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Physical fitness and somatic structure in adolescent taekwondo athletes and untrained peers

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Abstract

Study aim: The purpose of the study was to assess the level of physical fitness (PF) and somatic structure in children training a Korean martial art (ITF taekwondo) and untrained peers and to determine the associations of children's BMI with that of their parents.

Material and methods: The research material consisted of data from 135 individuals, representing 45 child-mother-father triplets, including 22 triplets with children practicing taekwondo and 23 triplets with untrained children. The children had an average chronological age of 10.08 ± 1.35 years, whereas the age of mothers and fathers was 38.09 ± 4.56 years and 40.57 ± 4.70 years, respectively. Traits analyzed included those evaluated by selected physical fitness tests from the Eurofit Physical Fitness Test battery, body mass index (BMI), and waist-to-height ratio (WHtR) in children, and BMI in parents. Statistical analyses included the chi-square test, Mann-Whitney U test, and Spearman's correlations, with a significance level set at $\alpha = 0.05$.

Results: The results showed no significant differences in the somatic structure, physical fitness, BMI, and WHtR in the children studied. However, a tendency was observed for children attending ITF taekwondo classes to be characterized by higher levels of physical fitness. Higher BMI was found in the parents of the trained children and positive correlations were found between the BMI of the trained children and their parents.

Conclusions: Identifying and studying the effect size of PA determinants in adolescents, with a particular focus on the influence of parents, may be the key to improving the health of future generations.

Key words: EUROFIT – ITF taekwondo – Children – Parents' BMI – Socioeconomic factors

Introduction

Adequate levels of daily physical activity (PA) in children and adolescents are critical to their proper biological and intellectual development, especially proper growth processes, well-being, and future health. PA levels in childhood and early adolescence have a direct impact on the risk of a number of both serious metabolic diseases, including cardiovascular problems, and non-metabolic diseases in adulthood [4, 17].

Research has indicated that the obesity epidemic observed in the world and Poland is beginning to involve increasingly younger age groups, and one of the main factors contributing to this situation is the low and steadily declining PA levels in children and adolescents [47]. A group at higher risk for the consequences of low PA are adolescents, in whom peak PA occurring in earlier stages of ontogeny are followed by a sharp decline in later life. In particular, the prepubertal phase is considered a major critical period in adolescent motor development [2].

Participation in various types of classes that increase the amount of time spent on physical activity is one of the key health-promoting behaviors [3, 6, 19, 22]. Globally, 39% of adults aged 18 and older in 2016 were characterized by excess body weight, and 13% were obese [47]. More than 340 million children and adolescents aged 5 to 19 years struggled with being overweight or obese [47]. Physical activity plays an important role in preventing obesity in both adult and child populations [13, 21, 23, 37]. Due to the increased risk among adolescents with excess body weight to remain overweight in adulthood, leading an active lifestyle from the earliest years and practicing sports is one of the primary preventive factors for obesity [18, 25]. In addition, it has been demonstrated that adults tend to exhibit health-related behavioral patterns, such as

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those related to PA levels, that were instilled in them during their younger years, and physically active adolescents are more likely to continue this activity at a more mature age. Therefore, habits developed in childhood and early adolescence related to healthy lifestyles persist throughout life and ensure a longer and healthier life [1, 11]. As shown by research, social support for PA from parents, legal guardians, and immediate family members can significantly increase PA levels in adolescents [32, 35, 36].

The level of PA is strongly correlated with physical fitness (PF) [44]. Its level reflects the body's readiness to undertake and solve motor tasks that require endurance, strength, flexibility, speed, and agility in various life situations [12].

In Asian martial arts and modern combat sports, preparation for confronting opponents that ensures the effectiveness of defense requires a holistic approach. This concerns both the physical and mental spheres. Despite the variety of current forms of combat and their divergence in terms of philosophical foundations, technical and tactical solutions, teaching methodology, and the applicable rules of competition, an indispensable common characteristic of all these forms is the focus on the aspects of physical fitness [15].

The main aim of the study was to compare PF levels and somatic structure in children aged 8–12 years practicing ITF taekwondo (International Taekwon-do Federation) and their untrained peers and to identify the health-promoting effects of taekwondo training for adolescents. Therefore, we expect that subjects practicing ITF taekwondo will have better PF results and a more healthy somatic structure, e.g. lower values of relative body weight. An additional goal was to assess the strength and direction of the relationship between BMI in children and their parents. We assume that parents of training children may have a greater pro-health awareness, which will be associated with a lower, more health-promoting body weight or relative body mass.

