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Physical fitness and body build parameters of children and adolescents participating in the physical activity promotion programme "Athletics for all!"

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Abstract

Background This study attempts to analyse physical fitness and basic anthropometric parameters of children and adolescents participating in the nationwide physical activity promotion programme "Athletics for All!" (AFA). The programme aims to establish a national system for diagnosing, selecting, recruiting, and identifying talents in youth training. It also aims to build a career development path for athletics, forming the basis of a new structure for youth training in Poland. The primary goal of this study was to assess physical fitness of AFA participants over the years of its implementation (2015–2022) and to identify the leading motor ability with consideration for age, gender, and body build parameters determined with Body Mass Index and Ponderal Index.

Methods Nationwide measurements of basic anthropometric parameters as well as physical fitness tests were conducted among 31,790 girls (F) and 22,260 boys (M) participating in the AFA programme. Physical fitness assessments were performed using the OSF test (3 × 10 m shuttle run, standing broad jump, 1 kg medicine ball throw, 4-minute run). Comparative analysis of OSF test results, considering gender, was conducted using the independent samples T-test. The strength and direction of correlations between variables were calculated using the rho-Spearman coefficient.

Results OSF test results were converted into points, considering age and gender. Gender was found to be a significantly differentiating factor in physical fitness of AFA participants. Among twelve- and fifteen-year-olds, statistically significant differences were observed in all analysed variables, i.e. in each of the four tests and the overall score. It was noted that the examined girls aged 11 to 17 exhibited higher levels of strength compared to their male counterparts. Statistical analysis revealed significant correlations between OSF test results and the age and body build indicators, with the strength of the correlations being negligible in most cases.

Conclusions Participants of the nationwide programme "Athletics for All!" demonstrate a high level of physical fitness, with endurance being a fundamental motor ability. Physical fitness levels show significant correlations with

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the anthropometric parameters of children and adolescents. The study results confirm the need and justification for implementing physical activity promotion programmes for the younger generation.

Keywords Physical fitness, Body mass index, Ponderal index, Children, Adolescents, OSF test

Text box 1. Contributions to the literature

- The study highlights the health benefits of youth physical activity programs and the importance of promoting exercise among children and adolescents.
- The analysis of physical parameters and fitness provides valuable insights into the relationship between regular exercise and physical development, which is important for coaches and physical education teachers.
- The findings serve as a basis for further research into the long-term effects of physical activity programs, helping to tailor them to the needs of younger generations.
- The publication also raises awareness among parents and carers of the crucial role of physical activity in children's development.

Introduction

Regular physical activity (PA) brings numerous health benefits, which are particularly crucial for children and adolescents. These benefits include improvements in overall physical and mental fitness, cardiovascular functioning, metabolic functions, and the development of the musculoskeletal system [1–5]. Additionally, PA positively influences cognitive abilities and enhances learning outcomes [6]. Increased PA is also a key element in preventing obesity and metabolic diseases, including type II diabetes [2]. Given the contemporary global epidemic of childhood obesity, actions aimed at promoting health and physical activity seem to be extremely important [7, 8].

According to the current World Health Organization (WHO) guidelines, children and adolescents aged 5 to 17 should engage in at least 60 min of moderate-to-vigorous physical activity (MVPA) per day. Simultaneously, it is recommended that vigorous physical activity as well as muscle- and bone-strengthening exercises be performed at least three times a week [9–12].

Regular PA reflects acquired health competencies: knowledge, skills, beliefs, attitudes, and recognised health needs [13]. Unfortunately, a significant percentage of the child and adolescent population still does not meet the PA recommendations [14, 15]. Sedentary behaviours, defined as those performed in a sitting or lying position with an energy expenditure ≤ 1.5 METs (Metabolic Equivalent of Tasks), are a common aspect of the lifestyle of contemporary societies worldwide [16]. Since 2020, the COVID-19 pandemic has led to changes in the functioning of many areas of economy and education through introducing remote work and learning, thus further contributing to the increase in sedentary behaviour [17, 18]. Therefore, there is an urgent need to increase physical activity, especially in the lifestyles of children and adolescents, and the promotion of PA in this subpopulation should be part of the responsibilities not only of schools but also external organisations [3, 19].

Researchers focusing on health behaviours emphasise that during adolescence, there is a significant decrease in physical activity [7, 9, 13, 20] resulting in a subsequent decline in physical fitness [21–23].

Physical fitness (PF), as the ability of physiological systems to collaborate efficiently, allows for the performance of daily activities with minimal effort while being a prerequisite for maintaining health [24]. Physically fit individuals can handle schoolwork, meet household duties, and still have enough energy to enjoy sports and other leisure activities [25, 26].

Somatic structure is one of the main components of physical fitness. The analysis of morphological and structural predispositions is used, among other things, in sports recruitment and selection, when observing the effectiveness of activities in sports or health training, and is also considered in a comprehensive and individualised assessment of the level of physical fitness [24].

Body mass index (BMI) is considered as a component of physical fitness and health, especially in older children and adolescents worldwide [27–29]. However, a more useful measure in the analysis and interpretation of youth physical fitness may be the ponderal index (PI) because it better corrects significant differences in body mass occurring during development [30, 31].

Children with low cardiorespiratory fitness are more susceptible to exceeding the pro-health BMI [32]. This is particularly important as childhood overweight and obesity are major public health issues in the 21st century [33]—the problem has reached epidemic status [32]. According to Nittari et al. [34], in 2016, the prevalence of overweight in European children and adolescents was over 30%, and obesity was over 10%. Therefore, it seems justified to adopt a strategy of early prevention of excessive fat accumulation by increasing levels of PA [35] and improving physical fitness [36] of young people, which are interconnected and will also influence each other [37]. Genetic factors determine physical fitness, but they probably account for less variability observed in physical fitness than is caused by environmental factors, mainly through engaging in physical activity [38].

