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Physical fitness and health behaviors of 15-16-year-old students from Wrocław schools

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Authors' contribution:

A. Study design/planning
B. Data collection/entry
C. Data analysis/statistics
D. Data interpretation
E. Preparation of manuscript
F. Literature analysis/search
G. Funds collection

Abstract

Background. The research aimed at examining the relationship between physical fitness (PF) and health behaviors (HB) in 15- and 16-year-olds, distinguishing between those with health-enhancing and health-risk behaviors. The results covered physical activity, sedentary behavior, diet, tobacco use, alcohol, and cannabis consumption.
Material and methods. The analysis included 636 students from 34 Wrocław schools, Poland. PF was measured using the International Physical Fitness Test (IPFT), a comprehensive assessment tool. HB were assessed with the standardized Health Behavior in School-aged Children questionnaire from a WHO study, used in cross-national research across Europe and North America.
Results. Adolescents with health-enhancing behaviors had higher levels of motor abilities: speed, strength (lower-limb, arm, abdominal, and hand muscles), and flexibility. Health-conscious girls scored better in speed, strength, and flexibility, while boys demonstrated greater strength (lower-limb, arm, and hand muscles) than peers with health-risk behaviors.
Conclusions. It is important to implement health-promoting behaviors in adolescents through the entire educational environment. The behaviors will ultimately become a key factor in supporting adolescents' PF.

Keywords: dietary behaviors, sedentary behaviors, physical activity, physical fitness, adolescents

Introduction

Research have confirmed the importance attached to monitoring not only young peoples' health behaviors (HB) but also their physical fitness (PF) [1,2]. With a view to rendering the definition of PF more precise, it was recognized as the ability to use a person's own motor potential effectively [3]. In motor fitness there are two aspects to be distinguished: the potential side and effective side. The first one encompasses predispositions, abilities and skills, whereas the second one is comprised of motor fitness and PF [4].

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In the definition of PF the emphasis is put on a person's current abilities to perform a physical activity which requires having to engage a considerable amount of strength, speed, endurance, agility, flexibility and all the other motor abilities. PF may be conducive to achieving a higher level of physical activity and everyday life capacity, as well as to supporting mental health or helping to avoid diseases [4]. Furthermore, PF represents a desirable value which stands in a close relation to general human biological development. In comparison to somatic development, it is determined, on the one hand, by genetic variations, while, on the other hand, it is affected by environmental factors [5].

Studies conducted over many years on a range of aspects involved in PF triggered a process leading to a shift away from the mechanical and biological concepts, behavioral and cultural, as well as motor concepts towards adopting physiological, medical, as well as health approaches [6].

The inevitable changes that our civilization has been experiencing as a result of a rapid scientific and technological development are posing new challenges to the theory and practice in the field of healthcare and disease prevention, as well as physical education (PE). Numerous technological conveniences have ever more frequently made people eliminate physical effort from their daily lives. On top of that, people seem to be increasingly less inclined to undertake activities designed to foster their health and well-being.

In order to develop a proper strategy for multiplying health gains, PF has drawn closer to a concept of health that is no longer interpreted as a lack of disease but rather a phenomenon in its own right. As such it needs to be explored and diagnosed, while methods to assess its determinants and mechanisms need to be searched for [7].

The ultimate task of PF is to achieve a level of physical and mental health that would reduce the risk of succumbing to diseases [8]. Once PF is thus interpreted, it is possible to see the role of PE in the process of teaching people healthy behaviors. At this point it is worth noting the measures implemented within the PE curriculum aimed at encouraging young people to take care of their health and multiply health gains.

Enhancing PF, perceived as a manifestation of adolescents' positive health, should not involve only body training, but, first and foremost, should teach an individual how to care about their PF and health [9]. Increasing professional knowledge about young people's HB, their motor and somatic development plays a crucial role in the evaluation of the directions taken by the development [10]. The health and development of a population may determine the health of the future generations.

Aim of the work

The aim of the study was to show the correlation between PF and HB among Wrocław (Poland) adolescents aged 15-16 years.

Material and methods

The study included Wrocław adolescents in the 15-16 age group from 34 schools who had volunteered to participate in the project "New Quality of Pedagogical Practices" – conducted by the staff of the Institute of School Physical Education Methodology at the Wrocław University of Health and Sport Sciences (AWF Wrocław). The survey on the pupils' HB as well as somatic and fitness measurements were carried out in collaboration with the students of AWF Wrocław, as part of their pedagogical practices.

For the study of HB of young people in Wrocław, the project used a standardized survey questionnaire as a research tool: Health Behavior in School-aged Children (HBSC), a WHO Collaborative Study. The WHO survey is comprised of questions whose accuracy and reliability have been proven, while the fact that it

is conducted on a periodic basis allows for monitoring new trends and developments over time [11]. In Poland, the HBSC study has been carried out every four years since 1990, covering school-aged children in the 11-15 age group.

The current paper presents the results obtained by investigating health-enhancing and health risk behaviors in the following areas: physical activity (moderate-to-vigorous physical activity (MVPA) indicator, vigorous physical activity (VPA) indicator), sedentary behaviors, dietary behaviors, tobacco smoking, alcohol consumption, cannabis use.

To present the data reliably and transparently, it was shown in a tabular format. The value of the MVPA indicator, was broken down into two categories. It allowed the participants to be identified as those who displayed health-enhancing behaviors (HEB) and those with health risk behaviors (HRB). The value denoting less than seven days was considered to be a threshold implying respondents' failure to meet the international recommendations deemed as necessary for maintaining health and proper development. The value of seven days of physical activity performed for at least 60 minutes daily throughout the week was recognized as a level of physical activity in line with the international guidelines.

Before asking the question about the participants' MVPA, they had been given information prepared by the HBSC research network explaining that MVPA referred to every activity and classes where a person's heart rate increased and they had the sensation of being "out of breath" (we breath faster). It is related not only to PE classes held at school, but also to doing sports, playing physical games or marching to school.

