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GROWTH AND FUNCTIONAL CHARACTERISTICS OF MALE ATHLETES 11–15 YEARS OF AGE

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ABSTRACT
Purpose. To evaluate the growth and functional characteristics of male athletes 11–15 years of age. **Basic procedures.** The sample included 190 boys, 10.5–15.4 years, undergoing training of sport schools for track and field (136) and other sports (54). Height, weight, three skinfolds and % Fat (NIR) were measured. Grip strength, standing long jump, 2 kg medicine ball throw and 20 m sprint were tested. Track and field athletes were compared by discipline and to athletes in other sports using MANCOVA (multivariate analysis of covariance). Multiple linear regression analysis was used to estimate the relative contributions of age, body size and adiposity to the four functional indicators in two age groups, those 11–13 years and 14–15 years. **Main findings.** All variables except the standing long jump and 20 m sprint differed significantly by track and field discipline. Only height and ball throw differed among athletes in other sports. Track and field athletes had a significantly lower BMI and % Fat and performed better in the jump and sprint than athletes in other sports. Variance explained in each of the functional indicators was greater in younger than in older athletes. The sum of skinfolds and % Fat exerted a negative influence on all functional indicators. **Conclusions.** Trends in body size of male athletes attending sport schools were consistent with observations for youth male athletes in several sports. Height, weight and adiposity accounted for significant portions of variation in the four functional indicators in each age group, but the explained variance was higher in younger athletes.

Key words: body size, adiposity, power, strength, speed, youth sports

Introduction

Young male athletes in a variety of sports have mean heights and weights that equal or exceed reference medians. Though less extensive, data for male gymnasts and figure skaters, on the other hand, present a profile of short statures and lower weights. The heights and weights of youth athletes in weight category sports such as wrestling and weight lifting are affected by competitive weight categories which obviously influence weight and also height [1–5]. Although mean weights tend to equal or exceed reference medians, the percentage body fat (% Fat) is lower than average in young male athletes with the exception of athletes specializing in track and field throwing events and the heavier weight categories in wrestling [6, 7]. In contrast to body size and body composition, the available data for maturity status in male adolescent athletes indicate a trend towards average and advanced status relative to the chronological age in most sports; an exception is gymnastics [1–3].

This paper is a sequel to a corresponding paper dealing with the growth, maturity and functional characteristics of female sport school participants [8]. It considers the growth and functional characteristics of male sport school participants 11–15 years of age for three purposes: (1) to evaluate the growth and functional status of sport school participants, (2) to compare the growth and functional status of track and field athletes by discipline and of other athletes by sport, and (3) to estimate the contributions that age, body size and adiposity have to variation in functional capacities. An indicator of maturity status was not available for male athletes.

Material and methods

Subjects

The sample included 190 boys 10.54 to 15.45 years of age who were participants in sport schools in the Lower Silesia region (Wrocław, Jelenia Góra, Wałbrzych, Bogatynia, Zgorzelec) in 2004. Most were involved in track and field (n = 136) while the remainder (n = 54) were distributed among four team (basketball

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17, football 20, handball 5, volleyball 3) and four individual (swimming 3, tennis 3, karate 2, skiing 1) sports. Track and field disciplines included general athletics (*n* = 43), sprinters (*n* = 36), middle distance runners (*n* = 12), distance runners (*n* = 31), jumpers (*n* = 8) and throwers (*n* = 6).

The youth had been training for one to two years prior to the study for about 1.5 hours per session, twice a week. Younger athletes (< 13 years) can be viewed as beginners in their respective sports, while older athletes (14–15 years) are further along in their training. The project was approved by the local Ethics Committee. Parents provided informed consent while each athlete provided assent. All athletes were notified that the project was voluntary and that they could withdraw at any time. The identities of individual athletes were anonymous in the analyses.

Variables considered

Variables considered and protocols for assessment were the same as in the paper dealing with female athletes [8]. Briefly, information for each athlete included their experience in the sport, hours of training per week, height, weight, three skinfolds, relative fatness estimated with the near-infrared interactance (NIR) method using a Futrex analyzer apparatus calibrated for youth (model 5000A/ZL), and four indicators of functional capacity: static strength – sum of right and left grip strength, muscular power of the lower extremities – standing long jump, muscular power of the upper extremities – 2 kg medicine ball throw, and running speed – 20 m sprint with a running start (5 m). The BMI was calculated and skinfolds were summed to provide an indicator of subcutaneous adiposity.