While insufficient PA among children and adolescents is commonly considered a global phenomenon, actual programmes aiming to address this issue are mainly

implemented at the national level [39]. It is essential to define problems, measure progress, and determine intervention tools [20].

The authors of this publication attempted to carry out a detailed analysis of physical fitness and basic anthropometric parameters of children and adolescents participating in the nationwide physical activity promotion programme of the Polish Athletic Association (PAA) called "Athletics for All!" (AFA). One of the main goals of AFA is to establish a nationwide system for diagnosing, selecting, recruiting, and identifying talents in youth training, as well as creating an athletics-oriented career development path that will form the basis of a new structure for youth training organisations in Poland.

The main goal of this study was to assess physical fitness of children and adolescents participating in the AFA programme over the years of its implementation (2015–2022), thereby indicating the leading motor ability considering age, gender, and body build parameters determined with BMI and PI.

Table 1 General characteristics of the study group participating in the AFA programme (N = 54,050)

		N	%
Age (years)	8	748	1.4
	9	2346	4.3
	10	7788	14.4
	11	12,234	22.6
	12	13,381	24.8
	13	8280	15.3
	14	5117	9.5
	15	3270	6.0
	16	733	1.4
	17	153	0.3
Year of study implementation	2015	4938	9.1
	2016	9627	17.8
	2017	1230	2.3
	2018	9646	17.8
	2019	8535	15.8
	2020	7615	14.1
	2021	6825	12.6
	2022	5634	10.4
Gender	F	31,790	58.8
	M	22,260	41.2
BMI (kg/m^2)[a]	underweight (below 18.5)	33,512	62.0
	norm (18.5 to 24.9)	19,556	36.2
	overweight (25.0–29.9)	833	1.5
	obesity (30 and above)	149	0.3
PI (kg/m^3)[b]	underweight (10 and below)	20,684	38.3
	norm (11 to 15)	32,426	60.0
	overweight (16 and above)	940	1.7

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[a] Body Mass Index (BMI) is calculated by dividing body mass in kilogrammes by the square of body height expressed in meters

[b] Ponderal Index (PI) is calculated by dividing body mass in kilogrammes by the cube of body height expressed in meters

Materials and methods

Participants

The selection of groups was purposeful. Inclusion criteria included participation in athletics classes within the AFA programme (parent/legal guardian consent) and an age range of 8–17 years. Ages below 8 or above 17 and/or lack of parental/legal guardian consent for participation in the study resulted in exclusion from the research.

Between 2015 and 2022, nationwide measurements of basic anthropometric parameters and physical fitness tests were conducted among 31,790 girls (F) and 22,260 boys (M) participating in the AFA programme. Throughout the analysed years, the most numerous group consisted of twelve-year-olds, while the least numerous were seventeen-year-olds. The general characteristics of the study population taking into account age and somatic parameters are presented in Table 1.

Methods

The material was collected using the Physical Fitness Assessment (OSF) test developed for the AFA programme – a validated and normalised test [19]. The test consists of four components – 3×10 m shuttle run (speed test), standing broad jump (power test), overhead 1 kg medicine ball throw (strength/power test), and a 4-minute run (endurance test). The obtained test results were entered into a spreadsheet that converts individual scores into point values on a scale from 1 to 100. The scoring table developed for the OSF test takes into account the type of PF test (results with the adopted cutoff point-interval, the age, and gender of the participant).

Based on the measurements of body mass and height, Body Mass Index (BMI), and Ponderal Index (PI) were calculated.

Study design

The research was conducted from 2015 to 2022 (May) according to strictly defined principles (in accordance with the developed instructions for the OSF test). Researchers had prior training in this area. The study was carried out as part of the "Athletics for All!" programme, which is a programme of the Polish Athletic Association (PAA) aimed at popularising athletics as a first-contact sport among children and adolescents. The programme is funded by the Ministry of Sport and Tourism, as well as external sponsors and local government authorities. Currently, "Athletics for All!" includes over 600 training groups throughout Poland. Sessions are conducted considering the age of participants and their level of advancement in three groups. The first two groups include children from primary school grades I-IV (7–10

years) and V-VIII (11–15 years). As for the third group, the most talented children can continue their adventure with athletics in the so-called Centres of Oriented Training (COTs). Training in this group is more advanced, youth participate in sports competitions and training camps, and they regularly undergo physical fitness tests. In the youngest group, sessions are held twice a week for 1.5 h each. In the group V-VIII, sessions take place three times a week for 1.5 h each, and in the COT group, training is conducted five times a week for 1.5 h each.

Each participant in the study provided written informed consent signed by parents or legal guardians to participate in the AFA programme, including participation in the OSF test and measurement of height and weight. The consents were forwarded to the PAA.

The authors of the publication obtained written permission from the Polish Athletic Association to use the results of research carried out as part of the "Athletics for All!" programme. The authors did not have access to information that could identify individual participants during or after data collection.

The Bioethics Committee of John Paul II University in Biala Podlaska approved the study protocol (Resolution no. 3/2023, 14.03.2023). This study was conducted within the project "Physical fitness and body build parameters of children and adolescents participating in the 'Athletics for All!' programme," funded by John Paul II University in Biala Podlaska (PB/9/2022).

Statistical analysis

The data collected were analysed using SPSS 17.0 (Softonic, Ashburn, VA, USA). Quantitative variables were presented taking into account mean ($\bar{x}$), median, standard deviation (SD), ranges, and 95% confidence intervals.

Comparative analysis between girls and boys was conducted using the independent samples t-test. Effect size was assessed using Cohen's d. Cohen's d has the following effect size ranges: 0.2 - small effect, 0.5 - moderate effect, and 0.8 or above - large effect (Cohen's d statistics can exceed 1). This is a commonly used measure when comparing means. The strength and direction of the correlations between variables were calculated using the Spearman's rho coefficient. The coefficient ranges from −1 to 1, where correlation values from 0 to 0.3 indicate a weak relationship, from 0.3 to 0.5 a moderately strong relationship, and values from 0.5 to 1 signify a strong or very strong relationship. Extremely negative deviation means that the higher the value of one variable, the lower it is for the other. Conversely, an extremely positive result indicates that both values will rise or fall synchronously [40]. Statistical significance was set at $p<0.05$.

