). It is disturbing that the distribution of time devoted to active and inactive leisure among pre-school children has changed unfavorably in recent years. Research by Rokicka-Hebel (2017) showed that more than 65% of girls aged 6 spend less than an hour a day on physical activity, which is contrary to the recommendations of the World Health Organization (WHO 2017). In Poland, there is a shortage of up-to-date research on screen time of children aged 6–7. Research conducted by Kołodziejczyk (2012) showed that 6–7-year-old children have their own audiovisual device in the room, such as: TV (28.5%), computer (25.5%), video game console or Gameboy (15.8 %) or a DVD player (20%). In addition, 18.8% of them have access to the Internet and 19.6% to satellite TV.

The increase in screen time and the decrease in physical activity are widely documented in studies in the context of increasing overweight and obesity in children (de Onis et al. 2010). In children who are moderately or intensively active for less than an hour during the day, as well as in those who do not participate in additional, organized sports or recreational activities , adverse changes in body weight and physical fitness were found (Carson et al. 2017, Chen et al. 2020, Felix et al. 2020, Hebert et al. 2017, Wyszyńska et al. 2020). Similar unfavorable associations are observed between screen time and obesity indices (Li et al. 2020). However, the association between physical fitness and sedentary behavior is not so obvious (Carson et al. 2016, Cieśla et al. 2014, Filho et al. 2014, Hardy et al. 2018). Especially in younger children (Grund et al. 2001).

There is substantial evidence that sex is one of the major predictors of physical activity, sedentary behavior and physical fitness (Hallal et al. 2014, Nielsen et al. 2011, Tanaka et al. 2019). Compared to boys, girls seem to be less physically active, and they also less often attend organized sports activities (Tanaka et al. 2019). However, the differences between sexes are not so obvious (Hallal et al. 2014, Norman and Nyberg 2021, Tanaka et al. 2019).

In Poland, few studies focus on the assessment of the association between physical activity, screen time overweight and obesity, as well as physical fitness in girls aged 6–7 (Cieśla et al., 2014, Trzcińska et al. 2013). There are only publications on the assessment of the level of BMI, fitness and physical activity in this age group (Dobosz 2012, Kryst et al. 2016, Żegleń et al. 2020). The conducted research may constitute the basis for undertaking activities in the field of health promotion, including forming healthy habits regarding physical activity, especially since this age is the best time for their formation. Our research can be could be a valuable reference for studies conducted in the current pandemic situation in Poland.

With the above in mind, the aim of the study is to assess the associations between physical activity, screen time and overweight and obesity and physical fitness in 6–7-year-old girls.

Material and methods

The research was carried out as part of the project 'A 6-year-old child on the threshold of school education', organized by the Ministry previously known as the Ministry of National Education and Sport, partially financed by the European Union and partially through the state budget within European Social Funds (nr 5/2.1a/2004), in which girls 6–7 years old (N = 21.528) took part. It was carried out in 2006 in the months of April–June and September–November. The groups of girls were selected separately in each of the voivodships. At a later stage in the selection of the sample, the administrative division into urban and rural areas was taken into account. Urban areas include administrative territorial units with municipal rights or the status of a town or city. All other territorial units with a predominance of agricultural activity and without granted municipal rights were classified as rural areas (Dziennik Urzędowy 2003). 32 layers of sampling were distinguished. Further on during the selection process,, 10% of institutions were selected in each of the layers: preschool and schools, implementing the program of annual preparation for school education which is called grade '0'. Information on the number and type of educational institutions implementing such a program was obtained from the Educational Information System and the Central Statistical Office. The study group accounted for 5.767% of all 6–7 year old girls in Poland. The mean age of the respondents was: $\bar{x}$ = 6.56 (sd=0.41). The applied sampling procedure ensured representativeness of the studied population and taking into account the influence of social background. The results of the girls' surveys were used for the analysis, together with anthropometric measurements and physical fitness data. The research was carried out by 64 teams consisting of: two physical education teachers and a nurse. The team members were trained on the procedure of research and detailed instructions were given during a two-day training sessions in each voivodeship.

Measurements

The girls' height (B-v) and body weight and waist circumference were measured according to the procedure developed by Lohman et al (1988). During the tests, height, weight and waist circumference were measured using an anthropometer, digital scales and anthropometric measuring tape with an accuracy of 0.1cm. These measurements were used to calculate the BMI (Body Mass Index = kg/m^2) and WHtR = ((waist circumference (cm))/(body height (cm)) × 100.

The following components of physical fitness were calculated:

Body flexibility (sit and reach – the person was examined from the sitting position with straight back, feet resting on the side of a box, he bends his torso forward, trying to reach with his arm as far as possible along the measuring line fixed on the top of the box. The result is recorded with an accuracy of 0.5 cm).

Explosive force of the lower limbs (standing long jump – the subject made a jump from one place as far forward as possible from the designated line. The measurement result was recorded with an accuracy of 1 cm).

Abdominal strength (sit-ups for 30 seconds – from the supine position, with arms bent at the elbows, hands resting on the back of the neck, legs bent at the knees, feet resting on the floor, the subject made sit-ups. The result was the number of sit-ups performed within 30 seconds).

Arm strength (hanging from a bar with straight arms. The score was the time to stay in this position. The score was recorded with an accuracy of 0.1 seconds.

Ethical approval

At the time of the study ethical approval was not required. The Bioethical Committee of the Faculty of Health Sciences of JKUHS approved the ethical and methodological aspects of the project after it had been finished.

Covariates

The following covariates were included in the regression analysis: mother's education (higher and below higher), the fact of having siblings (has siblings, an only child), place of residence (urban-rural) and age of the subjects of the study. Age of the children was determined on the basis of the decimal age. Girls aged 5.50–6.49 qualified to the group of 6 years old, and girls aged 6.50–7.49 to the group of 7 years old. The covariates were established on the basis of a correlation matrix with the dependent variables. The absolute values of the correlation between the mother's education and the features included in the analysis ranged from 0.12 to 0.23; the fact of having siblings from 0.06 to 0.29, place of living: from 0.09 to 0.30, and the age of the subjects: 0.30–0.35. The majority was statistically significant.