Analysis

Descriptive statistics (means, standard deviations) were calculated by age group for the total sample; given the small number of 11 (*n* = 10) and 12 (*n* = 16) athletes, the sample was combined into a single group. Age-specific means for height, weight, BMI, better grip and standing long jump were compared with the corresponding means from a 1999 national survey of the growth and physical fitness of Polish youth [9]. The national survey used the EUROFIT test battery; grip strength of the preferred hand was used [10]. For comparison, it was assumed that the better grip strength between right and left hands was that of the preferred hand.

Multiple linear regression analysis was used to estimate the relative contributions of age, height, weight, the interaction of height and weight, and either the sum of three skinfolds or an estimated % Fat based on the NIR method to each indicator of function in athletes aged 11–13 years and 14–15 years. Since male athletes as a group tend towards earlier rather than later maturity, the younger group approximates the interval leading up to and including the growth spurt leading up to peak height velocity (PHV), while the older group approximates the interval after PHV for most boys [3]. Mean age at PHV among 25 boys from the Wrocław Growth Study and Wrocław Longitudinal Twin Study who were involved in several individual and team sports was 13.6 ± 0.9 years [11], while mean age at PHV in 21 boys from Warsaw who were involved primarily in track and field, rowing and swimming was 13.1 ± 1.0 years [12].

Separate regressions were done using the sum of skinfolds and % Fat. Though related (partial correlation controlling for age, $r = 0.70$), the two estimates are not identical indicators of adiposity. Skinfolds reflect subcutaneous fat, while % Fat is a global estimate of adipose tissue as a percentage of body weight. The sum of skinfolds is not related to age ($r = 0.11$), while % Fat is negatively related to age ($r = –0.39$, $p < 0.001$) in this sample of young athletes. The height × weight interaction term was derived from centered scores [(height – mean height) × (weight – mean weight)]. The regression protocol was the same as used in the study of female athletes [8]. The analysis permitted all variables to enter into the equation, and then the variables that met the criterion for elimination (backward elimination) were sequentially removed. In this protocol, the variable with the smallest partial correlation with the dependent variable was considered first for removal; if it met the criterion for removal ($p > 0.10$), it was removed. The procedure was repeated for the other potential predictors until those variables that did not meet the removal criterion remained in the equation. Standardized regression coefficients (β) permit comparison of the estimated contributions of each independent variable to the explained variance. The coefficients are not related to the scale of the raw data and are interpreted without scale. Positive and negative coefficients indicate, respectively, an increase and decrease in function associated with change in the particular independent variables.

The Statistical Package for the Social Sciences (SPSS) version 14.0 was used for all analyses.

Results

Descriptive statistics for the total sample are presented by age group in Table 1. The smaller samples of athletes aged 11–13 years should be noted. The years of training increase with age though not linearly, while training time

Table 1. Characteristics (means and standard deviations) of male athletes by age group

Variable	Age Groups, years							
	11–12 (*n* = 25–26)		13 (*n* = 23–27)		14 (*n* = 74–75)		15 (*n* = 62)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age, yrs	11.6	0.7	13.0	0.3	14.1	0.3	15.0	0.3
Training, yrs	1.6	0.8	2.7	1.2	2.2	1.5	3.1	1.7
Training, hrs/wk	1.9	0.3	1.8	0.4	1.8	0.3	1.7	0.3
Height, cm	149.4	9.6	163.7	8.5	169.1	8.1	175.4	7.4
Weight, kg	38.3	8.9	49.2	9.7	54.2	8.7	61.9	9.8
BMI, kg/m^2	16.9	2.2	18.2	2.5	18.8	1.9	20.1	2.7
Sum skinfolds, mm	21.0	5.9	25.0	8.5	21.7	5.7	25.0	9.9
Fat, %	19.2	5.1	15.7	5.6	11.9	4.8	12.2	6.6
Sum R+L grip, kg	46.0	16.8	63.9	16.3	76.9	15.7	85.8	18.5
Standing long jump, cm	166.9	20.8	190.1	18.3	199.7	24.4	209.0	27.0
2 kg throw, m	5.1	1.8	6.7	1.3	7.7	1.6	8.7	1.8
20 m run, sec	3.30	0.25	3.16	0.23	3.04	0.40	3.05	0.44