Results

The starting point in the analysis of the collected research material was to characterise the participants of the AFA programme in terms of age, gender, body build parameters, and the level of physical fitness.

In each year of the study, the largest group consisted of youth aged 11 to 12, while the least numerous groups were observed among 16- and 17-year-olds. In each year of the study, a higher percentage was represented by girls (Table 2).

The average age of the participants was 12 years. The average BMI and PI values of the participants of the AFA programme were within the normal range [41], thus indicating proper body build among the subjects. The predominant motor ability is endurance. The average result in the 4-minute run was 820 m (median 814 m), which, when converted into points, yielded a value of 62.22 (median 64 points). The "model" participant showed the lowest predispositions in terms of strength, as assessed in the 1 kg medicine ball throw test. Out of 400 possible points within the four OSF tests, the average point value was 242.26 (median 248 points). Detailed data are presented in Table 3.

According to the guidelines of the OSF test, all results, taking into account age and gender, were converted into points. It was found that gender is a significantly differentiating factor in physical fitness of the participants of the AFA programme in each examined age group, from 8 to 17 years old ($p<0.05$). However, the size of Cohen's d correction mostly indicates a small effect. In the case of twelve- and fifteen-year-olds, gender significantly differentiated point scores in all analysed variables, i.e., each of the four tests and the total score. Detailed data are presented in Table 4. It was observed that the examined girls aged 11 to 17 showed a higher level of physical fitness in terms of strength (1 kg medicine ball throw test) compared to their male counterparts. Furthermore, statistically significant differences in total points from the four tests were observed in the groups of 8-year-olds and 11-15-year-olds (except for the youngest group) in favour of girls.

The analysis of the relationship between OSF test results and the age and body build indicators of the participants showed that correlations exist and are statistically significant ($p<0.001$), but their strength proved to be negligible in most cases (Spearman's rho<0.3) - Tables 5 and 6. More pronounced correlation coefficients were only noted in the group of sixteen- and seventeen-year-olds. In the first case, significant correlations occurred in the group of girls between the result of the endurance test (4-minute run) and BMI (Table 5), and in the group of boys also between the result of the endurance test and PI (Table 6). These were negative

Table 2 Characteristics of AFA programme participants with consideration of the year of study implementation (N = 54,050)

			Year of study implementation								
			2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**Total**
Age (years)	**8**	N	23	93	1	101	140	120	133	137	748
		%	0.47	0.97	0.08	1.05	1.64	1.58	1.95	2.43	1.38
	9	N	275	376	26	654	335	271	230	179	2346
		%	5.57	3.91	2.11	6.78	3.93	3.56	3.37	3.18	4.34
	10	N	1050	1699	68	1490	1459	1010	632	380	7788
		%	21.26	17.65	5.53	15.45	17.09	13.26	9.26	6.74	14.41
	11	N	1415	2451	152	2265	2172	1567	1351	861	12,234
		%	28.66	25.46	12.36	23.48	25.45	20.58	19.79	15.28	22.63
	12	N	1332	2479	458	2209	2138	1920	1446	1399	13,381
		%	26.97	25.75	37.24	22.90	25.05	25.21	21.19	24.83	24.76
	13	N	647	1159	447	1139	1160	1152	1437	1139	8280
		%	13.10	12.04	36.34	11.81	13.59	15.13	21.05	20.22	15.32
	14	N	139	1057	52	799	503	586	1015	966	5117
		%	2.81	10.98	4.23	8.28	5.89	7.70	14.87	17.15	9.47
	15	N	56	309	25	810	454	537	536	543	3270
		%	1.13	3.21	2.03	8.40	5.32	7.05	7.85	9.64	6.05
	16	N	1	3	1	175	124	365	38	26	733
		%	0.02	0.03	0.08	1.81	1.45	4.79	0.56	0.46	1.36
	17	N	0	1	0	4	50	87	7	4	153
		%	0.00	0.01	0.00	0.04	0.59	1.14	0.10	0.07	0.28
Gender	**F**	N	2789	5425	739	5742	5037	4563	4093	3402	31,790
		%	56.48	56.35	60.08	59.53	59.02	59.92	59.97	60.38	58.82
	M	N	2149	4202	491	3904	3498	3052	2732	2232	22,260
		%	43.52	43.65	39.92	40.47	40.98	40.08	40.03	39.62	41.18
Total		N	4938	9627	1230	9646	8535	7615	6825	5634	54,050
		%	100,00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

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correlations, meaning that the higher the value of one variable, the lower the value of the other.

Among the oldest participants, statistically significant correlations were observed between the results of the 1 kg medicine ball throw test as well as 4-minute run and BMI and PI, both in the overall group and in groups divided by gender. In the case of the strength/power test, it was a positive correlation, while in the case of the endurance test, it was a negative correlation. Additionally, in the group of seventeen-year-olds, a moderately strong, negative correlation occurred between the PI value and the result of the speed test (3×10 m run) and overall fitness expressed with the total number of points from the four OSF tests.

Discussion

Childhood and adolescence are crucial periods in life marked by various physiological changes. During puberty, children almost double their body weight within a relatively short time, accompanied by significant psychological changes. Both physiological and psychological changes influence behaviour and lifestyle in the short and long term. Habits initiated during adolescence, such as smoking, alcohol consumption, fruit and vegetable intake, or physical activity, tend to persist for a long time and are difficult to change [42]. Therefore, it is vital to form good habits as early as possible. The results of our research confirm that participation in the AFA programme improves body build parameters in children and adolescents, thereby supporting the rationale for implementing and carrying out physical activity programmes for the younger generation.