Statistical analysis

For categorized features, counts and percentages were calculated. The association between the age of the respondents and the variables characterizing the background of the subjects as well as their sedentary behavior and physical activity was analyzed using the chi square test.

For all quantitative characteristics, the distributions were verified using the Kolmogorov-Smirnov test with the Lilieforce correction. The arithmetic means and standard deviations in groups divided by spontaneous PA were calculated, and the differences between them were determined using the Student's t test or Mann-Whitney's U test depending on the value of the K-S test. When the number of distinguished groups was greater (organized PA and screen time), the Anova or Anova Kruskall-Wallis tests were used. Tukey's test was used for multiple comparisons.

The influence of sedentary behaviors related to exposure to a TV/computer screen as well as physical activity, on the indexes of body proportions and physical fitness, was assessed by the use of polynomial logistic regression. For this purpose, on the basis of the calculated values of percentiles: 25, 50, 75, quartiles were selected for each dependent variable (Q1–Q4), (Table 1). The reference value for the remaining quartiles was the quartile with the lowest values (Q1). Two types of models were used. Model I – adjusted for age and model II – adjusted for age, mother's education and the fact of having siblings. In the case of models constructed for the flexibility of the body, explosive strength of the lower limbs, abdominal strength and arm strength, BMI was additionally taken into account as a continuous variable. The following categories of variables were the reference groups: screen time (not at all), spontaneous physical activity (<hour/day), organized physical activities (not at all), mother's education (higher), siblings: (only child), place of residence (rural).

Table 1. Percentile values related to the quartile division for individual characteristics and components of physical fitness

Indices and components	6 years old			7 years old			Total group		
	C25	C50	C75	C25	C50	C75	C25	C50	C75
BMI (kg/m²)	14.36	15.36	16.67	14.44	15.55	16.99	14.39	15.46	16.84
WHtR	43.32	45.41	47.87	42.72	44.92	47.60	42.98	45.16	47.72
Flexibility (cm)	49.00	52.00	55.00	48.00	52.00	55.00	48.50	52.00	55.00
Explosive strength of the lower limbs (cm)	77.00	89.00	101.00	82.00	94.00	105.00	80.00	92.00	103.00
Abdominal strength (n/30s)	4.00	8.00	11.00	5.00	9.00	12.00	4.00	9.00	12.00
Arm strength (s)	12.25	19.53	30.22	12.80	20.99	32.72	12.47	20.18	31.42

In this type of models, a backward stepwise regression was used. The significance level was established with an accuracy of 0.001. The calculated odds ratio (OR) and 95% CI (confidence interval) values were the basis for the analysis of the research results. Results with p value <0.05 were considered statistically significant. For more precise calculations the notation <0.001 was used. All analyzes were performed with the use of the statistical packages: STATISTICA 13.3, PS Imago Pro 6.0, SPSS (StatSoft PL, Statistical Package for the Social Sciences 26).

Results

In the study group, 57.41% lived in an urban area. Only 24.83% of girls were only children, and 69.29% of the mothers of the studied girls had higher education. The percentage of mothers declaring secondary was 18.89% and primary and vocational education was 20,82%. Data received from parents showed that 73.00% of girls met the recommendations regarding the time devoted to spontaneous physical activity outside pre-school, but 76.43% of them did not attend additional, paid physical activities organized outside the educational institution. The other girls attended extracurricular activities with varying frequency: from 1 to 5 times a week. As many as 43.51% of the girls used a computer or watched TV programs <1 hour/day, 20.85% ≥1 hour <2 hours, and 33.03% used ≥2 hours/day. A small percentage of girls did not devote any time to such activities (2.60%) (Table 2).

The more physically active girls (≥1hr/day) turned out to be significantly heavier ($p<0.001$) and taller ($p<0.001$). They were also characterized by a more muscular body build ($p<0.001$). The explosive strength of the lower limbs ($p<0.001$) and the abdominal strength were significantly higher ($p<0.001$), but no significant differences were observed in the level of arm strength, flexibility and WHtR (Table 3). Significant differences were also shown for height ($p<0.001$), body weight ($p<0.001$), and BMI ($p=0.003$) under the influence of additionally organized physical activities.

Table 2. Demographic and social characteristics of 6–7 years old girls

Variables		Place of living		Mothers' education			Siblings		Spontaneous PA		Organized PA			Screen time			
		Urban areas	Rural areas	Elementary and vocational	Secondary	University	only one child	Has a siblings	≤1hour/day	> 1hr/day	not at all	1–2times/week	≥3times/week	not at all	<1 hour/day	≥1hour <2 hours/day	≥2 hours/day
Girls	N	12360	9168	4482	4067	12979	5345	16183	15715	5813	16454	4843	231	560	9367	4489	7112
	%	57.41	42.59	18.89	20.82	60.29	24.83	75.17	73.00	27.00	76.43	22.50	1.07	2.60	43.52	20.85	33.03

Table 3. Characteristics of somatic features, physical fitness with division according to spontaneous physical activity, organized physical activity and screen time