The International Physical Fitness Test (IPFT), a standardized test for measuring performance, was employed to assess the level of PF among the Wrocław adolescents. The IPFT consists of a battery of tests recommended for a comprehensive assessment of PF [12].

In total, 1110 pupils were surveyed, including 496 girls and 614 boys. Having verified the data, the final results to be qualified were those obtained in reference to 636 pupils, 404 girls and 232 boys (Table 1). The pupils participated in the study voluntarily. Moreover, they had been informed of the right to refuse to answer questions which they perceived too personal. The participants had been reassured as to the confidentiality and anonymity of their responses. The results referring to 474 pupils whose parents had failed to give the relevant consent were not qualified for the analysis.

Table 1. Sample characteristics by calendar age and gender (N=636)

Gender	15 years and 1st quarter	15 years and 2nd quarter	15 years and 3rd quarter	15 years and 4th quarter	16 years and 1st quarter	16 years and 2nd quarter
Boys (N=232)	3	69	34	66	49	11
Girls (N=404)	13	116	63	104	84	24
Total (N=636)	16	185	97	170	133	35

The WHO questionnaire, HBSC was coded to allow synchronization of the data obtained on the basis of the IPFT conducted parallelly, and the body height and weight measurements.

In order to investigate the relationships between HEB and HRB reported by Wrocław adolescents and their PF and somatic build, the Mann-Whitney U test was employed. The significance level was adopted at a level of 0.05. The Mann-Whitney U test allowed one to establish whether the difference between the groups was statistically significant, and thereby whether it was possible to reject that the distributions did not differ at the set level of significance.

Results

The findings produced over the course of the survey suggested that adolescents who undertook MVPA on a daily basis were characterized by a statistically significant higher level of motor abilities. Those included: speed abilities (50 m sprint), leg muscle strength (standing long jump), agility (4x10 m shuffle run), abdominal muscle strength (sit-ups performed in 30 seconds) and flexibility (standing forward bend) which proved to be at a higher level, as compared to participants displaying HRB in terms of the aspect in question (Table 2).

Table 2. Variation in mean values for selected motor abilities (expressed on a point scale) in relation to MVPA reported by respondents

MVPA At least 60 minutes a day over the last seven days					
Results in total	**HEB**	**HRB**	**Mann-Whitney U**	**Z**	**Asymptotic significance (two-sided)**
	7 days a week	**Less than 7 days a week**			
Speed	73	64	14604.500	-3.482	0.000
Lower-limb muscle strength	58	54	14427.000	-3.216	0.001
Arm muscle strength	59	59	17855.000	-0.903	0.366
Agility	73	64	14545.500	-3.526	0.000
Abdominal muscle strength	62	54	14579.500	-3.497	0.000
Flexibility	57	52	12512.000	-4.972	0.000
Hand muscle strength	47	49	18345.000	-0.780	0.436

Notes: MVPA – moderate-to-vigorous physical activity, HEB – health-enhancing behaviors, HRB – health risk behaviors.

Looking into the varying means of the selected motor abilities (expressed on a point scale), and MVPA reported by respondents, controlling for gender, one could observe that the differences found failed to be statistically significant although boys displaying HEB in the given aspect scored better in terms of the mean point values of such motor abilities as speed (50 m sprint), lower-limb muscle strength (standing long jump), agility (4x10 m shuffle run), abdominal muscle strength (sit-ups in 30 seconds) and flexibility (standing forward bend) (Table 3).

The results proved to be different for the group of girls. In terms of PF girls reporting HEB indeed differed significantly from those displaying HRB and performing insufficient amount of physical activity throughout the week (Table 3).

Table 3. Variation in mean values for selected motor abilities (expressed on a point scale) in relation to MVPA, controlling for respondents' gender

MVPA At least 60 minutes a day in the last seven days					
Results by gender	HEB	HRB	Mann-Whitney U	Z	Asymptotic significance (two-sided)
	7 days a week	Less than 7 days a week			
Boys (N=232)					
Speed	62	60	2802.500	-0.435	0.664
Lower-limb muscle strength	55	52	2530.500	-1.270	0.204
Arm muscle strength	49	49	2816.000	-0.065	0.949
Agility	71	65	2538.000	-1.251	0.211
Abdominal muscle strength	52	50	2685.000	-0.795	0.427
Flexibility	56	53	2412.500	-1.631	0.103
Hand muscle strength	48	50	2529.000	-1.273	0.203
Girls (N=404)					
Speed	80	67	4126.500	-4.562	0.000
Lower-limb muscle strength	60	55	4541.000	-3.496	0.000
Arm muscle strength	67	65	5137.000	-3.025	0.002
Agility	75	63	4999.500	-3.250	0.001
Abdominal muscle strength	70	57	4448.000	-4.071	0.000
Flexibility	59	51	3696.500	-5.171	0.000
Hand muscle strength	47	48	7049.000	-0.197	0.844

Notes: MVPA – moderate-to-vigorous physical activity, HEB – health-enhancing behaviors, HRB – health risk behaviors.

The data analysis revealed that girls who performed the recommended amount of MVPA (at least 60 minutes a day) achieved statistically significant higher scores in terms of PF involving the following motor abilities: speed (sprint, agility), strength (lower-limb muscle strength, arm muscle strength, abdominal muscle strength) and flexibility in comparison to girls who were less likely to take up MVPA.

Further exploration of the associations between PF level and HB in terms of vigorous physical activity (VPA) also found statistically significant differences among girls.

The VPA indicator referred to the prevalence and duration of VPA during respondents' free time after school. Participants were asked about physical exercises requiring as much effort as to make them out of breath and sweat.

Pupils who followed the level recommended for the VPA indicator (frequent VPA performed at least four times a week for a duration of at least four hours a day) achieved better results in the PF tests measuring speed (sprint, agility), strength (lower-limb muscle strength) and flexibility than the group of pupils who did not exercise as often and as long (Table 4). However, no statistically significant difference was found between the groups examined.