The main goal of this study was to assess physical fitness of children and adolescents participating in the AFA programme over the years of its implementation (2015–2022) and to identify the leading motor abilities with consideration for age, gender, and body build parameters determined with BMI and PI.

Physical fitness is correlated with children's cognitive abilities and academic performance [43]. Its level serves as a significant indicator of the health status of children and adolescents, thus predicting health in later life. Promoting physical fitness in youth brings benefits in preventing cardiometabolic diseases in adulthood [44]. Many countries recognise the need to monitor the physical fitness level of children as part of preventing lifestyle-related diseases and reducing economic costs associated with public health. Various test batteries, including

Table 3 Physical fitness and body build parameters of AFA programme participants (N = 54,050)

	Mean	Median	Standard deviation	Min	Max
Age (years)	11.89	12.00	1.66	8	17
Body height (cm)	155.55	155.00	11.74	110.00	200.00
Body mass (kg)	44.27	43.00	11.13	18.00	144.00
BMI (kg/m^2)	18.05	17.75	2.67	10.20	44.94
PI (kg/m^3)	11.62	11.40	1.62	6.07	25.37
3 × 10 m - result (sec.)	8.52	8.41	0.95	5.67	79.00
3 × 10 m - points	59.86	62.00	19.88	1	99
Standing broad jump - result (m)	1.78	1.76	0.31	0.45	17.70
Standing broad jump - points	61.93	65.00	19.88	1.0	99.0
Medicine ball throw (1 kg) - result (m)	7.42	7.00	2.30	1.10	23.00
Medicine ball throw (1 kg) - points	58.27	63.00	18.99	1	100
4-minute run - result (m)	820.32	814.00	144.30	151.00	1420.00
4-minute run - points	62.22	64.00	19.84	1	99
Total number of points (4 tests)	242.26	248.00	58.37	16.0	394.0

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EUROFIT [45], FITNESSGRAM [46], and ALPHA-FIT [47], are used for this purpose. The OSF test developed by the authors of this study, due to its ease of execution and low cost, can serve as a fundamental tool for monitoring physical fitness of children and adolescents. This tool allows the assessment of four leading motor abilities: endurance, speed, strength, and jumping ability/power.

The findings of the current study show that gender is a significantly differentiating factor in physical fitness of AFA participants. Girls aged 11–17 achieved higher scores in terms of strength compared to their male counterparts. Moreover, significant correlations were noted between OSF test results and the age and body build indicators.

Higher cardiovascular and respiratory efficiency during childhood and adolescence is associated with a healthier cardiovascular system in adulthood [48]. The results of this study demonstrate that participants of the AFA programme exhibit a high level of endurance. Endurance emerged as the leading motor ability in this group. The findings of the current study showed numerous statistically significant correlations between the results of the 4-minute run and the age and body build parameters of the examined children and adolescents. Numerous studies prove that a higher level of physical fitness in childhood is correlated with a lower risk of cardiovascular and metabolic diseases, such as type II diabetes [44, 49].

A higher level of muscle strength in childhood is associated with a lower level of body fat in adulthood [48]. The results of our study indicated a positive correlation between the result of the medicine ball throw (test assessing strength/power) and body build indicators (BMI and PI). Positive correlations between body mass and medicine ball throw results were also observed by Sacchetti et al. [50].

Haga [51] reported that children with high motor competence exhibited greater physical fitness compared to children with low motor competence. The "model" participant of the AFA programme demonstrates endurance, strength, speed, and power abilities above the 50th percentile of reference values developed for the OSF test [19]. The fifth percentile can be used as a biological indicator, and values obtained in the tests below this threshold may be considered pathological [52].

In the research conducted by Vaccari et al. [53] on a group of 30,472 Italian children, the authors noted that in the speed test (shuttle run), girls and boys achieved similar results, while in the standing long jump test, boys performed better. Secchi et al. [54] also observed significant differences in 4×10 m shuttle run and standing long jump in favour of boys. Regarding speed, the results of our study showed an advantage of better performance by girls – girls aged 9, 11, and 13–17 were faster, and these differences were statistically significant. In the case of the power test, girls aged 9–13 also achieved better results than boys. However, Huang et al. [55] and Bianco et al. [56] noted significant differences between girls and boys in terms of power and speed in favour of boys. When comparing the level of physical fitness in 13-year-old girls and boys, Ortega et al. [57] did not find significant differences between the two genders in standing broad jump and 4×10 m shuttle run. However, our results contradicted this, as in the group of 13-year-olds (5002 - F, 3278 - M), we observed statistically significant differences ($p < 0.001$) in favour of girls.

Henning et al. [58] emphasised the need to promote physical activity among children and parents. They observed that a higher level of physical fitness strongly motivates to engage in physical activity. Therefore, further research on physical fitness of children and adolescents is essential. The adoption of reliable and standardised tools for assessing physical fitness at the national level creates the opportunity to collect and compare data on the health status of adolescents [19, 56]. It may also be helpful in implementing initiatives aimed at improving the physical fitness levels of the adolescent

Table 4 Differences in the OSF test results of AFA programme participants considering gender (t-test)