per week is reasonably constant across the age groups. Body size increases while three of the functional indicators improve, on average, from 11 through 15 years of age. Performance in the 20 meter dash improves (lower time) between the ages of 11 and 14 and is stable to 15 years. The mean sum of skinfolds changes relatively little across age, while % Fat declines from the ages of 12 through 14 and then increases slightly at 15 years.

Compared to the national sample of Polish youth in the 1999 fitness survey, athletes 11–12 years old are, on average, similar in height to the reference but athletes 13–15 years old are taller (Fig. 1). Mean weights are similar to the reference (Fig. 2). Mean BMIs are thus lower than the reference except at 15 years of age (Fig. 3). The athletes are also stronger in grip strength (Fig. 4) and more powerful in the standing long jump (Fig. 5).

Results of the MANCOVA comparing track and field athletes by discipline and age-adjusted means and standard errors are summarized in Table 2. All variables except the standing long jump and 20 m sprint differ significantly by discipline. Although height differs among disciplines, none of the post hoc pairwise comparisons are significant. The difference in height between middle distance and distance is of borderline significance (p = 0.09). Boys in general athletics and throwers do not differ in weight and BMI, but both groups are significantly larger in size than distance runners. Other pairwise comparisons are not significant.

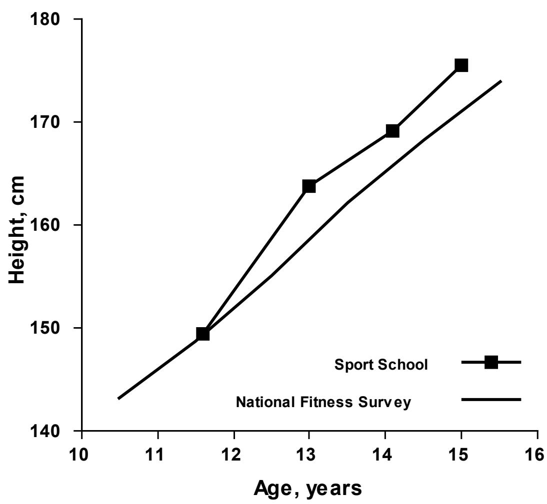

Figure 1. Mean height of male athletes plotted relative to mean height of boys in the 1999 national survey of growth and physical fitness of Polish youth [9]

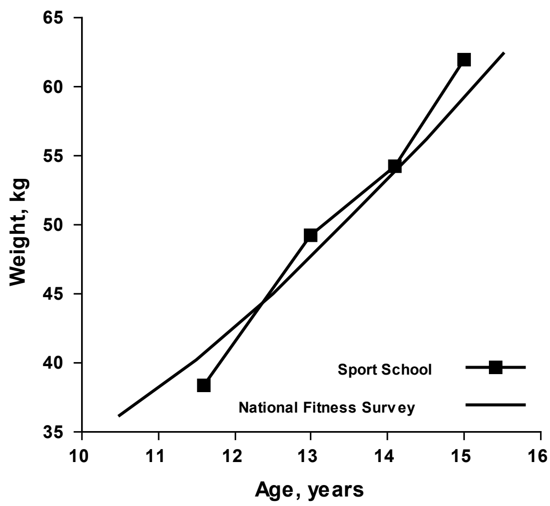

Figure 2. Mean weight of male athletes plotted relative to mean weight of boys in the 1999 national survey of growth and physical fitness of Polish youth [9]