Table 4. Variation in mean values for selected motor abilities (expressed on a point scale) in relation to VPA

VPA					
Results in total	HEB	HRB	Mann-Whitney U	Z	Asymptotic significance (two-sided)
	At least 4 times a week not less than 4 hours a day	Less than 4 times a week			
Speed	69	64	13044.000	-1.629	0.103
Lower-limb muscle strength	57	54	12107.500	-1.587	0.112
Arm muscle strength	55	59	13308.000	-1.341	0.180
Agility	69	63	12986.500	-1.675	0.094
Abdominal muscle strength	53	55	14438.500	-0.512	0.609
Flexibility	55	52	12824.500	-1.785	0.074
Hand muscle strength	48	49	14140.000	-0.751	0.453

Notes: VPA –vigorous physical activity, HEB – health-enhancing behaviors, HRB – health risk behaviors.

The data obtained suggested that girls displaying HEB in terms of VPA were physically fitter than girls reporting HRB (Table 5). The surveyed girls who performed physical activity at least four times a week for at least four hours a day achieved significantly higher scores in the following motor abilities: speed (sprint) and flexibility than the group of girls reporting HRB for VPA.

Moreover, boys displaying HEB had a higher average point value in terms of their speed abilities (sprint speed, agility) and strength abilities (lower-limb muscle strength) than boys reporting HRB in this particular aspect. The difference, however, did not prove to be statistically significant (Table 5).

Table 5. Variation in mean values for selected motor abilities (expressed on a point scale) in relation to VPA, controlling for respondents' gender

VPA					
Results by gender	HEB	HRB	Mann-Whitney U	Z	Asymptotic significance (two-sided)
	At least 4 times a week and not less than 4 hours a day	Less than 4 times a week and less than 4 hours a day			
Boys (N=232)					
Speed	61	59	2574.000	-0.592	0.554
Lower-limb muscle strength	55	52	2335.000	-1.323	0.186
Arm muscle strength	46	49	2246.000	-1.493	0.135
Agility	70	64	2385.500	-1.172	0.241
Abdominal muscle strength	47	51	2412.500	-1.084	0.278
Flexibility	53	53	2766.500	-0.003	0.998
Hand muscle strength	49	50	2584.000	-0.560	0.575
Girls (N=404)					
Speed	76	66	3391.500	-2.424	0.015
Lower-limb muscle strength	58	55	3181.500	-1.779	0.075
Arm muscle strength	64	64	4036.500	-1.236	0.217
Agility	68	63	4138.500	-1.071	0.284
Abdominal muscle strength	60	57	4420.000	-0.563	0.574
Flexibility	56	51	3451.500	-2.292	0.022
Hand muscle strength	47	48	4201.000	-0.958	0.338

Notes: PA – vigorous physical activity, HEB – health-enhancing behaviors, HRB – health risk behaviors.

In the overall group of the surveyed adolescents no statistically significant differences were found (Table 6). It was despite the fact that respondents who reported spending less time on sedentary behaviors (less than two hours a day) achieved higher average scores in 50 m sprint, 4x10 m shuttle run, as well as in standing long jump than their peers.

Table 6. Variation in mean values for selected motor abilities (expressed on a point scale) in relation to reported sedentary behaviors

Sedentary activities Watching TV, including videos and DVDs, using a computer: Chat, the Internet, sending emails, playing computer or console games					
Results in total	HEB	HRB	Mann-Whitney U	Z	Asymptotic significance (two-sided)
	Up to 2 hours a day	More than 2 hours a day			
Speed	66	64	13974.000	-1.060	0.289
Lower-limb muscle strength	55	51	15239.000	-0.056	0.956
Arm muscle strength	58	54	13554.500	-1.393	0.164
Agility	52	54	14245.500	-0.845	0.398
Abdominal muscle strength	52	52	14318.000	-0.787	0.431
Flexibility	47	49	14727.000	-0.463	0.644
Hand muscle strength	56	57	14558.500	-0.596	0.551

Notes: HEB – health-enhancing behaviors, HRB – health risk behaviors.

Statistically significant differences were found among boys while considering the average scores obtained in the PF tests in relation to the reported HEB and HRB within sedentary behaviors (Table 7). Spending more than two hours a day motionless in front of a computer screen was recognized as a HRB. Moreover, a HEB was defined as one that included no computer use during free time and spending no more than one to two hours a day on this activity.

Boys who did not devote more than two hours a day to sedentary behaviors were characterized by a statistically significant higher level of such motor abilities as strength (lower-limb muscle strength, arm muscle strength), as compared to boys who spent more than two hours a day of their free time on activities which involved little energy expenditure (Table 7).

Examining the average score values, expressed in points, for girls' PF, the finding was that girls reporting HEB displayed a higher level of motor abilities such as flexibility, speed (sprint, agility) and strength (abdominal muscle strength, lower-limb muscle strength, and arm strength) than girls showing HRB in this particular aspect (Table 7). However, the differences did not prove to be statistically significant.

Table 7. Variation in mean values for selected motor abilities (expressed on a point scale) in relation to reported sedentary behaviors, controlling for respondents' gender

Sedentary activities Watching TV, including videos and DVDs, using a computer: Chat, the Internet, sending emails, playing computer or console games					
Results by gender	HEB	HRB	Mann-Whitney U	Z	Asymptotic significance (two-sided)
	Up to 2 hours a day	More than 2 hours a day			
Boys (N=232)					
Speed	61	59	2609.000	-0.446	0.656
Lower-limb muscle strength	53	48	2127.000	-1.926	0.054
Arm muscle strength	49	44	1949.500	-2.382	0.017
Agility	64	65	2629.000	-0.385	0.700
Abdominal muscle strength	45	51	2294.500	-1.410	0.159
Flexibility	51	53	2390.500	-1.115	0.265
Hand muscle strength	48	50	2398.500	-1.090	0.276
Girls (N=404)					
Speed	70	67	4485.500	-0.737	0.461
Lower-limb muscle strength	57	55	4281.000	-0.816	0.414
Arm muscle strength	66	64	4355.500	-0.946	0.344
Agility	66	63	4545.000	-0.630	0.528
Abdominal muscle strength	58	57	4887.000	-0.024	0.981
Flexibility	54	52	4264.500	-1.106	0.269
Hand muscle strength	47	48	4530.000	-0.657	0.511

Notes: HEB – health-enhancing behaviors, HRB – health risk behaviors.