Somatic parameters and fitness	Spontaneous physical activity			Organized physical activity				Screen time				
	<hr/day N=5813 (sd)	≥hr/day N=15715 (sd)	*p*	Not at all N=16454 (sd)	1–2 times/ week N=4843 (sd)	≥3 times/ week N=231 (sd)	*p*	Not at all N=560 (sd)	<1 hr/ day N=9367 (sd)	≤1 less than 2 hrs/day N=4489 (sd)	≥2 hrs/ dayp N=7112 (sd)	*p*
Body height (cm)	119.88 (5.59)	121.07 (5.60)	<0.001	120.57 (5.60)	121.39 (5.62)	119.82 (5.87)	<0.001	118.80 (5.44)	120.73 (5.64)	119.89 (5.37)	121.46 (5.66)	<0.001
Body mass (kg)	22.62 (4.09)	23.46 (4.54)	<0.001	23.13 (4.42)	23.61 (4.46)	22.97 (4.74)	<0.001	22.11 (3.90)	23.13 (4.38)	22.89 (4.31)	23.67 (5.48)	<0.001
BMI (kg/m^2)	15.67 (2.06)	15.92 (2.28)	<0.001	15.82 (2.23)	15.93 (2.20)	15.90 (2.36)	0.003	15.60 (2.05)	15.78 (2.16)	15.85 (2.33)	15.95 (2.25)	<0.001
WHtR	45.57 (3.85)	45.73 (4.11)	0.122	45.67 (4.03)	45.76 (4.06)	45.92 (4.28)	0.266	45.83 (3.82)	45.57 (3.99)	45.88 (4.08)	45.71 (4.10)	<0.001
Flexibility (cm)	52.08 (5.41)	52.16 (5.44)	0.231	52.04 (5.35)	52.46 (5.70)	52.94 (5.33)	<0.001	52.67 (5.53)	52.17 (5.34)	52.19 (5.44)	52.03 (5.5)	0.155
Explosive strengh of the lower limbs (cm)	88.95 (16.73)	91.28 (16.04)	<0.001	90.36 (16.37)	92.66 (15.28)	91.91 (19.19)	<0.001	91.50 (16.08)	91.89 (18.14)	89.54 (17.87)	90.78 (16.22)	<0.001
Abdominal strength (n/30s)	7.88 (5.20)	8.28 (5.20)	<0.001	8.10 (5.17)	8.38 (5.30)	8.66 (5.17)	0.006	9.63 (4.14)	8.23 (5.17)	7.59 (5.20)	8.27 (4.92)	<0.001
Arm strength (s)	24.65 (18.31)	24.50 (17.54)	0.699	24.79 (17.76)	23.58 (17.72)	27.59 (17.04)	<0.001	25.04 (17.77)	25.12 (17.77)	23.79 (18.19)	24.23 (16.28)	<0.001

The highest parameters of height, weight and BMI were observed in girls involved in physical activities 1–2 times a week, and the lowest in girls attending exercise classes ≥3 times a week, and in the case of BMI not attending at all. There were no significant differences in the WHtR. Significant intergroup differences calculated for each pair of comparisons are presented in Table 4.

Significant differences in the level of physical fitness according to organized PA were observed in flexibility of the body, explosive strength of the lower limbs, abdominal strength and arm strength. The differences, except for arm strength, showed that girls who attended organized physical activities obtained significantly higher average results in fitness tests than their peers who did not attend such classes at all. Regarding flexibility of the body ($p<0.001$) and abdominal strength ($p=0.006$), the average values increased with each distinguished category of physical activities. In the explosive power of the lower limbs, the highest average results were achieved by girls attending physical activities 1–2 times a week, and the lowest by their peers who did not attend such activities at all ($p<0.001$). Girls attending physical activities 1–2times/week, compared to other girls, turned out to have the weakest arm strength, while their peers more involved in extracurricular activities were the strongest ($p<0.001$), (Table 3). The post-hoc values showed significant intergroup differences, which are presented in Table 4.

Table 4. *P*-value for post-hoc tests – organized physical activity

Somatic parameters and fitness	Gropus	Not at all	1–2 times/week	≥3 times/week
Body height (cm)	Not at all	–	$p<0.001$	ns
	1–2 times/week	–	–	$p<0.001$
	≥3 times/week	–	–	–
Body mass (kg)	Not at all	–	$p<0.001$	ns
	1–2 times/week	–	–	$p=0.026$
	≥3 times/week	–	–	–
BMI (kg/m²)	Not at all	–	$p=0.018$	ns
	1–2 times/week	–	–	ns
	≥3 times/week	–	–	–
Flexibility (cm)	Not at all	–	$p<0.001$	$p<0.001$
	1–2 times/week	–	–	ns
	≥3 times/week	–	–	–
Explosive strength of lower limb (cm)	Not at all	–	$p<0.001$	$p<0.001$
	1–2 times/week	–	–	$p<0.001$
	≥3 times/week	–	–	–
Abdominal strength (n/30s)	Not at all	–	$p<0.001$	$p<0.001$
	1–2 times/week	–	–	$p=0.002$
	≥3 times/week	–	–	–
Arm strength (s)	Not at all	–	$p=0.024$	$p<0.001$
	1–2 times/week	–	–	$p<0.001$
	≥3 times/week	–	–	–

Legend: ns – no significant.

Girls who spent ≥2hrs/day in front of a TV screen, a computer and/or a tablet, turned out to be significantly taller and heavier than their peers less involved in this type of activity ($p<0.001$). They were also characterized by a higher BMI level ($p<0.001$), but the WHtR index turned out to be significantly lower ($p<0.001$).The highest values of this index were recorded in girls who spend 1–2hrs/day on screen time. Significant differences in the level of physical fitness influenced by screen time, were related to the strength components. Explosive force of lower limbs and arm strength turned out to be the highest in the group of girls who spent less than an hour a day on this type of activity ($p<0.001$), while the strength of abdominal muscles was the lowest in the group of girls whose parents declared that they did not spend any time at all onscreen time ($p<0.001$). For all analyzed components, the lowest mean values were observed in the group of children using a TV/computer /tablet 1<2 hrs/day. There were no significant

Table 5. *P*-value for post- hoc tests – screen time

	Gropus	Not at all	<1 hr/day	≤1 less than 2 hrs/day	≥2 hrs/day
Body height (cm)	Not at all	–	ns	$p=0.001$	$p<0.001$
	<1 hr/day	–	–	$p<0.001$	$p<0.001$
	≤1 less than 2 hrs/day	–	–	–	ns
	≥2 hrs/day	–	–	–	–
Body mass (kg)	Not at all	–	$p<0.001$	$p=0.001$	$p<0.001$
	<1 hr/day	–	–	$p<0.001$	$p<0.001$
	≤1 less than 2 hrs/day	–	–	–	$p<0.001$
	≥2 hrs/day	–	–	–	–
BMI (kg/m^2)	Not at all	–	ns	$p<0.001$	ns
	<1 hr/day	–	–	$p<0.001$	ns
	≤1 less than 2 hrs/day	–	–	–	ns
	≥2 hrs/day	–	–	–	–
WHtR	Not at all	–	ns	ns	ns
	<1 hr/day	–	–	$p<0.001$	ns
	≤1 less than 2 hrs/day	–	–	–	$p=0.016$
	≥2 hrs/day	–	–	–	–
Explosive strength of lower limb (cm)	Not at all	–	ns	ns	ns
	<1 hr/day	–	–	$p<0.001$	$p<0.001$
	≤1 less than 2 hrs/day	–	–	–	ns
	≥2 hrs/day	–	–	–	–
Abdominal strength (n/30s)	Not at all	–	$p<0.001$	$p=0.001$	$p<0.001$
	<1 hr/day	–	–	$p<0.001$	ns
	≤1 less than 2 hrs/day	–	–	–	$p<0.001$
	≥2 hrs/day	–	–	–	–
Arm strength (s)	Not at all	–	ns	$p<0.001$	$p=0.01$
	1–2 times/week	–	–	$p<0.001$	$p=0.01$
	≥3 times/week	–	–	–	ns
	≥2 hrs/day	–	–	–	–

Legend: ns – no significant.