Material and methods

The material consisted of data from 135 individuals representing 45 family triplets (child-mother-father) including 45 adolescents: 25 girls and 20 boys, and their 90 parents, including 45 mothers and 45 fathers. In 22 triplets, the child trained taekwondo twice a week for 60 minutes in the LKS LOTOS Jabłonna club (11 girls, 11 boys). In 23 triplets, the children trained neither taekwondo nor any other sport (14 girls, 9 boys). The inclusion criterion for the study was informed parental consent to participate and the chronological age of the adolescents ranging from 8 to 12 years. First, the respondents were purposively selected from among those attending training sessions, and then triplets with untrained children were randomly selected from the general population. The mean age of the adolescents surveyed was 10.08 ± 1.35 years, while that of the mothers and fathers was 38.09 ± 4.56 years and 40.57 ± 4.70 years, respectively. The subjects did not have any visible physical disabilities and did not declare any mobility limitations that could not affect their level of physical fitness and somatic structure. The group was ethnically homogeneous (Poles, Caucasian) with no national, linguistic, religious, or racial minorities. The study participants were permanent residents of Legionowo district in Mazowieckie Voivodeship, Poland, with a comparable proportion of individuals by origin, and therefore without a significant effect of the phenomenon of selective migration on biological condition [42]. All data was collected at the end of 2018 and beginning of 2019. On average, every fourth person invited to the survey responded to the invitation. The enrolment rate was similar to that observed in Poland and amounted to about 25% [27].

The research was conducted in accordance with the Helsinki Declaration and its later amendments or comparable ethical standards. All persons were orally informed about the aims of the project and all testing procedures, and all of them gave their informed consent prior to their inclusion in the study. At any time, the subjects could withdraw without giving any reason. All participants signed informed consent.

Author's survey questionnaire

In the initial stage of the study, parents completed author's survey questionnaires on their socioeconomic characteristic consisting of two parts. The first part concerned themselves, whereas the second concerned their children. Part 1 included questions about the parents' age (in years), education (primary or vocational/secondary/higher), body weight, body height, number of children in a common household, and the place of birth (rural areas/small town up to 50,000 residents/large city of over 50,000 residents). Part 2 of the survey questionnaire focused on information about the child: gender (girl/boy), date of birth (year/month/day), place of birth, and, in the case of trained children, training experience (in years).

Physical fitness tests

Children participating in the study were subjected to five selected physical fitness tests of the EUROFIT Physical Fitness Test battery. The participants performed tapping (arm movement) tests, jump tests, functional strength tests, trunk strength tests, and endurance tests [8].

The upper limb movement speed test (tapping) was performed twice. In the test, the participant taps discs with a diameter of 20 cm and centers 80 cm apart (the distance between the discs' edges was 60 cm) with the hand as fast as possible. On the command "Start!", the participant performed 50 alternating taps of the discs with the dominant upper limb, moving it over the non-dominant limb,

immobilized on a rectangular plate measuring 10x20 cm and located in the middle between the discs. Before the test, the dominant hand was placed crosswise on the opposite disc. The task ended with the command "Stop!" given by the investigator who counted taps when the disc was tapped for the 25th time. Between the tests, the participants were given time to rest. The result obtained in the better test, measured to the nearest 0.1 second, was used for the analysis.

The jump test was performed three times. The participant was asked to take off from the ground so as to perform the longest possible jump from a standing position, completed with landing on the feet. In the event of falling backward or touching the ground with another part of the body after the jump, the test was repeated. The result was measured from the take-off line (board) to where the rear edge of the first-landing heel made contact with the ground. The result was recorded to the nearest centimeter. The best score obtained was used for further analysis.

The functional strength test was performed once. The participant's task was to perform a flexed-arm pull-up hang for as long as possible. The person performing the exercise stood under the bar, holding it with a closed grip (the thumb from below and other fingers from above the bar) at shoulder width. Then, with the help of the investigator, the child participating in the test pulled their body up so that their chin was above the height of the bar. When the desired initial position for the exercise was achieved, the investigator let go of the participant while turning on the stopwatch. The measurement was stopped when the child's eye level was lowered below the bar line. The result was recorded to the nearest 0.1 second.