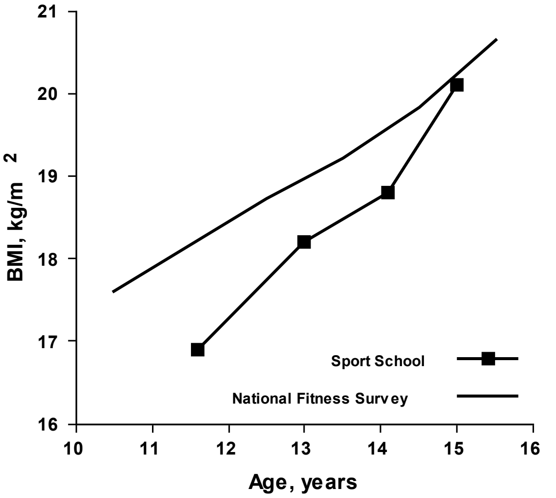

Figure 3. Mean BMI of male athletes plotted relative to mean BMI of boys in the 1999 national survey of growth and physical fitness of Polish youth [9]

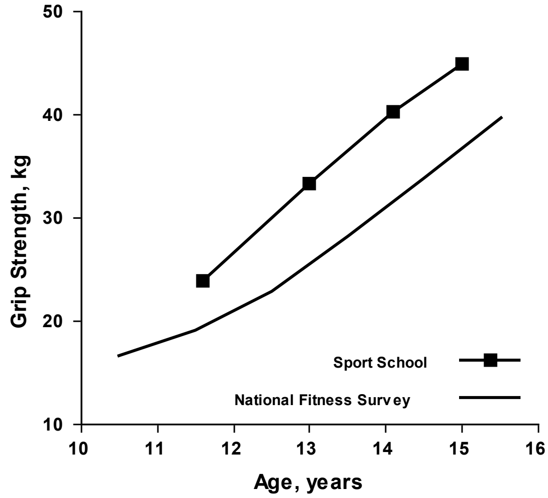

Figure 4. Mean grip strength of the dominant hand of male athletes plotted relative to mean grip strength of the dominant hand of boys in the 1999 national survey of growth and physical fitness of Polish youth [9]

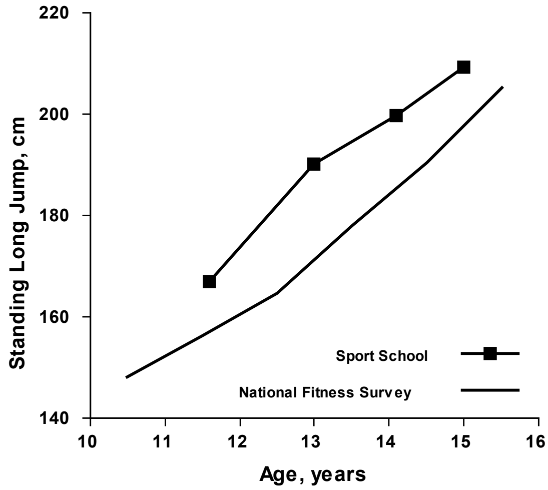

Figure 5. Mean standing long jump of male athletes plotted relative to mean standing long jump of boys in the 1999 national survey of growth and physical fitness of Polish youth [9]

Table 2. Characteristics of male track and field athletes by discipline. Means and standard deviations for age and training history and age-adjusted means and standard errors based on MANCOVA with age at the covariate

	Sprints (n = 36)		Middle Distance (n = 12)		Distance (n = 31)		Athletics (n = 43)		Jumps (n = 8)		Throws (n = 6)			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Age, yrs	14.1	1.2	14.1	0.8	13.8	1.4	13.9	1.1	14.5	0.4	13.3	1.9		
Training, yrs	2.3	1.5	2.6	1.5	2.7	1.6	2.1	1.4	2.6	1.6	1.5	0.5		
Training, hrs/week	1.8	0.3	1.8	0.3	1.8	0.3	1.8	0.4	1.8	0.4	1.9	0.2		
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	F	p
Height, cm	168.6	1.3	166.7	1.2	165.1	1.4	169.8	1.2	173.7	2.8	172.3	3.2	2.58	< 0.05
Weight, kg	54.2	1.5	51.4	2.6	48.5	1.6	56.4	1.4	55.7	1.4	64.1	3.7	4.62	< 0.01
BMI, kg/m^2	18.8	0.4	18.3	0.6	17.6	0.4	19.4	0.3	18.3	0.8	21.4	0.9	4.03	< 0.01
Sum skinfolds, mm	22.5	1.2	20.5	2.1	20.0	1.3	24.7	1.1	19.5	2.5	31.6	3.0	3.88	< 0.01
Fat, %	12.0	0.9	12.7	1.5	10.5	0.9	13.5*	0.9	10.2	1.9	19.4	2.2	3.57	< 0.01
Sum R+L grip, kg	74.4	2.7	67.2	4.7	65.8	2.9	80.7	2.5	73.8	5.7	83.2	6.7	3.85	< 0.01
Standing long jump, cm	207.1	3.9	189.0	6.8	196.0	4.3	200.9	3.6	202.2	8.4	195.9	9.7	1.42	ns**
2 kg ball throw, m	7.8	0.3	7.3	0.4	7.0	0.3	8.0	0.2	7.8	0.5	8.8	0.6	2.45	< 0.05
20 m sprint, sec	2.92	0.05	2.88	0.09	2.99	0.06	3.01	0.05	2.75	0.11	3.07	0.13	1.41	ns