Further on in the research the focus was on exploring the relationships between reported HEB as well as HRB in terms of dietary behaviors and the level of PF. Dietary behaviors were investigated according to the following three categories: the prevalence of healthy food consumption (fruits and vegetables); the prevalence of unhealthy food consumption (sweets and soft drinks); the prevalence of breakfast consumption (daily breakfast consumption, breakfast consumption but not on a daily basis).

Eating fruits and vegetables more often than once a day was recognized as a HEB. Moreover, consuming fruits and vegetables once a week at the most was considered to be a HRB.

The data collected showed that the respondents who observed, as much as possible, the recommendations and standards in terms of proper nutrition in the categories listed above also displayed a higher level of PF.

Respondents reporting fruit and vegetable consumption that was more frequent than once a day were characterized by better strength abilities (lower-limb muscle strength, arm muscle strength, and abdominal muscle strength) (Table 8).

Table 8. Variation in mean values for selected motor abilities (expressed on a point scale) in relation to reported dietary behaviors

Dietary behaviors Fruit and vegetable consumption throughout the week					
Results in total	HEB	HRB	Mann-Whitney U	Z	Asymptotic significance (two-sided)
	More often than once a day	Once a week at the most			
Speed	66	61	4725.000	-1.791	0.073
Lower-limb muscle strength	56	53	4458.500	-2.060	0.039
Arm muscle strength	61	56	4282.500	-2.788	0.005
Agility	65	63	5119.500	-0.900	0.368
Abdominal muscle strength	57	51	4475.000	-2.353	0.019
Flexibility	53	51	4952.000	-1.277	0.202
Hand muscle strength	50	47	4792.000	-1.638	0.101

Notes: HEB – health-enhancing behaviors, HRB – health risk behaviors.

The boys who tended to eat fruits and vegetables more frequently than once a day scored better in terms of PF in the area of strength abilities (arm muscle strength, hand muscle strength) than boys who reported the consumption of those foods once a week at the most. Those differences proved to be statistically significant (Table 9).

Statistically significant differences were also found among girls. Girls reporting the consumption of healthy foods such as fruits and vegetables more frequent than once a day scored better in terms of their speed abilities than their 15-16-year old counterparts who had fruits and vegetables once a week at the most (Table 9).

Table 9. Variation in mean values for selected motor abilities (expressed on a point scale) in relation to reported dietary behaviors, controlling for respondents' gender

Dietary behaviors Fruit and vegetable consumption throughout the week					
Results by gender	HEB	HRB	Mann-Whitney U	Z	Asymptotic significance (two-sided)
	More often than once a day	Once a week at the most			
Boys (N=232)					
Speed	57	59	738.500	-0.421	0.674
Lower-limb muscle strength	55	49	600.500	-1.734	0.083
Arm muscle strength	53	47	578.000	-1.941	0.052
Agility	69	61	642.000	-1.337	0.181
Abdominal muscle strength	56	50	585.500	-1.868	0.062
Flexibility	53	52	725.000	-0.548	0.583
Hand muscle strength	51	46	555.000	-2.154	0.031
Girls (N=404)					
Speed	70	63	1593.500	-2.168	0.030
Lower-limb muscle strength	56	56	1811.500	-0.687	0.492
Arm muscle strength	64	64	1909.500	-0.653	0.514

Dietary behaviors Fruit and vegetable consumption throughout the week					
Results by gender	HEB	HRB	Mann-Whitney U	Z	Asymptotic significance (two-sided)
	More often than once a day	Once a week at the most			
Agility	64	64	2027.500	-0.088	0.930
Abdominal muscle strength	58	53	1742.500	-1.449	0.147
Flexibility	53	50	1772.500	-1.307	0.191
Hand muscle strength	48	49	1992.000	-0.258	0.796

Notes: HEB – health-enhancing behaviors, HRB – health risk behaviors.

A reduction in unhealthy food consumption was considered to be a HEB, where the acceptable norm for the participants was to consume sweets and soft drinks in the smallest amount possible, that is, once a week at the most or even better, never.

The analysis conducted on the general group showed no statistically significant differences (Table 10), the sample conducted on the boys' group also showed no such differences (Table 11).

Still, it was possible to observe that participants who reported HEB (eating sweets not more than once a week, and cutting down on soft drinks) scored higher on the PF tests measuring such motor abilities as: speed (sprint) and strength (arm muscle strength, abdominal muscle strength) than participants who displayed health risk behaviors – consuming sweets and soft drinks two to seven times a week.

Table 10. Variation in mean values for selected motor abilities (expressed on a point scale) in relation to reported dietary behaviors in terms of the consumption of sweets and soft drinks

Dietary behaviors Consumption of sweets and soft drinks throughout the week					
Results in total	HEB	HRB	Mann-Whitney U	Z	Asymptotic significance (two-sided)
	Once a week at the most	More often than once a day			
Speed	63	61	6520.500	-0.830	0.406
Lower-limb muscle strength	54	55	6591.500	-0.318	0.751
Arm muscle strength	59	56	5816.500	-1.857	0.063
Agility	63	64	6915.000	-0.102	0.919
Abdominal muscle strength	55	52	6415.500	-1.024	0.306
Flexibility	53	53	6828.000	-0.262	0.793
Hand muscle strength	48	48	6916.000	-0.100	0.921

Notes: HEB – health-enhancing behaviors, HRB – health risk behaviors.