The test, which assesses trunk muscle endurance, lasted 30 seconds and was conducted once. This test consisted of performing the maximum number of sit-ups with the legs bent so that the angle at the knee joint was 90 degrees. In this position, the legs were immobilized by the helper by pressing the feet to touch the ground with entire soles, while the hands were intertwined at the nape of the neck. Each time after completing the sit-up, the participant returned to lying so as to touch the dorsal part of the hand to the ground. A sit-up during which the participant touched his or her knees with the elbows was considered a correct repetition. The final result was expressed as the number of correctly completed repetitions.

The last test conducted was the measurement of running endurance. It consisted of covering a distance of 5 meters ten times, each time crossing the lines marking the distance in the shortest possible time. The participant performed a standing start with both feet placed in front of the line. On the command "Start!" given by the examiner, the exerciser started running. Time was measured until the section was covered for the 10th time, and recorded to the nearest 0.1 second. The task was performed once.

Anthropometric measurements

In the children studied, both in the group of adolescent athletes and the control (untrained) group, basic body measurements were taken using anthropometric instruments. The child's body height in an upright position without shoes, considered a *Basis-vertex* distance between anthropometric points, was measured with a Martin-type anthropometer (in cm, to the nearest 0.1 cm). Adolescents' body weight was measured using medical scales (in kg, to the nearest 0.01 kg). Waist circumference (measured at the midpoint between the lower rib and the upper edge of the ala of ilium) and hip circumference (measured through the greatest protrusion of the gluteal muscles) were measured using an anthropometric tape measure. Anthropometric measurements were taken in accordance with the principles of the Martin technique and those used in population-based surveys [26, 31].

Based on raw anthropometric data, body height (cm), and body weight (kg), the participant's BMI was calculated and then classified into underweight, normal weight, overweight, or obese in terms of the ratio of body weight to height (for the participant's age) [7]. The distribution of body fat in the children studied and the prevalence of abdominal obesity was evaluated based on the WHtR index (waist-to-height ratio), which is the ratio of waist circumference (cm) to body height (cm) [33].

The adults (parents of the children) self-reported their body height and weight. Since the anthropometric data were not used to determine social differences in the risk of excess body weight, the use of subjective measures was not associated with significant errors in the results [28]. Parents' BMI values were calculated from height and weight data, and the basic BMI categories were used [46]. Individuals with a BMI of less than 18.5 were considered underweight. Those with a BMI between 18.5 and 25.0 were considered to be of normal weight. Those with a BMI between 25.0 and 29.9 were considered overweight, whereas those with a BMI ≥30 were considered obese.

Statistical methods

Means, standard deviations (SD), and percentage frequencies were calculated. The Kolmogorov–Smirnov test with Lilliefors corrections was used to determine if the variables had a normal distribution. As the conditions for normality of distribution were not met and the number of data collected was relatively small, non-parametric statistical tests were used to perform the analyses. A chi-square test (chi^2) was used to assess differences in prevalence distributions for individual categories of qualitative characteristics (e.g., socioeconomic data, BMI categories). The Mann-Whitney U test (U test) was used to assess the significance of uncorrelated pair differences (here the fitness test results of the trained and untrained individuals or the BMI in the compared subgroups). Spearman's correlation

Table 1. Basic socioeconomic characteristics of girls and boys practicing sports and non-athletes