* n = 34 for the sample in athletics; ** ns = not significant

Throwers have a significantly larger sum of skinfolds than distance and middle distance runners and jumpers. Throwers also have a significantly larger % Fat than distance runners, sprinters and jumpers. Other pairwise comparisons for skinfolds and % Fat are not significant. Among functional measures, only grip strength differs significantly between general athletics and distance runners. All other pairwise comparisons indicate no significant differences among athletes by discipline.

The results of the MANCOVA comparing other athletes by sport and age-adjusted means and standard errors are summarized in Table 3. Only height and the 2 kg ball throw for distance differ significantly among groups, and only two pairwise comparisons indicate differences. Basketball players are significantly taller than soccer players, and the small combined sample of handball and volleyball players (other team sports) throw the 2 kg medicine ball significantly farther than soccer players.

Comparisons of track and field athletes and athletes in other sports are summarized in Table 4. Participants in other sports have significantly more experience, while track and field athletes spend significantly more

Table 3. Characteristics of male athletes in other sports. Means and standard deviations for age and training history and age-adjusted means and standard errors based on MANCOVA with age at the covariate

	Basketball (n = 17)		Football (n = 20)		Other Team[1] (n = 8)		Individual[2] (n = 9)			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Age, yrs	14.0	0.8	13.4	1.4	13.8	1.4	14.3	1.2		
Training, yrs	2.5	1.6	3.1	1.5	2.3	1.0	3.3	1.9		
Training, hrs/week	1.6	0.3	1.7	0.3	1.7	0.5	1.7	0.3		
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	F	p
Height, cm	170.9	1.7	162.6	1.6	166.0	2.4	166.9	2.5	4.13	< 0.05
Weight, kg	55.2	2.0	51.0	1.8	56.7	2.8	57.1	2.9	1.65	ns*
BMI, kg/m^2	18.7	0.6	19.1	0.5	20.4	0.8	20.2	0.8	1.52	ns
Sum skinfolds, mm	22.0	2.1	22.7	1.9	29.7	3.0	29.5	3.1	2.51	ns
Fat, %	13.9	1.3	16.7	1.2	18.1	1.9	18.7	1.8	1.87	ns
Sum R+L grip, kg	79.1	3.7	68.8	3.4	72.7	5.2	71.3	5.4	1.37	ns
Standing long jump, cm	194.6	5.7	182.0	5.2	192.4	8.0	192.4	8.3	1.02	ns
2 kg ball throw, m	7.6	0.4	6.6	0.4	8.5	0.6	6.8	0.6	3.15	< 0.05
20 m sprint, sec	3.40	0.08	3.47	0.07	3.26	0.11	3.45	0.12	0.86	ns

[1] The sample includes sport school participants in handball (5) and volleyball (3)
[2] The sample includes sport school participants in swimming (3), tennis (3), karate (2), skiing (1)
[*] ns = not significant

Table 4. Characteristics of male athletes in track and field and in other sports. Means and standard deviations for age and training history and age-adjusted means and standard errors based on MANCOVA with age at the covariate