Statistics for groups – 8 years (N: F-401, M-347)												
OSF - points	**Gender**	**Mean**	**SD**	**Standard error of the mean**	**t**	**df**	**p**	**Differences in means**	**Standard error of the difference**	**95% confidence interval for differences in means**		**Cohen's d correction**
										Min	**Max**	
3 × 10 m	**F**	**58.46**	22.50	1.123	-0.965	745.245	0.335	-1.503	1.557	-4.561	1.554	-0.070
	M	**59.96**	20.09	1.079								
Standing broad jump	**F**	**57.11**	21.45	1.071	-0.847	746	0.398	-1.297	1.532	-4.305	1.711	-0.620
	M	**58.41**	20.23	1.086								
Medicine ball throw (1 kg)	**F**	**49.09**	18.61	0.929	-4.823	746	0.001***	-6.452	1.338	-9.078	-3.826	-0.354
	M	**55.54**	17.81	0.956								
4-minute run	**F**	**54.83**	21.34	1.066	-4.116	741.496	0.001***	-6.221	1.511	-9.188	-3.254	-0.300
	M	**61.05**	19.96	1.072								
Sum of points	**F**	**219.48**	67.28	3.360	-3.303	744.585	0.001***	-15.473	4.684	-24.669	-6.277	-0.240
	M	**234.96**	60.80	3.264								
Statistics for groups – 9 years (N: F-1332, M-1014)												
3 × 10 m	**F**	**64.03**	18.90	0.518	1.659	2102.987	0.097	1.358	0.819	-0.247	2.964	0.070
	M	**62.67**	20.19	0.634								
Standing broad jump	**F**	**61.49**	18.37	0.503	4.796	2344.000	0.001***	3.786	0.789	2.238	5.334	0.200
	M	**57.70**	19.66	0.617								
Medicine ball throw (1 kg)	**F**	**56.61**	16.90	0.463	-8.407	2244.236	0.001***	-5.720	0.680	-7.055	-4.386	-0.347
	M	**62.33**	15.87	0.498								
4-minute run	**F**	**61.50**	18.98	0.520	-1.441	2124.698	0.150	-1.173	0.813	-2.768	0.423	-0.060
	M	**62.68**	19.92	0.626								
Sum of points	**F**	**243.63**	56.06	1.536	-0.738	2344.000	0.461	-1.749	2.370	-6.397	2.900	-0.031
	M	**245.37**	57.93	1.819								
Statistics for groups – 10 years (N: F-4489, M-3299)												
3 × 10 m	**F**	**60.33**	18.38	0.274	-0.920	7786.000	0.357	-0.386	0.420	-1.209	0.436	-0.021
	M	**60.72**	18.17	0.316								
Standing broad jump	**F**	**63.50**	18.69	0.279	7.600	7786.000	0.001***	3.284	0.432	2.437	4.131	0.174
	M	**60.22**	19.06	0.332								
Medicine ball throw (1 kg)	**F**	**55.77**	15.98	0.239	-0.151	6896.259	0.880	-0.057	0.378	-0.797	0.684	-0.003
	M	**55.83**	16.82	0.293								
4-minute run	**F**	**59.92**	19.40	0.290	-2.256	6937.379	0.024*	-1.029	0.456	-1.922	-0.135	-0.052
	M	**60.95**	20.22	0.352								
Sum of points	**F**	**239.53**	55.52	0.829	1.423	7786.000	0.155	1.820	1.279	-0.688	4.328	0.033
	M	**237.71**	56.14	0.978								
Statistics for groups – 11 years (N: F-7108, M-5126)												
3 × 10 m	**F**	**60.77**	19.92	0.236	1.648	12232.000	0.099	0.606	0.367	-0.115	1.326	0.033
	M	**60.16**	20.24	0.283								

Table 4 (continued)

Statistics for groups – 8 years (N: F-401, M-347)												
OSF - points	**Gender**	**Mean**	**SD**	**Standard error of the mean**	**t**	**df**	**p**	**Differences in means**	**Standard error of the difference**	**95% confidence interval for differences in means**		**Cohen's d correction**
										Min	**Max**	
Standing broad jump	**F**	**64.84**	18.54	0.220	14.968	10766.411	0.001***	5.211	0.348	4.529	5.894	0.276
	M	**59.63**	19.32	0.270								
Medicine ball throw (1 kg)	**F**	**54.49**	17.99	0.213	1.455	10802.004	0.146	0.490	0.337	-0.170	1.150	0.027
	M	**54.00**	18.65	0.261								
4-minute run	**F**	**60.87**	18.87	0.224	-6.136	10690.957	0.001***	-2.189	0.357	-2.889	-1.490	-0.113
	M	**63.06**	19.89	0.278								
Sum of points	**F**	**240.96**	56.55	0.671	3.931	12232.000	0.001***	4.119	1.048	2.065	6.173	0.072
	M	**236.84**	58.04	0.811								
Statistics for groups – 12 years (N: F-8053, M-5328)												
3 × 10 m	**F**	**60.46**	19.76	0.220	-0.072	13379.000	0.942	-0.025	0.350	-0.712	0.661	-0.001
	M	**60.49**	19.95	0.273								
Standing broad jump	**F**	**63.42**	19.23	0.214	10.484	10867.215	0.001***	3.712	0.354	3.018	4.406	0.188
	M	**59.71**	20.57	0.282								
Medicine ball throw (1 kg)	**F**	**59.04**	17.58	0.196	11.647	10160.859	0.001***	3.995	0.343	3.322	4.667	0.212
	M	**55.04**	20.55	0.282								
4-minute run	**F**	**60.24**	19.35	0.216	-8.660	11009.244	0.001***	-3.050	0.352	-3.741	-2.360	-0.154
	M	**63.29**	20.33	0.279								
Sum of points	**F**	**243.12**	57.08	0.636	4.384	10883.548	0.001***	4.601	1.049	2.544	6.658	0.078
	M	**238.52**	60.92	0.835								
Statistics for groups – 13 years (N: F-5002, M-3278)												
3 × 10 m	**F**	**58.92**	19.66	0.278	0.809	6614.022	0.419	0.375	0.464	-0.534	1.285	0.018
	M	**58.55**	21.27	0.372								
Standing broad jump	**F**	**62.50**	19.92	0.282	6.941	6462.576	0.001***	3.329	0.480	2.389	4.270	0.160
	M	**59.18**	22.23	0.388								
Medicine ball throw (1 kg)	**F**	**63.32**	17.44	0.247	11.047	5843.722	0.001***	5.070	0.459	4.171	5.970	0.261
	M	**58.25**	22.17	0.387								
4-minute run	**F**	**62.16**	19.79	0.280	-6.603	6816.627	0.001***	-3.007	0.455	-3.899	-2.114	-0.150
	M	**65.16**	20.56	0.359								
Sum of points	**F**	**246.91**	57.62	0.815	4.137	6408.570	0.001***	5.780	1.397	3.041	8.519	0.095
	M	**241.13**	64.99	1.135								
Statistics for groups – 14 years (N: F-3012, M-2105)												
3 × 10 m	**F**	**60.82**	18.79	0.342	16.340	4144.189	0.001***	9.449	0.578	8.315	10.583	0.475
	M	**51.37**	21.38	0.466								
Standing broad jump	**F**	**62.52**	19.28	0.351	-0.391	4089.770	0.696	-0.235	0.600	-1.412	0.943	-0.011
	M	**62.75**	22.34	0.487								