	Variable	Girls				n	chi²	Boys				n	chi²
		Athletes		Nonathletes				Athletes		Nonathletes			
		n	%	n	%			n	%	n	%		
	total	n = 25						n = 20					
Age	8-00–9.99 years	3	27.27	10	71.43	13	p = 0.0734	5	45.45	4	44.44	9	p = 0.6843
	10.00–12.00 years	8	72.73	4	28.57	12		6	54.55	5	55.56	11	
	total	11	100.00	14	100.00	25		11	100.00	9	100.00	20	
Place of birth	rural areas	1	9.09	2	14.29	3	p = 0.6731	1	9.09	0	0.00	0	p = 0.6455
	small town	2	18.18	1	7.14	3		2	18.18	2	22.22	4	
	large city	8	72.73	11	78.57	19		8	72.73	7	77.78	15	
	total	11	100.00	14	100.00	25		11	100.00	9	100.00	20	
Mother's level of education	higher	9	81.82	10	71.43	19	p = 0.8334	7	63.64	7	77.78	14	p = 0.2690
	secondary	1	9.09	2	14.29	3		4	36.36	1	11.11	5	
	primary and vocational	1	9.09	2	14.29	3		0	0.00	1	11.11	1	
	total	11	100.00	14	100.00	25		11	100.00	9	100.00	20	
Father's level of education	higher	6	54.55	9	64.29	15	p = 0.0301*	6	54.44	5	55.56	11	p = 0.4954
	secondary	5	45.45	1	7.14	6		5	45.45	3	33.33	8	
	primary and vocational	0	0.00	4	28.57	4		0	0	1	11.11	1	
	total	11	100.00	14	100.00	25		11	100.00	9	100.00	20	
Number of children in the household	1	2	18.18	1	7.14	3	p = 0.1145	3	27.27	3	33.33	6	p = 0.1187
	2	5	45.45	12	85.71	17		6	54.55	3	33.34	9	
	3	3	27.27	0	0.00	3		0	0.00	3	33.33	3	
	4 and more	1	9.09	1	7.14	1		2	18.18	0	0	2	
	total	11	100.00	14	100.00	25		11	100.00	9	100.00	20	

analysis (spearman's rho) was used to assess the relationship of children's BMI with parents' BMI. The level of significance was set at $\alpha = 0.05$. The STATISTICA 13.5, and 12.0. packages were used for analyses [40].

Results

Table 1 presents the general socioeconomic characterization of trained adolescents and untrained peers in terms of gender, age (younger group: 8.00–9.99 years; older group: 10.00–12.00 years), and place of residence, as well as their parents' data on education level and the number of children in their households. There were no significant differences in the vast majority of basic socioeconomic characteristics of the participants. Most of the children were born in large cities, and the parents, both mothers and fathers, had higher education. However, a significant difference ($p = 0.0301$) was found in the frequency of the category of the level of education in the girls' fathers. Fathers of girls who did not practice taekwondo were more likely to have primary and vocational education (Table 1).

Table 2 presents the results of selected tests of the EUROFIT Physical Fitness Test battery for adolescents. Among younger girls (8.00–9.99 years), there were no statistically significant differences in mean test scores. However, a trend toward more favorable results for trained girls (except for tapping) was found. In the group of older girls (10.00–12.00 years old), it was found that the athletes obtained significantly better results in tapping ($p = 0.0415$) and running endurance ($p = 0.0219$). In boys, regardless of age, in 3 of the 5 fitness tests, the better results were obtained by trained boys, but similarly to the younger girls, none of the results were statistically significant (Table 2).

Table 3 presents information on the basic somatic parameters of children and classification due to the values of BMI and WHtR indices. In the group of girls, there were no significant differences in somatic structure between trained and untrained girls, except for body height in 10–12-year-old girls. The athletes turned out to be significantly taller than the untrained girls (157.69 cm vs 142.00 cm, $p = 0.0138$). For almost all other somatic parameters, trained girls had higher values of somatic traits than non-training peers (except for hip circumference in the younger group). In the group of boys, regardless of age, no significant differences were found in the somatic structure between athletes and non-athletes. In younger boys, non-athletes had slightly higher values in 3 of the 4 traits. In the group of older boys, higher mean body height and body weight were found in martial artists, who, at the same time, on average, had smaller waist and hip circumferences relative to the untrained group (Table 3).

In terms of the prevalence of each BMI category, regardless of age, there were no differences, neither in boys nor in girls, in the prevalence between those who trained taekwondo and non-athletes. The vast majority of athletes

Table 2. Results of selected fitness tests among girls and boys and the significance of differences between groups