Table 6. Results of multivariate logistic regression for the variables of body proportions (model I and model II)

Variables		BMI model I[A]		BMI model II[B]		WHtR model I[A]		WHtR model II[B]	
		OR 95%CI	*p*	OR 95%CI	*p*	OR 95%CI	*p*	OR 95%CI	*p*
Q1 – ref.	Screen time								
Q2	not at all	ref.		ref.		ref.		ref.	
	<1hr/day	1.23 (0.89–1.42)	0.328	1.12 (0.89–1.42)	0.326	0.76 (0.59–0.97)	0.027	0.83 (0.65–1.07)	0.157
	1<2hrs/day	1.12 (0.88–1.42)	0.373	1.11 (0.88–1.42)	0.375	0.86 (0.67–1.11)	0.245	0.88 (0.68–1.13)	0.311
	≥2hrs/day	1.19 (0.94–1.51)	0.152	1.20 (0.94–1.52)	0.142	0.72 (0.56–0.93)	0.011	0.84 (0.66–1.09)	0.193
Q3	not at all	ref.		1.0		ref.			
	<1hr/day	1.21 (0.95–1.54)	0.119	1.21 (0.95–1.53)	0.122	0.77 (0.60–0.99)	0.045	0.92 (0.71–1.18)	0.493
	1<2hrs/day	1.24 (0.97–1.59)	0.084	1.24 (0.97–1.59)	0.084	0.97 (0.74–1.25)	0.793	0.99 (0.77–1.30)	0.995
	≥2hrs/day	1.29 (1.01–1.65)	0.039	1.30 (1.01–1.65)	0.038	0.77 (0.60–0.99)	0.042	1.01 (0.78–1.31)	0.950
Q4	not at all	ref.		ref.		ref.		ref.	
	<1hr/day	1.10 (0.86–1.40)	0.434	1.09 (0.86–1.39)	0.491	0.76 (0.59–0.97)	0.029	0.86 (0.67–1.11)	0.258
	1<2hrs/day	1.29 (1.00–1.65)	0.047	1.28 (0.99–1.64)	0.053	0.94 (0.72–1.21)	0.624	0.96 (0.74–1.25)	0.766
	≥2hrs/day	1.32 (1.03–1.69)	0.027	1.30 (1.02–1.66)	0.037	0.79 (0.62–1.02)	0.074	0.98 (0.76–1.27)	0.889
Q1 – ref.	Spontaneous Physical Activity								
Q2	<1hr/day	ref.		ref.		ref.		ref.	
	≥1hr/day	1.02 (0.94–1.11)	0.591	1.01 (0.93–1.10)	0.142	0.96 (0.88–1.04)	0.342	1.02 (0.93–1.11)	0.710
Q3	<1hr/day	ref.		ref.		ref.		ref.	
	≥1hr/day	1.08 (0.99–1.18)	0.069	1.21 (0.97–1.59)	0.122	0.95 (0.87–1.04)	0.256	1.04 (0.96–1.14)	0.350
Q4	<1hr/day	ref.		ref.		ref.		ref.	
	≥1hr/day	1.27 (1.17–1.39)	0.001	1.25 (1.14–1.36)	0.001	1.08 (0.99–1.18)	0.087	1.15 (1.06–1.26)	0.001
Q1 – ref.	Organized Physical Activity								
Q2	not at all	ref.		ref.		ref.		ref.	
	1–2 times/week	1.08 (0.99–1.18)	0.099	1.08 (0.98–1.18)	0.106	1.02 (0.93–1.11)	0.734	1.02 (0.93–1.12)	0.661
	≥3times/week	0.83 (0.57–1.21)	0.336	0.83 (0.57–1.21)	0.336	0.98 (0.67–1.43)	0.906	0.97 (0.66–1.42)	0.889

Q3	not at all	ref.		ref.		ref.		ref.	
	1–2 times/ week	1.13 (1.03–1.23)	0.011	1.12 (1.02–1.23)	0.015	1.04 (0.94–1.13)	0.453	1.05 (0.96–1.16)	0.263
	≥3times/ week	0.95 (0.66–1.36)	0.767	1.12 (1.02–1.23)	0.766	1.04 (0.72–1.52)	0.824	1.04 (0.71–1.52)	0.844
Q4	not at all	ref.		ref.		ref.		ref.	
	1–2 times/ week	1.14 (1.04–1.24)	0.006	1.10 (1.01–1.21)	0.035	1.06 (0.97–1.16)	0.185	1.06 (0.97–1.16)	0.210
	≥3times/ week	1.02 (0.71–1.45)	0.929	1.01 (0.71–1.45)	0.935	1.20 (0.83–1.72)	0.327	1.19 (0.82–1.71)	0.359

Legend: [A] adjusted to the age of the subjects; [B] adjusted to the age of the subjects, mother's education, siblings, place of living.

differences between the mean body flexibility influenced by screen time (Table 3). The results of the multiple comparisons are presented in Table 5.