The results produced for suggested statistically significant differences in the group of female respondents (Table 11). The girls who tended to consume sweets once a week at the most, and who had been successful in cutting down on soft drinks achieved statistically significant higher scores in their PF in terms of such motor abilities as speed (sprint, agility) and strength (arm muscle strength) than the girls who ate unhealthy foods more often than once a day.

Table 11. Variation in mean values for selected motor abilities (expressed on a point scale) in relation to reported dietary behaviors in terms of the consumption of sweets and soft drinks, controlling for respondents' gender

Dietary behaviors Consumption of sweets and soft drinks throughout the week					
Results by gender	HEB	HRB	Mann-Whitney U	Z	Asymptotic significance (two-sided)
	Once a week at the most	More often than once a day			
Boys (N=232)					
Speed	57	64	952.000	-1.494	0.135
Lower-limb muscle strength	50	55	899.500	-1.873	0.061
Arm muscle strength	48	50	1020.500	-0.667	0.505
Agility	63	73	901.000	-1.868	0.062
Abdominal muscle strength	50	52	1100.500	-0.421	0.673
Flexibility	53	54	1126.000	-0.238	0.812
Hand muscle strength	49	49	1071.000	-0.634	0.526
Girls (N=404)					
Speed	67	58	1853.000	-2.206	0.027
Lower-limb muscle strength	57	54	1819.000	-1.886	0.059
Arm muscle strength	66	60	1827.000	-2.236	0.025
Agility	64	56	1923.000	-1.918	0.055
Abdominal muscle strength	58	52	2055.000	-1.385	0.166
Flexibility	53	52	2242.500	-0.628	0.530
Hand muscle strength	47	48	2367.000	-0.125	0.900

Notes: HEB – health-enhancing behaviors, HRB – health risk behaviors.

Moreover, the data suggested that pupils who reported HEB in the daily-breakfast category showed a higher level of PF (Table 12). Eating breakfast on a daily basis was recognized as a HEB, whereas irregular breakfast consumption (not every day) was considered to be a HRB.

Participants declaring daily breakfast consumption achieved higher scores in the tests measuring motor abilities such as speed (sprint, agility) and strength (lower-limb muscle strength, abdominal muscle strength and hand muscle strength) than participants who admitted not having breakfast on a daily basis. Furthermore, the differences proved to be statistically significant (Table 12).

Table 12. Variation in mean values for selected motor abilities (expressed on a point scale) in relation to reported breakfast consumption

Dietary behaviors Breakfast consumption throughout the week					
Results in total	HEB	HRB	Mann-Whitney U	Z	Asymptotic significance (two-sided)
	Daily breakfast consumption	Breakfast consumption but not every day			
Speed	65	63	44464.000	-2.462	0.014
Lower-limb muscle strength	55	54	43562.000	-2.853	0.004
Arm muscle strength	58	59	49975.500	-0.068	0.946

Dietary behaviors Breakfast consumption throughout the week					
Results in total	HEB	HRB	Mann-Whitney U	Z	Asymptotic significance (two-sided)
	Daily breakfast consumption	Breakfast consumption but not every day			
Agility	66	62	43537.500	-2.865	0.004
Abdominal muscle strength	55	53	44585.500	-2.411	0.016
Flexibility	53	52	49210.500	-0.401	0.689
Hand muscle strength	49	48	44552.000	-2.424	0.015

Notes: HEB – health-enhancing behaviors, HRB – health risk behaviors.

The percentage of girls reporting daily breakfast consumption suggested statistically significant higher scores in the test measuring abdominal muscle strength (Table 13). Moreover, girls displaying HEB (daily breakfast consumption) achieved better scores in the remaining tests (Table 13) although the scores were not statistically significant. The boys who showed HEB (daily breakfast consumption) achieved higher average scores expressed in points in terms of speed (sprint, agility), strength (lower-limb muscle strength, arm muscle strength) and flexibility than their peers who displayed HRB in the given aspect. The difference, however, did not prove to be statistically significant.

Table 13. Variation in mean values for selected motor abilities (expressed on a point scale) in relation to reported breakfast consumption, controlling for respondents' gender

Dietary behaviors Breakfast consumption throughout the week					
Results by gender	HEB	HRB	Mann-Whitney U	Z	Asymptotic significance (two-sided)
	Daily breakfast consumption	Breakfast consumption but not every day			
Boys (N=232)					
Speed	61	57	5628.000	-1.448	0.148
Lower-limb muscle strength	53	50	5486.000	-1.734	0.083
Arm muscle strength	49	48	6133.000	-0.428	0.669
Agility	67	63	5681.000	-1.344	0.179
Abdominal muscle strength	50	50	6317.000	-0.057	0.955
Flexibility	54	52	5721.500	-1.260	0.208
Hand muscle strength	50	50	6329.000	-0.032	0.974
Girls (N=404)					
Speed	68	66	18421.500	-1.564	0.118
Lower-limb muscle strength	56	55	20073.000	-0.148	0.882
Arm muscle strength	65	64	19322.500	-0.791	0.429
Agility	65	61	18066.500	-1.868	0.062
Abdominal muscle strength	59	54	17370.000	-2.467	0.014
Flexibility	52	51	19390.500	-0.734	0.463
Hand muscle strength	48	48	19824.000	-0.362	0.717

Notes: HEB – health-enhancing behaviors, HRB – health risk behaviors.

Further analysis confirmed that the PF of 15- and 16-year-olds reporting no use of stimulants (tobacco smoking, alcohol drinking, and cannabis use) differed significantly from that of respondents who reported HRB in this respect. All pupils who had been using the stimulants were considered to display risky behaviors.

According to the survey findings, the difference between the level of strength abilities (arm muscle strength, abdominal muscle strength) among adolescents reporting tobacco smoking and those who did not smoke tobacco proved to be statistically significant. The percentage of Wrocław adolescents who did not smoke cigarettes was characterized by a higher level of strength abilities (arm muscle strength and abdominal muscle strength) (Table 14).