Test	Girls					
	8.00–9.99 years			10.00–12.00 years		
	Athletes	Nonathletes	U test	Athletes	Nonathletes	U test
	Mean [pts] ± SD	Mean [pts] ± SD		Mean [pts] ± SD	Mean [pts] ± SD	
Tapping	58.67 ± 3.21	56.40 ± 10.89	p = 0.9326	48.75 ± 5.01	55.25 ± 2.22	p = 0.0415*
Jumping	62.67 ± 7.02	51.50 ± 11.34	p = 0.1508	60.00 ± 6.63	59.25 ± 6.85	p = 1.0000
Trunk strenght	54.33 ± 7.51	44.50 ± 5.32	p = 0.0759	49.88 ± 4.58	44.00 ± 3.83	p = 0.1066
Functional strenght	55.33 ± 7.57	50.90 ± 11.23	p = 0.3525	41.50 ± 4.47	48.50 ±8.70	p = 0.1742
Running endurance	55.00 ± 7.55	44.60 ± 7.72	p = 0.1083	52.38 ± 3.74	41.75 ± 6.13	p = 0.0219*
Test	Boys					
	8.00–9.99 years			10.00–12.00 years		
	Athletes	Nonathletes	U test	Athletes	Nonathletes	U test
	Mean [pts] ± SD	Mean [pts] ± SD		Mean [pts] ± SD	Mean [pts] ± SD	
Tapping	62.00 ± 10.07	57.00 ± 7.07	p = 0.5403	52.83 ± 12.02	53.60 ± 5.55	p = 0.8551
Jumping	60.40 ± 7.02	63.50 ± 8.35	p = 0.4624	58.17 ± 10.61	47.00 ± 8.51	p = 0.1709
Trunk strenght	46.80 ± 5.67	44.25 ± 2.06	p = 0.8065	45.33 ± 13.16	47.40 ± 10.90	p = 0.8551
Functional strenght	44.60 ± 5.59	48.25 ± 8.54	p = 0.5403	46.83 ± 6.71	46.20 ± 1.79	p = 1.0000
Running endurance	51.80 ± 5.81	48.50 ± 8.54	p = 0.3272	50.33 ± 14.92	45.80 ± 5.36	p = 0.9273

Table 3. Somatic parameters classification of body mass index, waist-to-height ratio, and significance of differences between the means in children

	Variable	Girls								
		8.00–-9.99 years					10.00–12.00 years			
		Athletes		Nonathletes		U test	Athletes		Nonathletes		U test
		Mean ± SD		Mean ± SD			Mean ± SD		Mean ± SD		
	Body height [cm]	136.70 ± 7.62		132.41 ± 4.28		p = 0.3525	157.69 ± 6.67		142.00 ± 6.05		p = 0.0138*
	Body weight [kg]	30.03 ± 6.06		29.31 ± 4.79		p = 1.0000	47.35 ± 4.98		36.35 ± 9.70		p = 0.1066
	Waist circumference [cm]	59.20 ± 2.55		58.72 ± 5.71		p = 0.8658	67.38 ± 5.82		61.63 ± 5.42		p = 0.2027
	Hip circumference [cm]	70.00 ± 5.77		71.00 ± 4.91		p = 0.8658	83.69 ± 2.94		75.95 ± 10.10		p = 0.3082
	Classification	n	%	n	%	chi^2	n	%	n	%	chi^2
BMI	Underweight	1	33.33	0	0.00	p = 0.1202	0	0.00	1	25.00	p = 0.1618
	Normal weight	2	66.67	7	70.00		6	75.00	1	25.00	
	Overweight	0	0.00	3	30.00		2	25.00	2	50.00	
	Obese	0	0.00	0	0.00		0	0.00	0	0.00	
WHtR	>0.5	0	10.00	1	10.00	p = 0.5686	0	0.00	0	0.00	p = 1.0000
	≤ 0.5	3	90.00	9	90.00		8	100.00	4	100.00	
	Variable	Boys								
		8.00–9.99 years					10.00–12.00 years			
		Athletes		Nonathletes		U test	Athletes		Nonathletes		U test
		Mean ± SD		Mean ± SD			Mean ± SD		Mean ± SD		
	Body height [cm]	136.46 ± 5.36		137.63 ± 8.92		p = 0.2703	145.83 ± 6.59		141.28 ± 7.44		p = 0.4113
	Body weight [kg]	31.90 ± 6.39		31.33 ± 8.64		p = 0.9025	35.45 ± 4.96		35.14 ± 7.18		p = 0.8551
	Waist circumference [cm]	60.40 ± 5.45		61.18 ± 9.40		p = 0.8065	61.42 ± 4.36		64.64 ± 7.77		p = 0.3613
	Hip circumference [cm]	69.76 ± 6.08		71.15 ± 10.43		p = 1.0000	73.92 ± 4.85		76.24 ± 6.39		p = 0.5228
	Classification	n	%	n	%	chi^2	n	%	n	%	chi^2
BMI	Underweight	1	20.00	0	0.00	p = 0.4868	0	0.00	1	20.00	p = 0.2307
	Normal weight	2	40.00	3	75.00		6	100.00	3	60.00	
	Overweight	2	40.00	1	25.00		0	0.00	0	0.00	
	Obese	0	0.00	0	0.00		0	0.00	1	20.00	
WHtR	>0.5	0	0.00	1	25.00	p = 0.2357	0	0.00	1	20.00	p = 0.2506
	≤ 0.5	5	100.00	3	75.00		6	100.00	4	80.00	