Table 4 (continued)

Statistics for groups – 8 years (N: F-401, M-347)												
OSF - points	**Gender**	**Mean**	**SD**	**Standard error of the mean**	**t**	**df**	**p**	**Differences in means**	**Standard error of the difference**	**95% confidence interval for differences in means**		**Cohen's d correction**
										Min	**Max**	
Medicine ball throw (1 kg)	**F**	**66.63**	17.19	0.313	15.801	3512.582	0.001***	9.776	0.619	8.563	10.989	0.477
	M	**56.85**	24.48	0.534								
4-minute run	**F**	**63.47**	19.63	0.358	-6.764	4390.209	0.001***	-3.881	0.574	-5.006	-2.756	-0.194
	M	**67.35**	20.58	0.449								
Sum of points	**F**	**253.36**	55.29	1.008	8.632	4021.968	0.001***	15.090	1.748	11.663	18.518	0.253
	M	**238.27**	65.55	1.429								
Statistics for groups – 15 years (N: F-1891, M-1379)												
3 × 10 m	**F**	**61.51**	19.01	0.44	10.12	2779.61	0.001***	7.26	0.72	5.86	8.67	0.364
	M	**54.25**	21.12	0.57								
Standing broad jump	**F**	**60.07**	20.50	0.47	-7.39	3268.00	0.001***	-5.40	0.73	-6.84	-3.97	-0.262
	M	**65.47**	20.84	0.56								
Medicine ball throw (1 kg)	**F**	**71.89**	15.39	0.35	17.28	2338.39	0.001***	11.84	0.69	10.49	13.18	0.645
	M	**60.05**	21.78	0.59								
4-minute run	**F**	**63.06**	19.86	0.46	-8.63	3268.00	0.001***	-6.14	0.71	-7.53	-4.74	-0.306
	M	**69.19**	20.35	0.55								
Sum of points	**F**	**256.67**	54.69	1.26	3.80	2798.24	0.001***	7.80	2.05	3.77	11.82	0.137
	M	**248.87**	60.16	1.62								
Statistics for groups – 16 years (N: F-419, M-314)												
3 × 10 m	**F**	**62.01**	17.51	0.856	4.434	600.255	0.001***	6.498	1.465	3.620	9.376	0.340
	M	**55.52**	21.08	1.190								
Standing broad jump	**F**	**56.67**	21.14	1.033	-5.990	731.000	0.001***	-9.569	1.598	-12.705	-6.433	-0.447
	M	**66.24**	21.75	1.228								
Medicine ball throw (1 kg)	**F**	**67.99**	11.77	0.575	6.115	489.823	0.001***	7.420	1.213	5.036	9.804	0.486
	M	**60.57**	18.93	1.068								
4-minute run	**F**	**58.83**	16.83	0.822	-4.213	731.000	0.001***	-5.397	1.281	-7.912	-2.882	-0.314
	M	**64.22**	17.60	0.993								
Sum of points	**F**	**245.50**	47.74	2.332	-0.301	599.225	0.764	-1.203	4.001	-9.062	6.655	-0.023
	M	**246.71**	57.61	3.251								
Statistics for groups – 17 years (N: F-83, M-70)												
3 × 10 m	**F**	**65.94**	16.24	1.783	4.038	122.506	0.001***	13.083	3.240	6.669	19.496	0.674
	M	**52.86**	22.63	2.705								
Standing broad jump	**F**	**54.23**	18.16	1.993	-3.053	125.786	0.003**	-10.757	3.524	-17.730	-3.784	-0.508
	M	**64.99**	24.31	2.906								
Medicine ball throw (1 kg)	**F**	**67.84**	13.34	1.464	1.561	118.587	0.121	4.301	2.755	-1.154	9.755	0.261
	M	**63.54**	19.52	2.333								

Table 4 (continued)

Statistics for groups – 8 years (N: F-401, M-347)

OSF - points	Gender	Mean	SD	Standard error of the mean	t	df	p	Differences in means	Standard error of the difference	95% confidence interval for differences in means		Cohen's d correction
										Min	Max	
4-minute run	**F**	**59.18**	16.67	1.829	-0.146	151.000	0.884	-0.448	3.070	-6.514	5.619	-0.024
	M	**59.63**	21.29	2.545								
Sum of points	**F**	**247.19**	41.85	4.593	0.753	124.511	0.453	6.178	8.206	-10.064	22.421	0.125
	M	**241.01**	56.90	6.801								

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Differences are statistically significant:

* - $p<0.05$, ** - $p<0.005$, *** - $p<0.001$

population. The results of the present study seem useful for both health promotion and sports, highlighting the beneficial effects of regular physical activity through participation in activities within the Athletics for All! programme, as already noted in our previous publication [59].