In the unadjusted model (model I) presented in Table 6, higher values of BMI (Q3) were positively associated with longer screen time (≥2hrs/day: $p=0.039$) and organized PA (1–2 times/week: $p=0.011$). BMI values related to Q4 were also found to be influenced by screen time (<2hrs/day: $p=0.047$ and ≥2hrs/day: $p=0.027$), spontaneous PA ($p=0.001$) and organized PA (1–2 times/week: $p=0.006$). Model II, adjusted for other variables, confirmed only a higher probability of reaching the values related to Q3–Q4 of BMI due to screen time (≥2 hrs/day; $p=0.037$) and sports activities (1–2 times/week: $p=0.015$, $p=0.035$). A positive effect of spontaneous activity was observed only for quartile 4 of BMI ($p=0.001$). WHtR turned out to be influenced by screen time and spontaneous physical activity. The fact of using TV and computer <1hr/day ($p=0.027$; $p=0.011$) and ≥2hours/day ($p=0.011$; $p=0.042$) lowered the probability of obtaining values related to quartiles 2 and 3 of WHtR. In addition, using a computer and watching TV <1hour/day significantly lowered the probability of achieving the results of quartile 4 of WHtR ($p=0.029$). In model II, most of the significant associations were not confirmed, and only the association between spontaneous activity and the values of Q4 of WHtR was significant ($p=0.001$) (Table 6).

In model I presented in Table 7, screen time in each of the distinguished categories significantly decreased the chance of achieving the results of Q2–Q4 of abdominal muscle strength compared to the values of Q1 ($p=0.001$). Sedentary behaviors related to exposure to a computer and TV screens in the amount of 1–2 hours a day reduced the probability of achieving the results of quartile 3 and 4 of explosive strength of the lower limbs (respectively: $p=0.024$; $p=0.25$) as well quartile 4 of arm strength ($p=0.031$). Longer screen time (>2 hours/day) was associated only with a lower probability of achieving Q4 results of explosive strength of the lower limbs ($p=0.004$). In the model, adjusted for variables, significant and negative impact of screen time on the abdominal muscle strength results in the distinguished quartiles ($p=0.001$) was confirmed, and the OR values were at a similar level. Additionally, prolonged sitting time in front of the computer and TV screen (>2hrs/day) decreased the chance of achieving high

Table 7. Results of multivariate logistic regression for the components of physical fitness (model I and model II)

Variables		Explosive strength of lower limbs model I^{A}		Explosive strength of lower limbs model II^{C}		Abdominal strength Model I^{A}		Abdominal strength Model II^{C}		Arm Strength Model I^{A}		Arm Strength Model II^{C}		Flexibility Model I^{A}		Flexibility Model II^{C}	
		p	OR 95%CI	*p*	OR 95%CI	*p*	OR 95%CI	*p*	OR 95%CI	*p*	OR 95%CI	*p*	OR 95%CI	*p*	OR 95%CI	*p*	OR 95%CI
Q1 – ref.	Screen time																
Q2	not at all	ref.		ref.		ref.		ref.		ref.		ref.		ref.		ref.	
	<1hr/day	0.88 (0.68–1.13)	0.312	0.86 (0.67–1.11)	0.253	0.17 (0.11–0.27)	0.001	0.17 (0.11–0.27)	0.001	0.89 (0.70–1.14)	0.345	0.89 (0.70–1.14)	0.366	0.99 (0.76–1.29)	0.934	1.05 (0.80–1.38)	0.721
	1<2hrs/day	0.83 (0.64–1.07)	0.154	0.86 (0.66–1.11)	0.249	0.16 (0.10–0.25)	0.001	0.16 (0.10–0.25)	0.001	0.90 (0.70–1.16)	0.416	0.92 (0.71–1.18)	0.492	0.94 (0.71–1.24)	0.657	0.95 (0.72–1.25)	0.697
	≥2hrs/day	0.92 (0.71–1.18)	0.503	0.89 (0.69–1.15)	0.371	0.18 (0.12–0.28)	0.001	0.18 (0.11–0.28)	0.001	0.93 (0.72–1.19)	0.541	0.93 (0.73–1.20)	0.592	0.88 (0.67–1.16)	0.363	0.97 (0.74–1.28)	0.843
Q3	not at all	ref.		ref.		ref.		ref.		ref.		ref.		ref.		ref.	
	<1hr/day	0.81 (0.63–1.04)	0.096	0.80 (0.62–1.03)	0.084	0.22 (0.14–0.36)	0.001	0.22 (0.14–0.35)	0.001	1.00 (0.76–1.28)	0.987	1.01 (0.78–1.29)	0.969	0.93 (0.73–1.18)	0.560	0.98 (0.77–1.25)	0.877
	1<2hrs/day	0.74 (0.57–0.96)	0.024	0.78 (0.60–1.01)	0.059	0.19 (0.12–0.31)	0.001	0.19 (0.12–0.31)	0.001	0.66 (0.73–1.22)	0.944	0.74 (0.96–1.24)	0.735	0.88 (0.69–1.13)	0.321	0.89 (0.70–1.15)	0.383
	≥2hrs/day	0.84 (0.65–1.09)	0.194	0.83 (0.64–1.08)	0.169	0.23 (0.14–0.36)	0.001	0.23 (0.14–0.36)	0.001	0.97 (0.75–1.25)	0.816	0.98 (0.76–1.27)	0.894	0.82 (0.64–1.05)	0.110	0.89 (0.70–1.15)	0.375
Q4	not at all	ref.		ref.		ref.		ref.		ref.		ref.		ref.		ref.	
	<1hr/day	0.84 (0.65–1.08)	0.173	0.83 (0.64–1.07)	0.148	0.17 (0.11–0.26)	0.001	0.17 (0.11–0.26)	0.001	0.85 (0.66–1.09)	0.190	0.83 (0.65–1.07)	0.150	0.87 (0.69–1.10)	0.248	0.98 (0.71–1.13)	0.356
	1<2hrs/day	0.74 (0.57–0.96)	0.025	0.81 (0.62–1.05)	0.106	0.15 (0.09–0.23)	0.001	0.15 (0.09–0.23)	0.001	0.76 (0.59–0.98)	0.031	0.77 (0.60–0.99)	0.045	0.30 (0.66–1.06)	0.143	0.85 (0.67–1.09)	0.199
	≥2hrs/day	0.69 (0.53–0.89)	0.004	0.68 (0.52–0.88)	0.003	0.16 (0.11–0.26)	0.001	0.16 (0.10–0.25)	0.001	0.78 (0.61–1.01)	0.054	0.77 (0.59–0.99)	0.039	0.82 (0.65–1.04)	0.111	0.87 (0.68–1.10)	0.238

values of arm muscle strength and explosive lower limb strength related to Q4 ($p=0.003$; $p=0.039$). while in the case of arm strength (Q4), the shorter screen time (1<2 hours/day) also reduced the probability of achieving high values related to Q4 ($p=0.045$).