	Track and Field (n = 135–136)		Other Sports[1] (n = 54)			
	Mean	SD	Mean	SD	F	p
Age, yrs	14.0	1.2	13.8	1.2	0.65	ns*
Training, yrs	2.3	1.5	2.8	1.6	4.14	< 0.05
Training, hrs/week	1.8	0.3	1.6	0.3	9.35	< 0.001
	Mean	SE	Mean	SE	F	p
Height, cm	168.0	0.7	167.1	1.1	0.46	ns
Weight, kg	53.4	0.8	54.8	1.2	0.94	ns
BMI, kg/m^2	18.7	0.2	19.4	0.3	4.03	< 0.05
Sum skinfolds, mm	22.6	0.7	24.6	1.1	2.64	ns
Fat, %	12.4**	0.5	16.1	0.7	17.33	< 0.001
Sum R+L grip, kg	73.6	1.4	74.4	2.2	0.08	ns
Standing long jump, cm	199.4	2.0	190.4	3.2	5.63	< 0.05
2 kg ball throw, m	7.6	0.1	7.3	0.2	1.37	ns
20 m sprint, sec	2.96	0.03	3.41	0.04	77.85	< 0.001

[1] The sample included sport school participants in basketball (17), football (20), handball (5), volleyball (3), swimming (3), tennis (3), karate (2), skiing (1)
* ns = not significant; ** n = 127 for the sample in track and field

time in weekly training. Participants in other sports have a significantly higher BMI and % Fat, while track and field athletes perform significantly better in the standing long jump and 20 m sprint. Height, weight, sum of skinfolds, grip strength and the 2 kg ball throw do not differ between the groups.

The results of the regression analyses are given in Tables 5 and 6. Among athletes aged 11–13 years, the variance explained is generally similar with either the sum of skinfolds or % Fat among the independent variables: grip strength (85% – 82%), 2 kg ball throw (72%) and standing long jump (48% and 50%). A slightly larger amount of variance in the 20 m sprint is explained when % Fat (20%) rather than the sum of skinfolds (15%) is among the predictors. Nevertheless, the sum of skinfolds and % Fat have a negative influence on each of the functional indicators. For grip strength and ball throw, weight has a positive influence while fatness has a negative influence. Predictors for the standing long jump vary. With skinfolds among the independent variables, significant predictors are age (positive), weight (positive) and skinfolds (negative), while with % Fat among independent variables, significant predictors are weight (positive), height × weight interaction (negative) and % Fat (negative). Height (positive) and skinfolds (negative), and weight (positive) and % Fat (negative) are significant predictors of the 20 m sprint.

Body size and adiposity explain a smaller percentage of the variance in the four functional tests among athletes aged 14–15 years (Tab. 6). % Fat has a negative influence on all functional tests while the sum of skinfolds has a negative influence on three tests. Skinfolds do not appear among the predictors for the 20 m sprint. Percentages of variance accounted for by the independent variables are reasonably similar for grip strength (69%, 64%) and the 2 kg ball throw (51%, 58%). However, significant predictors vary depending on whether skinfolds or % Fat is included among the independent variables. Weight and the height × weight interaction contribute positively to grip strength while skinfolds have a negative influence, whereas weight contributes positively to grip strength while height and % Fat con-

Table 5. Significant predictors of functional capacities and estimated R^2 in the total sample of 11–13 year old athletes based on multiple regression analyses including either sum of skinfolds (n = 52–53, left) or percentage fat (n = 47–48, right) among the predictors as an indicator of adiposity

Variable	Predictors	β	p	R^2	Adj R^2	p	Predictors	β	p	R^2	Adj R^2	p
Grip strength	Weight	1.129	< 0.001	0.86	0.85	< 0.001	Weight	0.950	< 0.001	0.83	0.82	< 0.001
	Skinfolds	–0.343	< 0.001				% Fat	–0.215	< 0.01			
Standing long jump	Age	0.337	< 0.01	0.51	0.48	< 0.001	Weight	0.456	< 0.01	0.53	0.50	< 0.001
	Weight	0.639	< 0.001				Ht X Wt	–0.304	= 0.07			
	Skinfolds	–0.400	< 0.01				% Fat	–0.395	< 0.01			
2 kg ball throw	Weight	1.025	< 0.001	0.73	0.72	< 0.001	Weight	0.898	< 0.001	0.73	0.72	< 0.001
	Skinfolds	–0.275	< 0.01				% Fat	–0.234	< 0.01			
20 m sprint*	Height	0.442	< 0.01	0.17	0.15	< 0.01	Weight	0.324	< 0.05	0.23	0.20	< 0.01
	Skinfolds	–0.259	= 0.07				% Fat	–0.465	< 0.01			

* Signs of the coefficients were reversed because a lower time was a better performance.