had normal relative body weight. Only in the group of younger boys (8.00–9.99 years), as many as 60% had abnormal body weight (20% were underweight and 40% were overweight). A similar phenomenon can be observed in groups of children who do not attend taekwondo classes. In the group of older girls, only 25% were characterized by a normal ratio of body weight to height. The WHtR results indicated that in each group, the vast majority of participants did not have abdominal obesity, and there were no differences in the WHtR categories between children with different levels of physical activity.

Data on somatic parameters and BMI categories for mothers and fathers are presented in Table 4. Among the physique traits studied, a significant relationship was found between the mothers' body weight and practicing taekwondo by their child (p = 0.0176). Mothers of girls who practiced taekwondo tended to have a higher body weight. The BMI results showed that the vast majority of mothers were characterized by normal body weight in each group. Among fathers, the excessive abnormal ratio of body weight to body height was prevalent in both groups.

Table 5 shows the BMI values of parents of trained and untrained children. Significant differences were found in the mean BMI of the mothers of trained and untrained girls (both younger and without age division, p = 0.0162

Table 4. Somatic parameters body mass index classification. and significance of differences between the compared groups in parents

Variable	Mother (n = 45)					Father (n = 45)				
	Athletes		Nonathletes		U test	Athletes		Nonathletes		U test
	Mean ± SD		Mean ± SD			Mean ± SD		Mean ± SD		
Age [years]	38.48 ± 5.35		37.74 ± 3.79		p = 0.2798	40.24 ± 4.35		40.39 ± 5.82		p = 0.5182
Body height [cm]	164.95 ± 5.38		162.78 ± 5.00		p = 0.1400	179.23 ± 5.36		179.59 ± 5.82		p = 0.9276
Body weight [kg]	66.40 ± 12.78		58.78 ± 7.97		p = 0.0176*	89.00 ± 13.98		87.35 ± 12.83		p = 0.5335
BMI [kg/m^2]	24.24 ± 3.99		22.23 ± 3.28		p = 0.0660	27.72 ± 3.97		27.03 ± 3.46		p = 0.3237
BMI classification	n	%	n	%	chi^2	n	%	n	%	chi^2
Underweight	0	0.00	2	8.70	p = 0.2739	1	4.76	0	0.00	p = 0.3944
Normal weight	11	55.00	16	69.57		4	19.05	6	26.09	
Overweight	7	35.00	4	17.39		10	47.62	14	60.87	
Obese	2	10.00	1	4.35		6	28.57	3	13.04	

Table 5. Means, SD and significance of differences values in parents' BMI and Spearman correlation coefficient values between parents' BMI and BMI of their children