Table 14. Variation in mean values for selected motor abilities (expressed on a point scale) in relation to reported stimulants use – tobacco smoking

Tobacco smoking					
Results in total	HEB	HRB	Mann-Whitney U	Z	Asymptotic significance (two-sided)
	I don't smoke	I smoke			
Speed	63	64	25329.000	-0.088	0.930
Lower-limb muscle strength	54	53	22037.000	-1.501	0.133
Arm muscle strength	57	54	21464.000	-2.216	0.027
Agility	64	63	24204.000	-0.774	0.439
Abdominal muscle strength	54	50	21920.500	-2.163	0.031
Flexibility	53	51	23402.000	-1.235	0.217
Hand muscle strength	49	48	23827.500	-1.002	0.316

Notes: HEB – health-enhancing behaviors, HRB – health risk behaviors.

Examining the average values scored by the boys in the tests measuring different motor abilities (Table 15) one can notice that boys displaying HEB (not smoking tobacco) achieved better results than their peers whose behaviors appeared to be risky to health (smoking tobacco). Those differences, however, did not prove to be statistically significant. A similar development took place among girls. Girls reporting HEB (not smoking tobacco) achieved higher average values in each PF test than those who showed a HRB (smoking tobacco). Likewise, those differences did not prove to be statistically significant (Table 15).

Table 15. Variation in mean values for selected motor abilities (expressed on a point scale) in relation to reported stimulants use – tobacco smoking, controlling for respondents' gender

Tobacco smoking					
Results by gender	HEB	HRB	Mann-Whitney U	Z	Asymptotic significance (two-sided)
	I don't smoke	I smoke			
Boys (N=232)					
Speed	59	63	3366.500	-1.041	0.298
Lower-limb muscle strength	52	51	3539.000	-0.589	0.556
Arm muscle strength	49	45	3050.500	-1.556	0.120
Agility	65	64	3721.500	-0.110	0.912

Tobacco smoking					
Results by gender	HEB	HRB	Mann-Whitney U	Z	Asymptotic significance (two-sided)
	I don't smoke	I smoke			
Abdominal muscle strength	51	47	3214.000	-1.439	0.150
Flexibility	53	51	3177.000	-1.536	0.125
Hand muscle strength	50	49	3510.500	-0.662	0.508
Girls (N=404)					
Speed	67	65	9126.000	-0.588	0.556
Lower-limb muscle strength	56	54	7762.500	-1.566	0.117
Arm muscle strength	65	61	8619.000	-1.188	0.235
Agility	64	61	8869.000	-0.907	0.364
Abdominal muscle strength	57	53	8357.500	-1.543	0.123
Flexibility	52	51	9166.500	-0.503	0.615
Hand muscle strength	48	47	8852.500	-0.927	0.354

Notes: HEB – health-enhancing behaviors, HRB – health risk behaviors.

Among alcoholic beverages, beer was the leading drink among the surveyed pupils. The remaining beverages (wine, vodka or other spirits, alcopops and other beverages containing alcohol) were very seldom indicated. The author decided to examine alcohol consumption as exemplified by respondents' consumption of beer. A higher level of PF was displayed by adolescents who engaged in HEB by not drinking alcohol. The youth who did not drink alcohol had a significantly higher level of abdominal muscle strength (Table 16).

Table 16. Variation in mean values for selected motor abilities (expressed on a point scale) in relation to stimulants consumption – alcohol drinking (beer)

Alcohol drinking – beer					
Results in total	HEB	HRB	Mann-Whitney U	Z	Asymptotic significance (two-sided)
	I don't drink alcohol	I drink alcohol			
Speed	64	65	46513.500	-0.708	0.479
Lower-limb muscle strength	54	54	43928.000	-0.898	0.369
Arm muscle strength	59	58	45949.000	-0.684	0.494
Agility	64	64	48056.000	-0.025	0.980
Abdominal muscle strength	56	52	43185.500	-2.182	0.029
Flexibility	52	53	46040.000	-0.834	0.404
Hand muscle strength	49	48	46143.500	-0.872	0.383

Notes: HEB – health-enhancing behaviors, HRB – health risk behaviors.

A statistically significant relationship between drinking alcohol and PF was found among boys; however, it was not in favor of HEB (Table 17).

The results showed that boys displaying HRB (alcohol consumption – drinking beer) had better motor abilities such as speed (50 m sprint) (Table 17). The finding suggested that there was a deviation in terms of proper behaviors and a need to continue the research on a larger sample in the future.

Table 17. Variation in mean values for selected motor abilities (expressed on a point scale) in relation to stimulants use – alcohol drinking (beer), controlling for respondents' gender

Alcohol drinking – beer					
Results by gender	HEB	HRB	Mann-Whitney U	Z	Asymptotic significance (two-sided)
	I don't drink alcohol	I drink alcohol			
Boys (N=232)					
Speed	57	64	5214.500	-2.540	0.011
Lower-limb muscle strength	52	52	6259.500	-0.452	0.651
Arm muscle strength	49	48	5886.500	-0.892	0.373
Agility	64	66	5774.500	-1.425	0.154
Abdominal muscle strength	52	48	5526.500	-1.914	0.056
Flexibility	53	54	6065.000	-0.840	0.401
Hand muscle strength	50	49	6185.500	-0.599	0.549
Girls (N=404)					
Speed	68	66	18296.000	-0.840	0.401
Lower-limb muscle strength	56	55	17315.500	-0.483	0.629
Arm muscle strength	64	64	18900.000	-0.199	0.842
Agility	64	62	18355.000	-0.787	0.431
Abdominal muscle strength	58	55	17821.500	-1.255	0.209
Flexibility	51	52	18699.000	-0.376	0.707
Hand muscle strength	48	48	18247.000	-0.882	0.378

Notes: HEB – health-enhancing behaviors, HRB – health risk behaviors.