Limitation

Biological age differences already occur in preschool age, indicating that biologically more mature children exhibit higher physical fitness levels. In some cases, the results may not be reliable because biological age can differ from chronological age. Also, the study also did not assess the participants' biological maturation. The strength of the study is the large population of the examined children. However, the study results may be influenced not only by participation in the AFA programme but also by the participants' involvement in other activities that increase physical fitness levels. Additionally, our study did not consider the regularity of participation in AFA classes and the so-called training experience of young athletes, which could affect their final fitness test results.

We recognise the need to continue research regarding the assessment of physical fitness levels among children and adolescents. Taking into account the results of WHO reports [10–12], we are convinced that the implementation of programmes promoting physical activity (such as "Athletics for All!") contributes to improving physical fitness and basic body build parameters in children and adolescents. The next stage will be to demonstrate the trend in physical fitness over the years of the programme's implementation, considering the age and gender of the participants.

Conclusions

Based on the analysis of research results, it was found that participants in the nationwide Athletics for All! programme demonstrate a high level of physical fitness. The average values of the results obtained by the participants in the four physical fitness tests are above the 50th percentile, with endurance being the leading motor ability. Physical fitness levels show significant correlations with the anthropometric parameters of children and adolescents. The strongest correlation was observed in the group of seventeen-year-old girls and boys. Negative correlations between PF and the values of BMI and PI indicators occurred in the

Table 5 Correlations between physical fitness (results expressed in points), the age of female AFA programme participants, and the size of body build indicators (N = 31,790)

OSF test		3 × 10 m		Standing broad jump		Medicine ball throw (1 kg)		4-minute run		Sum of points	
Spearman's rho		Correlation coefficient	Significance (two-way)	Correlation coefficient	Significance (two-way)	Correlation coefficient	Significance (two-way)	Correlation coefficient	Significance (two-way)	Correlation coefficient	Significance (two-way)
8 years (N = 401)	**Group**	0.004	0.930	-0.113*	0.024	-0.120*	0.016	-0.132**	0.008	-0.111*	0.026
	BMI	-0.195**	0.000	-0.150**	0.003	0.089	0.075	-0.161**	0.001	-0.146**	0.003
	PI	-0.217**	0.000	-0.229**	0.000	-0.061	0.222	-0.192**	0.000	-0.229**	0.000
9 years (N = 1332)	**Group**	0.021	0.443	0.024	0.385	-0.010	0.705	-0.038	0.170	0.005	0.846
	BMI	-0.127**	0.000	-0.133**	0.000	0.159**	0.000	-0.187**	0.000	-0.107**	0.000
	PI	-0.187**	0.000	-0.225**	0.000	0.018	0.515	-0.222**	0.000	-0.206**	0.000
10 years (N = 4489)	**Group**	0.030*	0.042	0.070**	0.000	0.046**	0.002	-0.004	0.767	0.049**	0.001
	BMI	-0.159**	0.000	-0.171**	0.000	0.172**	0.000	-0.221**	0.000	-0.150**	0.000
	PI	-0.200**	0.000	-0.254**	0.000	0.048**	0.001	-0.240**	0.000	-0.231**	0.000
11 years (N = 7108)	**Group**	0.055**	0.000	0.095**	0.000	0.058**	0.000	0.039**	0.001	0.085**	0.000
	BMI	-0.138**	0.000	-0.139**	0.000	0.210**	0.000	-0.189**	0.000	-0.100**	0.000
	PI	-0.181**	0.000	-0.226**	0.000	0.068**	0.000	-0.205**	0.000	-0.190**	0.000
12 years (N = 8053)	**Group**	0.046**	0.000	0.071**	0.000	0.072**	0.000	0.024*	0.030	0.071**	0.000
	BMI	-0.158**	0.000	-0.157**	0.000	0.204**	0.000	-0.204**	0.000	-0.120**	0.000
	PI	-0.197**	0.000	-0.244**	0.000	0.085**	0.000	-0.225**	0.000	-0.203**	0.000
13 years (N = 5002)	**Group**	0.016	0.263	0.040**	0.005	0.224**	0.000	0.044**	0.002	0.102**	0.000
	BMI	-0.148**	0.000	-0.148**	0.000	0.170**	0.000	-0.252**	0.000	-0.148**	0.000
	PI	-0.171**	0.000	-0.216**	0.000	0.075**	0.000	-0.264**	0.000	-0.210**	0.000
14 years (N = 3012)	**Group**	-0.031	0.085	0.014	0.447	0.261**	0.000	-0.012	0.514	0.064**	0.000
	BMI	-0.165**	0.000	-0.158**	0.000	0.157**	0.000	-0.211**	0.000	-0.145**	0.000
	PI	-0.174**	0.000	-0.215**	0.000	0.079**	0.000	-0.211**	0.000	-0.190**	0.000
15 years (N = 1891)	**Group**	-0.045	0.050	0.021	0.354	0.210**	0.000	0.040	0.079	0.068**	0.003
	BMI	-0.152**	0.000	-0.169**	0.000	0.187**	0.000	-0.275**	0.000	-0.170**	0.000
	PI	-0.158**	0.000	-0.236**	0.000	0.107**	0.000	-0.268**	0.000	-0.216**	0.000
16 years (N = 419)	**Group**	-0.072	0.143	-0.028	0.572	0.085	0.081	-0.020	0.679	-0.014	0.768
	BMI	-0.059	0.225	-0.066	0.180	0.234**	0.000	-0.311**	0.000	-0.113*	0.021
	PI	-0.050	0.309	-0.119*	0.015	0.157**	0.001	-0.251**	0.000	-0.131**	0.007
17 years (N = 83)	**Group**	0.006	0.959	0.010	0.930	-0.053	0.634	0.099	0.372	0.024	0.828
	BMI	-0.175	0.114	-0.097	0.385	0.637**	0.000	-0.419**	0.000	-0.088	0.431
	PI	-0.197	0.075	-0.136	0.219	0.586**	0.000	-0.334**	0.002	-0.100	0.370

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*. Correlation significant at 0.05 (two-way)

**. Correlation significant at 0.01 (two-way)

3 × 10 m shuttle run, standing broad jump, and 4-minute run tests. Positive correlations, on the other hand, were found in the strength/power test, i.e., 1 kg medicine ball throw. The authors recognise the need and justification for implementing programmes promoting physical activity among children and adolescents. Moreover, according to the authors, the OSF test used in the study, due to its ease of implementation and the possibility to assess key motor abilities essential for both health and sports training, is a valuable tool recommended for widespread use among children and adolescents.