The analysis of the OR values obtained for spontaneous activity in model I showed its significant and positive impact on the shaping of lower limb strength values higher than quartile 1 ($p<0.01$) and negative on the values of quartile 2 of arm strength ($p=0.027$). The final model showed a greater probability of achieving results related to the 3rd and 4rd quartile of lower limbs strength (both: $p=0.001$) and also a lower probability of achieving results related to quartile 2 of arm strength ($p=0.037$) (Table 7).

Model I showed a significant and positive effect of spontaneous physical activity on the achievement of results related to Q2–Q3 compared to Q1 (Q2: $p=0.009$; Q3 and Q4: $p=0.001$, respectively), but it lowered the probability of achieving the value of quartile 2 of arm strength ($p=0.027$). Model II, corrected for confounding factors, confirmed a significantly higher probability of reaching the values of Q3 and Q4 of the explosive strength of the lower limbs (both: $p=0.001$) as well as Q2 of arm strength ($p=0.037$). Both the unadjusted and adjusted models also confirmed a lower probability of reaching arm strength values related to quartile 2. There was no significant effect of spontaneous activity on abdominal strength. There was also no significant impact on the arm strength values related to quartile 3 and 4 (Table 7).

Physical activities organized 1–2 times a week turned out to be important for the explosive strength of the lower limbs, the strength of the abdominal muscles and arm. They increased the probability of achieving results related to Q2 and Q4 of lower limbs strength and quartile 3 of abdominal strength. Compared to the results related to Q1, they decreased the likelihood of achieving the results of Q3 and Q4 of arm strength. The final model confirmed their positive effect on the explosive strength of the lower limbs (Q2–Q4) and on the strength of the abdominal muscles (Q4). A significant negative impact on arm muscle strength was visible only in quartile 4. Both models proved that a higher frequency of physical activities (≥3 times/week) increased the probability of achieving results related to quartiles: 2–4 of each tested strength (Table 7).

Organized physical activity (1–2 times/week) significantly increased the probability of obtaining the values of body flexibility from the third ($p=0.050$) and fourth ($p=0.001$) quartiles, while activities organized more often (≥3 times/week) were associated with a higher probability of achieving results from the fourth quartile ($p=0.011$) than the first quartile. Model II confirmed the association calculated for the fourth quartile in model I at the same level of significance (Table 7).

Discussion

The results of our study showed that time spent in a sedentary manner, spontaneous PA and organized PA are important and independent predictors of body proportions: BMI, WHtR, and strength components, but not flexibility in girls aged 6 and 7. Their influence, however, manifests itself with different strength, depending on the analyzed index or component of physical fitness. After adjust-

Q1 – ref.	Spontaneous PA																
Q2	<1hr/day	ref.		1.0		ref.		ref.		ref.		ref.		ref.		ref.	
	≥1hr/day	1.12 (1.03–1.22)	0.009	1.08 (0.99–1.18)	0.069	1.08 (0.99–1.18)	0.095	1.08 (0.99–1.17)	0.102	0.91 (0.83–0.99)	0.027	0.91 (0.83–0.99)	0.037	0.98 (0.89–1.07)	0.587	1.01 (0.92–1.12)	0.766
Q3	<1hr/day	ref.		ref.		ref.		ref.		ref.		ref.					
	≥1hr/day	1.79 (1.63–1.98)	0.001	1.20 (1.10–1.31)	0.001	1.09 (0.99–1.19)	0.073	1.09 (0.99–1.19)	0.079	0.97 (0.89–1.06)	0.448	0.99 (0.90–1.08)	0.746	1.01 (0.92–1.09)	0.896	1.03 (0.95–1.13)	0.459
Q4	<1hr/day	ref.		ref.		ref.		ref.		ref.		ref.					
		1.29 (1.18–2.94)	0.001	1.25 (1.14–1.36)	0.001	1.09 (1.00–1.19)	0.053	1.09 (1.00–1.19)	0.058	0.93 (0.85–1.01)	0.094	0.94 (0.86–1.03)	0.185	1.03 (0.95–1.12)	0.488	1.02 (0.94–1.12)	0.561
Q1 – ref.	Organized PA																
Q2	not at all	ref.		ref.		ref.		ref.		ref.		ref.		ref.		ref.	
	1–2 times/ week	2.01 (1.27–1.54)	0.034	1.06 (0.96–1.17)	0.279	1.05 (0.95–1.15)	0.328	1.04 (0.95–1.15)	0.391	0.93 (0.85–1.02)	0.101	0.98 (0.89–1.07)	0.656	1.02 (0.92–1.13)	0.721	1.03 (0.93–1.14)	0.617
	≥3times/ week	1.40 (1.26–3.20)	0.003	2.04 (1.28–3.26)	0.003	3.19 (1.81–5.63)	0.001	3.07 (1.74–5.43)	0.001	2.45 (1.50–1.01)	0.001	2.52 (1.54–4.12)	0.001	1.13 (0.74–1.74)	0.565	1.12 (0.73–1.72)	0.611
Q3	not at all	ref.		ref.		ref.		ref.		ref.		ref.		ref.		ref.	
	1–2 times/ week	1.23 (1.12–1.35)	0.001	1.17 (1.06–1.29)	0.002	1.05 (0.95–1.15)	0.328	1.02 (0.92–1.12)	0.771	0.88 (0.80–0.96)	0.006	0.95 (0.87–1.05)	0.305	1.09 (1.00–1.20)	0.050	1.08 (0.99–1.19)	0.090
	≥3times/ week	1.97 (1.23–3.16)	0.005	1.98 (1.23–3.18)	0.005	3.19 (1.81–5.63)	0.001	3.28 (1.85–5.83)	0.001	3.24 (2.02–5.21)	0.001	3.31 (2.05–5.33)	0.001	1.20 (0.82–1.77)	0.347	1.19 (0.81–1.76)	0.370
Q4	not at all	ref.		ref.		ref.		ref.		ref.		ref.		ref.		ref.	
	1–2 times/ week	1.51 (1.37–1.65)	0.001	1.35 (1.23–1.49)	0.001	1.14 (1.04–1.28)	0.008	1.14 (1.03–1.25)	0.008	0.80 (0.77–0.80)	0.001	0.88 (0.80–0.97)	0.001	1.19 (1.09–1.30)	0.001	1.17 (1.07–1.28)	0.001
	≥3times/ week	3.50 (2.26–5.41)	0.001	3.56 (2.29–5.53)	0.001	3.76 (2.14–6.61)	0.001	3.58 (2.04–6.30)	0.001	1.61 (1.46–1.76)	0.001	2.91 (1.79–4.74)	0.001	1.60 (1.12–2.30)	0.011	1.60 (1.11–2.30)	0.011