	Mother				Father				Means for parents			
	Athletes		Nonathletes		Athletes		Nonathletes		Athletes		Nonathletes	
	Girls (8.00–9.99)											
BMI (mean ± SD)	23.06 ± 2.83		21.76 ± 2.95		31.51 ± 1.60		27.22 ± 2.97		27.28 ± 1.61		24.49 ± 2.40	
U test p-value	0.3706				0.0490				0.1608			
Spearman's rho	–0.5000		0.5836		1.0000		0.3647		0.5000		0.5228	
	Girls (10.00–12.00)											
BMI	25.37	4.87	20.61	0.94	26.85	2.82	28.84	5.91	26.11	3.55	24.73	2.84
U test p-value	0.0162				0.5697				0.6828			
Spearman's rho	0.6826		0.0000		0.5389		0.2000		0.8024		0.2000	
	Girls (8.00–12.00)											
BMI (mean ± SD)	24.74 ± 4.40		21.43 ± 2.55		28.12 ± 3.29		27.68 ± 3.84		26.43 ± 3.11		24.56 ± 2.42	
U test p-value	0.0108				0.7267				0.1340			
Spearman's rho	0.5786		0.4356		0.2192		0.1716		0.6241		0.3388	
	Boys (8.00–9.99)											
BMI (mean ± SD)	23.75 ± 4.61		25.24 ± 4.09		26.49 ± 7.21		26.90 ± 3.28		25.12 ± 4.57		26.07 ± 3.32	
U test p-value	0.6857				1.0000				1.0000			
Spearman's rho	1.0000		1.0000		0.4000		0.4000		0.2000		0.4000	
	Boys (10.00–12.00)											
BMI (mean ± SD)	23.52 ± 3.09		22.07 ± 3.76		27.01 ± 2.42		25.31 ± 2.14		25.26 ± 0.85		23.69 ± 2.51	
U test p-value	0.4206				0.1775				0.2222			
Spearman's rho	–0.7000		0.7000		0.7714		0.8000		–0.6000		0.7000	
	Boys (8.00–12.00)											
BMI (mean ± SD)	23.62 ± 3.57		23.48 ± 4.02		26.78 ± 4.74		26.02 ± 2.65		25.20 ± 2.86		24.75 ± 2.97	
U test p-value	0.7962				0.3562				0.3865			
Spearman's rho	–0.1004		0.5667		0.5515		0.4000		0.3833		0.4667	
Spearman's rho	0.2731		0.3861		0.3094		0.2902		0.4716		0.3841	

and 0.0108, respectively) and in the fathers of younger girls (p = 0.0490). In all cases, mothers and fathers of trained girls were found to have significantly higher BMI than mothers and fathers of untrained girls. In other comparisons, the relationships were not found to be significant, but, with minor exceptions, the direction was analogous. Parents of trained children had higher mean BMI. Table 5 also presents the results of the correlations of the BMI values of daughters and sons, as well as mothers, fathers, and the mean for parents with the children's BMI. The results show moderate to fairly strong correlations of children's BMI, mainly trained girls, with parents' BMI (rho = 0.6241–0.8024), and those of older boys with mothers' and fathers' BMI (rho = 0.7000–0.8000). An analysis of correlation strength conducted without dividing into age and gender indicated moderate positive correlations between the BMI of trained children and the mean calculated for their parents.

Discusion

In an era of increasingly low PA levels among adolescents, studies of the association of even low levels of physical activity with biological status, physical fitness, and anthropometric parameters, take on new importance. Studies of the determinants of PA and PF in a given age group also seem crucial. Although the present study failed to indicate strong correlations, it demonstrated a trend toward better physical fitness and more favorable somatic structure parameters for children aged 8 to 12 years participating in taekwondo physical activities compared to their non-athlete peers. Furthermore, a trend toward higher BMI values was found in parents of children involved in the sport compared to those of non-trained children.

Although a number of studies, including in the Polish population, have pointed to social determinants of participation in physical activity [29, 41], the present study failed to find such a relationship in the children studied. However, the lack of correlation between socioeconomic determinants and physical activity levels has been sometimes reported by other researchers [20, 36, 43]. In the present study, it was only observed that fathers of girls practicing taekwondo were more likely to have higher education. This result confirms the observations of the vast majority of researchers that as the level of education increases, the prevalence of health-promoting behaviors, including PA, increases. It seems reasonable to assume that an increase in the research group size could significantly affect the results of the observations. Perhaps, an increase in the number of subjects in each group and, moreover, a reduction in the disproportion between the compared groups and a re-examination would show a relationship between the analyzed characteristics in groups in which such significance was not found. On the other hand, a repeat study on an increased study group could contradict a given relationship, thereby confirming the results obtained during the conducted research.

The results of the individual tests of the European Physical Fitness Test battery conducted in a group of children showed a tendency for those attending ITF taekwondo classes to exhibit a higher level of physical fitness than non-athletes. Despite the lack of a significant relationship, in most of the traits compared in each of the four groups divided by age and gender, it was observed that in at least 3 of the 5 tests, the participants who were martial art practitioners obtained higher results compared to the control group. The results of a number of studies conducted by researchers show the positive impact of participation in sports by people of different ages on their fitness levels relative to physically inactive peers [10, 24, 38]. Depending on their expertise, taekwondo athletes have different levels of motor aptitudes. The lower the sports skill level, the greater the variation within a given aptitude [5]. Perhaps the teenagers studied were still characterized by too low a sports skill level or training experience to find significant differences in fitness levels relative to their untrained peers.