In terms of cannabis use, PF of adolescents reporting HEB differed significantly from that of their peers who reported HRB. Pupils reporting not using cannabis enjoyed a higher level of motor skills involved in abdominal muscle strength than pupils who admitted smoking hashish or marijuana. The statistically significant difference is demonstrated in Table 18 with the results.

Table 18. Variation in mean values for selected motor abilities (expressed on a point scale) in relation to stimulants use – cannabis use

Cannabis use					
Results in total	HEB	HRB	Mann-Whitney U	Z	Asymptotic significance (two-sided)
	I don't smoke	I smoke			
Speed	65	62	25306.500	-1.201	0.230
Lower-limb muscle strength	54	54	26208.500	-0.031	0.975
Arm muscle strength	59	57	23995.000	-1.745	0.081
Agility	64	63	26796.000	-0.324	0.746
Abdominal muscle strength	55	51	24081.000	-1.921	0.055
Flexibility	52	52	26768.000	-0.185	0.853
Hand muscle strength	48	50	25462.000	-1.109	0.267

Notes: HEB – health-enhancing behaviors, HRB – health risk behaviors.

Pupils displaying HEB (not smoking cannabis) also achieved higher average point values in terms of such motor abilities as speed (50 m sprint), agility (4x10 m shuttle run) and arm muscle strength (the flexed arm hang). Those differences, however, did not prove to be statistically significant.

Examining the average values of the scores achieved for the different motor abilities by boys (Table 19) one could infer that boys who had not been using illegal substances (cannabis) enjoyed a higher level of PF in terms of the following abilities: strength (arm muscle strength, abdominal muscle strength), flexibility and speed (4x10m shuttle run) than boys displaying HRB regarding cannabis use. However, those differences did not prove to be statistically significant.

The girls who smoked neither marijuana nor hashish scored better in the PF tests for speed (sprint, agility) and strength (abdominal muscle strength) than the girls reporting cannabis use. Nevertheless, the difference observed did not prove to be statistically significant (Table 19).

Table 19. Variation in mean values for selected motor abilities (expressed on a point scale) in relation to stimulants use – cannabis use, controlling for respondents' gender

Cannabis use					
Results by gender	**HEB**	**HRB**	**Mann-Whitney U**	**Z**	**Asymptotic significance (two-sided)**
	I don't smoke	**I smoke**			
Boys (N=232)					
Speed	59	62	4020.000	-0.905	0.365
Lower-limb muscle strength	52	53	4193.500	-0.483	0.629
Arm muscle strength	49	48	4029.000	-0.719	0.472
Agility	65	64	4310.500	-0.199	0.842
Abdominal muscle strength	51	47	3623.000	-1.869	0.062
Flexibility	53	52	4183.500	-0.507	0.613
Hand muscle strength	50	50	4332.000	-0.146	0.884
Girls (N=404)					
Speed	68	63	8235.500	-1.669	0.095
Lower-limb muscle strength	56	56	8783.500	-0.193	0.847
Arm muscle strength	64	64	9258.000	-0.174	0.862
Agility	64	63	9343.500	-0.283	0.777
Abdominal muscle strength	57	55	9074.500	-0.618	0.536
Flexibility	52	52	9352.000	-0.055	0.956
Hand muscle strength	48	49	8821.500	-0.934	0.350

Notes: HEB – health-enhancing behaviors, HRB – health risk behaviors.

The current study found that the differences between the PF of pupils reporting HEB and those displaying HRB were statistically significant. Moreover, the differences were found in most of the motor abilities tested (Table 20). The HEB determined significantly the level of respondents' PF.

Table 20. The relationships between PF and HB in Wrocław pupils in the 15-16 age group

HEB	Speed	Lower-limb muscle strength	Arm muscle strength	Agility	Abdominal muscle strength	Flexibility	Hand muscle
Total (N=632)							
MVPA of at least 60 minutes a day in the last 7 days	✓	✓	-	✓	✓	✓	-
Daily breakfast consumption	✓	✓	-	✓	✓	-	✓
Consuming fruits and vegetables more often than once a week	-	✓	✓	-	✓	-	-
No tobacco smoking	-	-	✓	-	✓	-	-
No alcohol drinking	-	-	-	-	✓	-	-
No cannabis use	-	-	-	-	✓	-	-
Boys (N=232)							
Sedentary behaviors of no more than 2 hours a day	-	✓	✓	-	-	-	-
Consuming fruits and vegetables more often than once a day	-	-	✓	-	-	-	✓
Girls (N=404)							
MVPA of at least 60 minutes a day in the last 7 days	✓	✓	✓	✓	✓	✓	-
VPA of at least 4 times a week for at least 4 hours a day	✓	-	-	-	-	✓	-
Daily breakfast consumption	-	-	-	-		-	-
Consuming fruits and vegetables more often than once a day	✓	-	-	-	-	-	-
Consuming sweets once a week at the most and cutting down on soft drinks	✓	-	✓	✓	-	-	-

Notes: MVPA – moderate-to-vigorous physical activity, VPA –vigorous physical activity, HEB – health-enhancing behaviors.

Discussion

Variations in the level of PF in relation to HB, as reported by the pupils surveyed (to ensure a clear interpretation, the following symbols were used HEB – health-enhancing behaviors; HRB – health risk behaviors).

Only 15% of boys and 7% of girls met the daily guideline of 60 minutes of MVPA each day [13]. Adolescents do not meet the recommendation of physical activity for maintaining health [2]. The Wrocław pupils who engage in HEB – daily MVPA are characterized by a statistically significant higher level of the following motor abilities: speed (50 m sprint), leg muscle strength (standing long jump), agility (4x10 m shuttle run), abdominal muscle strength (sit-ups performed in 30 seconds) and flexibility (standing forward bend) than pupils displaying HRB in the given aspect. The girls who engaged in the recommended MVPA, as a HEB (at least 60 minutes daily), achieved statistically significant higher scores in PF in terms of the following motor abilities: speed (sprint, agility), strength (lower-limb muscle strength, arm muscle strength, abdominal muscle strength) and flexibility than girls who were less likely to perform MVPA. The involvement of adolescents in MVPA is associated with improvements in motor competence, which is essential for performing motor tasks [14,15].