Legend: [A]adjusted to the age of the subjects; [C]adjusted to the age of the subjects, BMI, mother's education, siblings, place of residence.

ing for socio-demographic variables, the final models showed that screen time, especially at ≥2 hours/day, significantly increased the likelihood of achieving BMI scores related to quartiles 3 and 4. However, it did not significantly affect the other abdominal obesity index (WHtR), despite the fact that in the following quartiles an upward trend was observed for the OR parameters. Previous studies show that the associations between ST and obesity rates in preschool children are not clear and there are no studies taking sex into consideration (Cieśla et al. 2014, Goncalves et al. 2019, Jago et al. 2005, Stankiewicz et al. 2010, Wijtzes et al. 2014). The research of Wijtzes et al. (2014) showed that while screen time (≥2 hours/day) was associated with obesity, as assessed by various indicators in boys and girls analyzed together, the addition of socio-demographic variables and diet to the final models resulted in diminishing of this association. These findings contradict previous studies that found consistent cross-sectional and longitudinal associations between children's screen time and the risk of being overweight and obese. For example, the long-term research of Jago et al. (2005) proved that screen time (watching TV) negatively affects the level of BMI in the group of 6–7-year-olds, and in earlier age groups the association still exist, although less significantly. Most Probably, the period of 6–7 years of age can be considered a critical period when screen time may affect BMI, especially screen exposure time of ≥2 hours/day. The lack of association of screen time and WHtR obtained in our research, most probably results from the fact that general obesity (BMI) is typical for this age, not abdominal obesity. In the literature, the chosen indicator of obesity in preschool children is the BMI and the thickness of the skin and fat folds. On the other hand, WHtR is analyzed in older age groups as a risk of metabolic syndrome. Other studies have indicated a more indirect than direct role of screen time in shaping overweight and obesity. First of all, attention was drawn to the cause-and-effect association between the time devoted to sedentary behavior and the fact of having a TV or Internet connection in the children's room. The consequence of which was more frequent and longer watching TV programs or using a computer outside parental control (Emond et al. 2018). This created a risk of unhealthy eating behavior during and immediately after watching TV/using the computer (increased consumption of sugar-sweetened snacks and drinks), (Goncalves et al. 2019, Olafsdottir et al. 2014, Trofholz et al. 2017). In addition, a significant similarity was suggested between the way parents and their children spend their free time, as well as the parents' sense of self-efficacy in reducing the time spent on watching TV/using a computer (Goncalves et al. 2019).

The results of our research showed a significant association between both spontaneous and organized physical activities and BMI. In girls who attended organized PA 1–2 times/week, the probability of BMI values associated with Q3 of BMI increased 1.1–1.12 times. Whereas girls engaged in spontaneous PA ≥1hour/day obtained BMI values assigned to Q4 more often. In another index related to abdominal obesity – WHtR, only spontaneous PA ≥1hour/day increased the risk of reaching higher values related to Q4.

There are no studies in Poland to assess the association between spontaneous or organized physical activity and obesity indices in preschool children. However, the results of our study are in contrast to other studies conducted in other countries. Many publications drew attention to the positive effect of physical activity in lowering BMI values and adipose tissue. Fang et al. (2017) found that moderate and intense activity physical activity (MVPA) reduced the level of triceps skinfold thickness in a group of children not divided according to their sex. Remmers et al. (2014) pointed to the significant importance of MVPA in the reduction of BMI in children with high BMI. The reduction in BMI due to light PA does not apply to girls. In turn, Trost et al. (2003) showed that more overweight boys showed lower physical activity, but no such association was observed in girls. Drenowatz et al. (2019), examining the effect of sports training on body weight and BMI expressed in percentiles (BMIPCT) observed a slight and insignificant difference in both parameters in younger children (up to 10 years of age) without categorizing according to their sex. The inverse association between overweight and obesity indices and physical activity obtained in our study probably had a different cause. Perhaps, the typical relation of somatic features on the analyzed parameters in the group of more active girls and the fact that taller girls engage in physical activity more often than their peers with a slower growth rate. In our study group, the more active girls were significantly taller than their less active peers, which consistently resulted in higher levels of other somatic parameters, including body weight. Another possible explanation for this phenomenon is that the negative health effects of the time devoted to sedentary behavior were not compensated by physical activities undertaken by girls, even in the case of the most physically active girls.