Table 6. Significant predictors of functional capacities and estimated R^2 in the total sample of 14–15 year old athletes based on multiple regression analyses including either sum of skinfolds (n = 136–137, left) or percentage fat (n = 132–133, right) among the predictors as an indicator of adiposity

Variable	Predictors	β	p	R^2	Adj R^2	p	Predictors	β	p	R^2	Adj R^2	p
Grip strength	Weight	0.891	< 0.001	0.70	0.69	< 0.001	Height	–0.230	= 0.06	0.65	0.64	< 0.001
	Ht × Wt	0.097	= 0.09				Weight	1.132	< 0.001			
	Skinfolds	–0.409	< 0.001				% Fat	–0.458	< 0.001			
Standing long jump	Age	0.173	< 0.05	0.19	0.17	< 0.001	Height	–0.381	< 0.05	0.30	0.28	< 0.001
	Weight	0.330	< 0.01				Weight	0.861	< 0.001			
	Skinfolds	–0.390	< 0.001				% Fat	–0.771	< 0.001			
2 kg ball throw	Weight	0.807	< 0.001	0.52	0.51	< 0.001	Height	–0.357	< 0.01	0.59	0.58	< 0.001
	Skinfolds	–0.270	< 0.001				Weight	1.216	< 0.001			
							% Fat	–0.587	< 0.001			
20 m sprint*	Height	0.310	< 0.05	0.05	0.03	< 0.05	% Fat	–0.344	< 0.001	0.12	0.11	< 0.001
	Weight	–0.297	< 0.05									

* Signs of the coefficients were reversed because a lower time was a better performance.

tribute negatively. For the 2 kg ball throw, weight contributes positively and skinfolds contribute negatively, whereas weight contributes positively while height and % Fat contribute negatively. More of the variance is explained in the standing long jump when % Fat rather than the sum of skinfolds is among the independent variables (28% and 17%, respectively). % Fat and height contribute negatively and weight contributes positively to the jump, while skinfolds contribute negatively and age and weight contribute positively to the jump. With the sum of skinfolds among predictors, only 3% of the variance in the 20 m sprint is explained; significant predictors are height (positive) and skinfolds (negative). With % Fat among predictors, 11% of the variance in the sprint is explained and % Fat is the only significant predictor, exerting a negative effect.

Discussion

Trends in body size of male athletes attending sport schools were generally consistent with observations for adolescent male athletes in several sports [1–3]. The mean heights of the Polish athletes tended to vary between the age-specific medians and 75th percentiles of reference data for American youth, while mean weights tended to be slightly above the reference medians except at 11–12 years old [13]. As a result, mean BMIs were slightly, but consistently, below age-specific reference medians except at 15 years old. The data were consistent with the notion that young male athletes tend to be taller than average and to have body weights that approximate the average; hence, they tend to have less weight-for-height.

Studies of body composition of young athletes generally focus on % Fat. This is probably due to the fact that fat-free mass (FFM) has a growth pattern that is similar to height and weight so that variation in FFM in young athletes varies with body size [3]. More recently attention has shifted to bone mineral due in large part to advances in DEXA technology [14]. Reference data for body composition are lacking. For comparative purposes, densitometric estimates of % Fat for non-athletic youth in the early 1960s through mid-1980s provide a reasonable reference for the general population [15, 16]. The data pre-date the obesity epidemic which surfaced in the late 1980s in most of the developed world.