The adolescents participated in intense physical activity three times a week, with each session lasting 10 minutes and aiming for 80% to 95% of maximum heart rate [16]. 17.1% of adolescents engaged in VPA on a daily basis, while participation was observed 4-6 times per week, as well as 2-3 times per week. In addition, 6.4% of adolescents reported that they had never participated in VPA [17]. The girls who reported performing VPA, HEB – at least four times a week for at least four hours a day, achieved statistically significant higher scores in terms of the following motor abilities: speed (sprint) and flexibility than girls reporting HRB in the given aspect. VPA significantly improves motor skills in adolescents [18]. A relationship is found between motor competence and VPA in adolescents, indicating that higher VPA is associated with improved motor competence and vice versa [19].

Among adolescents, there is a correlation between sedentary behavior and motor skills. Sedentary behavior is associated with reduced PF, including agility and strength, which are key to the development of motor skills [20]. Boys spend less time on sedentary behavior [2]. The boys devoting to sedentary behaviors not more than two hours a day (HEB) displayed a statistically significant higher level of the following motor abilities: strength (lower-limb muscle strength, arm muscle strength) than the boys who spent their free time performing activities of low energy expenditure for more than two hours a day (HRB).

The average frequency of breakfast consumption among the study's adolescents was 3.4 times per week, with a standard deviation of 2.5 times [21]. 82% of adolescents eat breakfast every day [22]. The participants who had breakfast every day (HEB) achieved statistically significant higher scores in terms of the following motor abilities: speed (sprint, agility) and strength (lower-limb muscles, abdominal muscles, hand muscles) than the participants admitting not having breakfast on a daily basis (HRB). The girls reporting HEB – daily breakfast consumption – achieved statistically significant higher scores in the abdominal muscle strength test. The rate of skipping breakfast was higher among girls at 43.03%, as compared to boys at 35.57% [23].

The frequency of fruit and vegetable consumption among the adolescents varied, with daily vegetable consumption recorded between 7.8% and 66.3% and fruit consumption between 4.2% and 53.7% [24]. Less than half of the adolescents consumed fruit (39.6%) and vegetables (39.7%) daily, with no significant gender differences [25]. The study does not clearly reveal gender differences in fruit and vegetable consumption among adolescents [26]. The adolescents reporting HEB – fruit and vegetable consumption that was more frequent than once a day – were characterized by a significantly higher level of strength abilities (lower-limb muscle strength, arm muscle strength and abdominal muscle strength). The boys reporting HEB – fruit and vegetable consumption that was more frequent than once a day – achieved higher scores in PF in terms of strength abilities (arm muscle strength, hand muscle strength) than the boys who reported consuming the same foods once a week at the most (HRB). Girls consumed more fruit and vegetables per day than boys (p<0.001) [27]. The girls reporting health-enhancing fruit and vegetable consumption that was more frequent than once a day (HEB) achieved significantly higher scores in terms of sprint performance than their counterparts who consumed fruit and vegetables once a week at the most (HRB). The girls who ate sweets once a week at the most (HEB) and had cut down on soft drinks successfully achieved statistically significant higher scores in PF in terms of the following motor abilities: speed (sprint, agility) and strength (arm muscle strength) than the girls who tended to eat unhealthy foods more often than once a week (HRB).

Adolescent smoking adversely affects physical performance [28]. PF of the 15-, and 16-year-olds reporting not smoking tobacco differed significantly from the PF of those reporting HRB in this respect.

The youth displaying HEB – not smoking tobacco were characterized by a higher level of strength abilities (arm muscle strength and abdominal muscle strength).

Higher PF correlates with lower rates of alcohol consumption [29]. Increased physical activity was associated with a higher risk of alcohol consumption, indicating a complex relationship between PF and drinking behavior in the age group [30,31]. Physically active adolescents were less likely to engage in binge drinking [31]. A higher level of PF was found among the respondents who engaged in HEB by not drinking alcohol. The pupils who did not drink alcohol (HEB) displayed a significantly higher level of abdominal muscle strength. Of interest proved to be the result achieved in the speed test by boys who reported drinking alcohol (beer): a higher level of motor abilities in terms of speed (50 m sprint) was found among the boys reporting HRB (drinking beer). The respondents reporting HEB – no cannabis use - were characterized by a significantly higher level of motor abilities involving abdominal muscles than the respondents reporting health risk behaviors in this particular aspect.

Limitations

There is no doubt that some limitations of the study and the potential areas for expanding the research should be identified. First of all, it is advisable to involve many more respondents in further studies. Further research should focus on detailing differences that will allow direct individualized preventive action in adolescents' HB.

Conclusions

Adolescents engaging in daily MVPA demonstrated significantly better motor abilities, including speed, strength, agility, and flexibility, as compared to those with HRB.

Regular breakfast consumption and frequent intake of fruits and vegetables were linked to higher PF levels, particularly in strength and speed, among both boys and girls.

Girls performing VPA at least four times weekly showed better speed and flexibility, while boys limiting sedentary behaviors to two hours daily had greater lower-limb and arm strength.

Non-smoking and non-drinking behaviors were associated with better strength abilities, particularly in abdominal and arm muscles, while alcohol consumption showed mixed results, with some boys reporting faster sprint times.

Adolescents avoiding cannabis use displayed higher abdominal muscle strength, as compared to their peers engaging in HRB.

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Criminal Code (Journal of Laws of 1997, item 553, as amended) and the principles contained in the "Good manners in science. Collection of principles and guidelines" of the Committee on Ethics in Science of the Polish Academy of Sciences of 2001).

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