The analysis of the associations between screen time and physical fitness showed that they were most pronounced in the abdominal strength and were related to all the distinguished time categories related to the use of TV and computers. In girls, even the shortest selected category (<1hr/day) compared to the reference category was associated with a lower probability of achieving values related to quartiles 2–4. This suggests a significant weakening of the strength of the abdominal muscles during sedentary behavior, due to the forced position of immobility for a long time while watching TV or using a computer (Jago et al. 2005, Stiglic and Viner 2019, Straker et al. 2018, Straker and Zabatiero 2019.). In arm strength, the observed associations were slightly weaker and regarded only the values related to the last distinguished quartile (Q4), where time spent sitting too long >1hr/day clearly decreased the probability of achieving results related to the last distinguished quartile. The explosive force of the lower limbs seemed to be the least susceptible to screen time. Only girls engaged ≥2hours/day in screen time were less likely to achieve values related to quartile 4. Based on the observation of children aged 5–16, Hardy et al. (2018) indicated that every additional hour spent on sitting time during the day reduced the chance of a high level of explosive strength in the lower limbs, especially in older age groups. The research results were obtained after taking into account the potential covariates. Similar research results were obtained by Potter et al. (2017), who did not observe a significant relationship between sitting time and the explosive strength of the lower limbs and hands. To the best of our knowledge, there are no scientific publications on the association between arm strength measured by hanging on a bar and screen time in girls aged 6–7 years. However, there are studies that have used another index to assess arm strength: pull-ups. They show that screen time was only significantly inversely related to the ability to perform one or more pull-ups in children aged 6–15 years (Edelson et al. 2016).

No association has been observed between screen time and flexibility. There is surprisingly little research into the association between screen time and body flexibility in children. The previously shown association between screen time and flexibility were small and rather statistically insignificant and consistent with our observations (Potter et al. 2017). Most likely, this is due to the fact that age and physical activity play a greater role in the development of this trait (Koslow 1987).

Associations between spontaneous and organized PA and physical fitness have been observed. They related to the components of strength. A significant association between spontaneous PA and the explosive strength of the lower limbs in higher quartiles and in the quartile 2 of arm strength was found. Organized sports and recreational activities, regardless of the distinguished category, significantly increased the probability of achieving results related to quartile 4 of arm strength, abdominal strength and explosive strength of the lower limbs. The odds ratio values suggest that greater benefits for strength development come from more frequent (at least 3 times a week) than less frequent (1–2 times a week) participation in sports activities. A significant correlation between organized PA and body flexibility was also found in girls with the highest level of this feature. Participation in organized PA increased the probability of achieving high flexibility parameters related to quartile 4.

The improvement of muscle strength thanks to physical activity is a widely recognized fact. Earlier studies had established higher parameters of many fitness tests, even for children in preschool age (Bayer et al. 2009, Ebengger et al. 2012, Fang et al. 2017, Tuan et al. 2019). Fang et al. (2017) found a strong correlation between standing long jump results, and physical activity (MVPA and low PA) among preschool boys. The results of other studies showed significant correlation between physical activity and the skeletal muscle mass index score (Ito et al. 2021). A 12-month longitudinal study of 4-year-old Swedish children demonstrated the importance of intense and moderate physical activity for the improvement of strength abilities, and the persistent strong associations between the studied variables were visible throughout the follow-up period of the children (Leppänen et al. 2017). The literature on the subject also proves significant links between fundamental motor skills (grabbing, throwing, jumping, running, creeping) and physical activity in preschool children (Barnett et al. 2011, Morgan et al. 2013). They may provide some indirect evidence of a strong relationship between fitness and physical activity in children. The high level of motor skills determines active participation in various sports and recreational forms, while their low level will cause the child to withdraw from this type of activity, because, as we know, physical fitness is the foundation of motor skills, especially in preschool age (Bürgi et al. 2011). The study results that deal with this problem prove rather small and weak association between both variables. Earlier research results were inconsistent. In the studies of Fang et al. (2017) the association between physical activity (MVPA and LPA) and the level of flexibility in girls was not shown. However, in other studies related to the young population, it was observed that body flexibility, physical activity and strength were predictors of back pain in adults (Gordon and Bloxham 2016).

In children participating in organized physical activities, a higher level of strength was observed (Drenowatz et al. 2019). A meta-analysis by Oliveira et al. (2017) showed a similar association for overweight and obese children. However, study by Riso et al. (2019) only confirmed a significant difference in physical capacity, while the explosive strength of the lower limbs measured by a standing long jump was at a similar level in 6-year-old children from sports and non-sports classes, while the study by Ebenegger et al. (2012) only confirmed a significantly higher level of fitness in preschool children who attend sports classes. However, our study showed that improvement in strength capacity can most often be expected in girls who are more physically fit and exercise 3 or more times a week. The lower differentiation in younger children who exercise regularly and do not exercise is probably due to the fact that younger children are more likely than older children to participate in sports and recreation activities in preschool and school, and not in sports clubs. They also play spontaneously more often than the older ones, hence the possible differences in the level of fitness may be blurred, and their physical activity usually focuses on long-lasting forms of play associated with low level of activity, interspersed only with short-term segments of moderate and intense activity (Hardy et al. 2018). Hence, each additional organized physical activity will not only help to compensate for deficits related to physical fitness and physical activity, but also has a positive effect on the mass and strength of large muscle groups involved in specific sports activities (Dahab and McCambridge 2009). By early shaping the patterns of active participation in sport, they also constitute a solid basis for a more active lifestyle in youth and adulthood (Maillane-Vanegas et al. 2017).

However, our study suggests that it is likely that the associations between the observed variables relate to the fitter girls rather than the less fit ones, who engage in sports activities more often than others, thus improving the already high level of fitness in relation to their peers, including strength abilities and flexibility of the body.

Limitations

Our study has some limitations. First of all, these are cross-sectional studies, so the mechanism of cause-and-effect associations between screen time, physical activity and physical fitness is not entirely possible to analyze. Another important limitation seems to be the determination of spontaneous activity and screen time based on the parents' knowledge, who may overestimate or underestimate the data provided. However, this method of obtaining information on children's leisure activities, based on parents' reports, is widely recognized and used (Bentley et al. 2012). The strength of the study is the fact that the study group is a representative group of the child population in Poland and is ethnically homogeneous, and analyses conducted in two models, i.e., row and adjusted.

Conclusion

Our research has shown that screen time-related sedentary behavior and physical activity affect overweight and obesity indices (especially BMI) and strength abilities. The observed associations more often affected girls with a higher level of fitness. The observed significant associations between various forms of strength and screen time in 6–7-year-old girls, indicates the need for a greater understanding of the mechanisms of shaping a sedentary lifestyle and may provide the basis for further studies in this regard.

Authors' contribution

All four authors equally contributed to design the study, collecting the data, statistical analysis, preparing the first and final draft.

Conflict of interest

The authors declare no conflict of interests.

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