Table 6 Correlations between physical fitness (results expressed in points), the age of male AFA programme participants, and the size of body build indicators (N = 22,260)

OSF test		3 × 10 m		Standing broad jump		Medicine ball throw (1 kg)		4-minute run		Sum of points	
Spearman's rho		Correlation coefficient	Significance (two-way)	Correlation coefficient	Significance (two-way)	Correlation coefficient	Significance (two-way)	Correlation coefficient	Significance (two-way)	Correlation coefficient	Significance (two-way)
8 years (N = 347)	**Group**	-0.083	0.123	-0.214**	0.000	-0.100	0.062	-0.125*	0.020	-0.169**	0.002
	BMI	-0.218**	0.000	-0.085	0.116	0.162**	0.003	-0.210**	0.000	-0.128*	0.017
	PI	-0.279**	0.000	-0.214**	0.000	0.024	0.649	-0.276**	0.000	-0.248**	0.000
9 years (N = 1014)	**Group**	-0.119**	0.000	-0.019	0.556	-0.003	0.927	-0.109**	0.000	-0.089**	0.005
	BMI	-0.175**	0.000	-0.161**	0.000	0.147**	0.000	-0.247**	0.000	-0.162**	0.000
	PI	-0.197**	0.000	-0.211**	0.000	0.016	0.617	-0.242**	0.000	-0.216**	0.000
10 years (N = 3299)	**Group**	0.021	0.234	0.049**	0.005	0.065**	0.000	0.033	0.059	0.056**	0.001
	BMI	-0.225**	0.000	-0.217**	0.000	0.148**	0.000	-0.264**	0.000	-0.205**	0.000
	PI	-0.251**	0.000	-0.292**	0.000	0.031	0.072	-0.282**	0.000	-0.277**	0.000
11 years (N = 5126)	**Group**	-0.030*	0.034	0.027	0.051	0.018	0.187	0.004	0.753	0.008	0.576
	BMI	-0.265**	0.000	-0.225**	0.000	0.169**	0.000	-0.283**	0.000	-0.212**	0.000
	PI	-0.282**	0.000	-0.286**	0.000	0.052**	0.000	-0.295**	0.000	-0.279**	0.000
12 years (N = 5328)	**Group**	-0.013	0.361	0.031*	0.025	0.097**	0.000	0.010	0.457	0.043**	0.002
	BMI	-0.207**	0.000	-0.188**	0.000	0.158**	0.000	-0.260**	0.000	-0.172**	0.000
	PI	-0.250**	0.000	-0.296**	0.000	0.017	0.215	-0.294**	0.000	-0.279**	0.000
13 years (N = 3278)	**Group**	-0.049**	0.005	-0.046**	0.009	0.219**	0.000	0.004	0.818	0.049**	0.005
	BMI	-0.155**	0.000	-0.122**	0.000	0.195**	0.000	-0.241**	0.000	-0.109**	0.000
	PI	-0.248**	0.000	-0.285**	0.000	0.036*	0.040	-0.296**	0.000	-0.265**	0.000
14 years (N = 2105)	**Group**	-0.105**	0.000	-0.102**	0.000	0.266**	0.000	-0.043*	0.049	0.019	0.388
	BMI	-0.066**	0.003	-0.020	0.366	0.259**	0.000	-0.192**	0.000	0.008	0.706
	PI	-0.156**	0.000	-0.180**	0.000	0.129**	0.000	-0.254**	0.000	-0.141**	0.000
15 years (N = 1379)	**Group**	-0.015	0.574	-0.097**	0.000	0.246**	0.000	-0.048	0.072	0.029	0.285
	BMI	-0.059*	0.028	-0.035	0.198	0.242**	0.000	-0.211**	0.000	-0.036	0.186
	PI	-0.087**	0.001	-0.133**	0.000	0.148**	0.000	-0.225**	0.000	-0.115**	0.000
16 years (N = 314)	**Group**	-0.016	0.776	-0.059	0.296	0.056	0.320	-0.017	0.770	0.011	0.843
	BMI	0.002	0.966	0.081	0.152	0.275**	0.000	-0.259**	0.000	0.019	0.741
	PI	-0.051	0.369	-0.045	0.431	0.189**	0.001	-0.309**	0.000	-0.089	0.117
17 years (N = 70)	**Group**	-0.041	0.738	0.150	0.214	-0.065	0.591	0.095	0.435	0.075	0.539
	BMI	-0.254*	0.034	-0.235	0.050	0.544**	0.000	-0.590**	0.000	-0.268*	0.025
	PI	-0.300*	0.011	-0.262*	0.028	0.484**	0.000	-0.578**	0.000	-0.327**	0.006

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*. Correlation significant at 0.05 (two-way)

**. Correlation significant at 0.01 (two-way)

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JB-K, MW and SCh data collection/entry, JB-K and MW data analysis/statistics, JB-K, KZ and MJS data interpretation, literature analysis/search, All authors prepared the manuscript and collected funds.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
The study was conducted in accordance with the Declaration of Helsinki, and approved by the Bioethics Committee of John Paul II University in Biala Podlaska (protocol code 3/2023 14.03.2023).

Consent for publication
The authors of the publication obtained written permission from the Polish Athletic Association to use the results of research carried out as part of the "Athletics for All!" programme.

Competing interests
The authors declare no competing interests.

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