NIR was used to estimate % Fat in the present study. The validity of NIR relative to the densitometric estimates of % Fat has been questioned, specifically due to the somewhat larger standard errors of estimate. The problem apparently relates to the equations for deriving % Fat provided by the manufacturer [17]. Allowing for

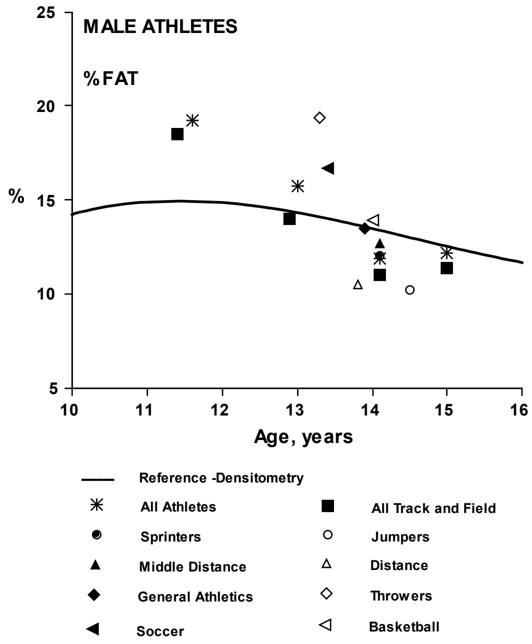

Figure 6. Estimated mean % Fat based on NIR for male track and field athletes by age group and age-adjusted estimated mean % Fat for track and field athletes by discipline and the combined sample of athletes in other sports plotted relative to estimated % Fat based on densitometry in non-athletic youth. Derivation of the non-athlete reference and source studies are reported in Malina et al. [15] and Malina [16]

this limitation, % Fat for males athletes was compared to the reference based on densitometry in Figure 6. Differences between the total samples of track and field athletes and athletes in other sports were small across the age range. Relative fatness declined with age from 11–12 years to 14 years. Age-adjusted mean % Fat varied by discipline and sport. It was, on average, above the reference in throwers and soccer players, at the reference for general athletics and basketball players, below the reference for middle distance runners and sprinters, and well below the reference for distance runners and jumpers. % Fat in sprinters was in the mid-range of estimates for other samples of adolescent sprinters, but % Fat in middle distance runners was consistently above estimates for other samples of adolescent middle distance runners [6, 7].

The percentage of variance explained by body size and adiposity in each of the functional indicators was greater in athletes 11–13 years (Tab. 5) compared to athletes 14–15 years (Tab. 6). In both age groups, however, adiposity expressed either as the sum of skinfolds or % Fat exerted a negative influence on the functional indicators. Greater proportions of the variance were explained by the size and adiposity in grip strength, and the

2 kg ball throw compared to the standing long jump and 20 m sprint. Among athletes 14–15 years old, more of the variance in the jump and sprint was accounted for when % Fat in contrast to the sum of skinfolds was included among the independent variables. This likely reflects differences between relative fatness and skinfolds. % Fat declines during male adolescence due to the rapid growth of muscle mass at this time; hence, fat as a percentage of body mass declines. In contrast, fat mass and skinfolds, especially skinfolds on the trunk increase with age across adolescence [3].

Overall, the results of the regression analyses were similar to estimates in samples of adolescent males in general [3]. Although height, weight and adiposity accounted for significant portions of variation in the four functional indicators, a considerable amount of variation was not explained by body size and fatness in this sample of male athletes, especially in the standing long jump and 20 m sprint. Unfortunately, a measure of biological maturity status was not available for the sample. This is of relevance because maturity status, size and adiposity contribute to the explained variance in a variety of functional indicators in adolescent males in general [3] and adolescent soccer players [18, 19]. Strength and performance are affected by motivation, quality of instruction and practice and other factors. Although experience in the sport school programs increased with age in this sample of male athletes, the amount of time spent in training per week was similar across age groups. This would seem to imply a need for more refined indicators of the duration and intensity of training in the sport schools to estimate any potential influences on functional capacity.

The study was limited to four indicators of functional capacity. There is a need to expand observations to other indicators, e.g., aerobic endurance, anaerobic capacity, agility, etc., and also to sport-specific skills in team (basketball, soccer, etc.) and individual sports (tennis) and to more technical skills in track and field and swimming. There is also a need to include an indicator of biological maturity status given its impact on the growth and performance of adolescent boys [3].

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