The somatic structure of specific social groups has been the subject of research undertaken by many scientists, including Orvanová [34], Gloc et al. [14], Dunsky et al. [9]. The studies showed no significant differences between the compared groups in most of the anthropometric parameters analyzed. However, there is a trend towards higher values of, for example, height or weight in girls who practice sports compared to those untrained. This may confirm a greater trend toward physical activity among children with higher biological age, and therefore early maturing [16]. Analysis of BMI also did not unequivocally indicate a differentiation between the mentioned subgroups in terms of the frequency of abnormal ratio of body weight to body height. However, as shown in the literature, a specific indicator does not always prove to be a reliable source of information. As demonstrated in the study, individuals within the same category can differ significantly in terms of body tissue composition [30]. Therefore, it seems reasonable to assume that both individuals who practice ITF taekwondo and non-athletes, despite the lack of differences in BMI, may be characterized by significantly different body composition, which should be investigated using other research tools.

Although it has been found that excess body weight in parents may correlate with the prevalence of overweight and obesity in children [45], it is unclear from the present study whether the elevated BMI in parents is due to sports participation and increased active tissue content. On the other hand, perhaps the unrealized sports passions of physically inactive parents who are overloaded with duties are

transferred to their offspring. However, regardless of the motivations, comprehensive and multi-level studies indicate that among the most significant factors influencing high levels of physical activity in children and adolescents are the widely understood encouragement of physical activity by parents, legal guardians, and other immediate family members [4]. Emotional and motivational support from parents in the form of encouragement, praise, or observational support, proves to be a key factor that highly positively affects girls' and boys' propensity to engage in active leisure activities in all age groups. The environment of the family home, especially parents, plays a key role in instilling habits of physical activity in children and is a kind of guardian of their children's physical activity [17, 39]. From the broad spectrum of parents' activities in the aspect of their children's physical activity, one can mention setting the right example, motivating, as well as providing certain facilities, such as appropriate sports clothing or transportation to places of organized physical activity. However, a key factor in activating physical activity in children is that the child feels pleasure and enjoyment in the physical activity he or she chooses. Children treat physical activity as something that gives purely hedonistic pleasure and do not view it as a long-term investment in health. Therefore, children and adolescents should be allowed to practice their preferred sports and not be forced into activities that do not give them satisfaction [4, 17, 39].

Limitation study

To improve the quality of the study and obtain a more accurate and reliable evaluation of the factors compared, it would be necessary to significantly increase the number of participants while paying particular attention to leveling the existing disparities in numbers in each group.

Selecting individuals with specific training experience (e.g., for at least 2 years) for the experimental group, thus eliminating individuals who have just begun regular participation in the sport, could also affect the final result of the analysis, more competently demonstrating the presence or absence of differences compared to the control group.

The use of a wider range of research tools, mainly in the aspect of assessing participants' normal or abnormal body weight, could also have a significant effect on the final outcome of the experiment. Therefore, it seems appropriate to use methods assessing body composition (with particular attention to the proportion of body fat in total body weight) such as measurement of skinfolds and calculation of body fatness using the Durnin-Womersley method, or electrical bioimpedance analysis (BIA) as a clarifying element and, perhaps, more reliably indicating possible disparities in a given aspect between the compared groups than the results obtained from the information on participants' weight and height. Expanding the methods to include those discussed above could help more accurately select the study participants whose nutritional status is abnormal.

Conclusion

Although no statistically satisfactory results were obtained, the tendency for higher levels of physical fitness and more favorable somatic parameters in adolescents who practice sports on a regular basis compared to those who do not participate in organized physical activities was confirmed. The results obtained in the study can be useful in promoting active participation in physical activity (or, more specifically, ITF taekwondo training) and showing both children and parents its positive impact on health. Understanding and becoming aware of the factors that influence physical activity in children, adolescents, and young people can be helpful in developing programs to increase their participation in physical activity. The efforts of schools and educational authorities should focus on promoting the benefits of being active and the importance of parental support, and providing safe and enjoyable opportunities to be active. The fact of social support from parents and guardians in PA undertaken by adolescents, instilling models of active spending and passion for PA can be an important part of health prevention for future generations.

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