ORIGINAL ARTICLE
HEALTHY LIVING

Physical fitness vs. postural defects in boys at age 10

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Authors' Contribution:
- A Study Design
- B Data Collection
- C Statistical Analysis
- D Manuscript Preparation
- E Funds Collection

Received: 09 June 2023; **Accepted:** 11 July 2023; **Published online:** 25 July 2023

AoBID: 15947

Abstract

Background & Study Aim: It is noted that postural defects in children and adolescents negatively affect their health and physical fitness. It was assumed that there is a relationship between physical fitness and postural defects. The purpose of this article was to verify the relationship between physical fitness and postural defects in boys aged 10 years.

Material & Methods: Non-training boys (n = 60) aged 10 years were studied in two groups: healthy (n = 30); with postural defects (n = 30): with defects of the shoulder blades (n = 13); with foot defects (n = 9); with spinal defects (n = 8). Basic somatic characteristics were transferred from school nurses' records. Physical fitness was examined with the International Physical Fitness Test, which consists of eight trials: speed (a 50m run from a low start); power (long jump from a standing start); endurance (600 m run); static strength (dynamometric measurement of hand grip strength); relative arm strength (hang on a bar); agility (4×10 m shuttle run with carrying blocks); dynamic strength (bends from lying to sitting in 30 seconds); flexibility (forward bending of the trunk while standing).

Results: The boys with postural defects were taller ($p<0.03$) and more massive ($p<0.02$). Statistically significant differences were noted between healthy children and children with postural defects in shuttle running (for row score $p<0.003$ and for points results $p<0.005$). Differences were noted between children with spinal defects and children with scapular defects in sit-ups from lying backwards and in forward trunk bending while standing. In addition, a difference was noted between children with spinal defects and children with foot defects in hanging on a bar. In addition, a trend was noted that healthy children had better average scores than children with postural defects.

Conclusions: In the study population, healthy boys presented little higher average values of physical fitness than the group of study boys with postural defects (they were statistically significantly superior to boys with postural defects only in the agility trait). These boys, however, were identified by significantly higher levels of height and weight. Spinal defects were found to affect the level of flexibility; scapular defects affected the level of agility; foot defects affected the level of endurance, relative arm strength and agility. Therefore, the conjunction of these results does not justify a general conclusion that body posture defects in young boys are a factor that significantly reduces overall physical fitness.

Keywords: foot defects • International Physical Fitness Test • moderate physical activity • shoulder defects • spinal defects

Conflict of interest: Authors have declared that no competing interest exists

Ethical approval: The study was approved by the local Ethics Committee

Provenance & peer review: Not commissioned; externally peer reviewed

Source of support: Departmental sources

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Spinal defects – include flat back, excessive kyphosis, lumbar lordosis, round-concave back, idiopathic scoliosis, scoliotic posture, Scheuermann's disease [12].

Shoulder defects – protruding scapulae, or scapular dyskinesis [13].

Foot defects – include: flat feet, flat-legged feet, clubfoot, hollow feet [14].

Motor skills – *plural noun* the ability of a person to make movements to achieve a goal, with stages including processing the information in the brain, transmitting neural signals and coordinating the relevant muscles to achieve the desired effect [15].

Training load – 'A simple mathematical model of training load can be defined as the product of qualitative and quantitative factor. This reasoning may became unclear whenever the quantitative factor is called ***workload volume*** or ***training volume*** interchangeably with ***volume of physical activity***. Various units have been adopted as measures i.e. the number of repetitions, kilometres, tons, kilocalories, etc. as well as various units of time (seconds, minutes, hours) (...) As in the real world nothing happens beyond the time, the basic procedure of improvement of workload measurement should logically start with separation of the time factor from the set of phenomena so far classified together as ***workload volume***. (...) Due to the fact that the heart rate (HR) is commonly accepted as the universal measure of workload intensity, the product of effort duration and HR seems to be the general indicator of ***training load*** defined as the amount of workload. It is useful in analyses with a high level of generality. (...) In current research and training practice the product of effort duration and HR was referred to as conventional units' or further calculations have been made to convert it into points.' [16, p. 238].

Training intensity – the effort of training. A number of methods are used to establish training intensities which give maximum benefits. These include the lactic acid method, minute ventilation method, and target heart-rate [17].

INTRODUCTION

Problems of postural defects affect 30% to 60% of Polish children and adolescents [1]. The aetiology in their formation is mainly lifestyle [2]. It is noted that problems of postural defects negatively affect the health and physical fitness of children and adolescents [3]. Therefore, numerous reports of deterioration in the level of physical fitness of young generations should be associated with postural defects [4]. This problem is being explored by physicians, physiotherapists, physical education teachers and parents [5].

Thus, an attempt was made to determine the relationship between physical fitness and postural defects in boys aged 10. Ten-year-old boys continue their education in the fourth grades of elementary schools after early childhood education. Due to the development of physical fitness, this is a very important age. The young person already has a high level of physical development, although the rapid pace of development is still noted. Therefore, this period is one of the first stages, which is characterized by high results of fitness tests. This is evidenced by the rapid development of motor skills [6].

By undertaking our research, we make assumptions that ten-year-old boys have the best time to start systematic training, as they have the capacity to acquire more and more complex movements. However, this period ends rather quickly, as it is followed by puberty. We think it is important to determine what is the level of physical fitness of ten-year-old boys, both healthy and with postural defects.

The purpose of this article was to verify the relationship between physical fitness and postural defects in boys aged 10 years.

MATERIAL AND METHODS

Surveyed persons

The subjects of the study were non-training boys (n = 60) aged 10 years, who were put together as two groups: healthy (n = 30) and with postural defects (n = 30). Children with postural defects were classified into individual defects: with defects of the shoulder blades (n = 13); with foot defects (n = 9); with spinal defects (n = 8).

The subjects were randomly selected from the population of students from elementary schools in Tarnów, a town in Małopolskie province, Poland. The study was conducted in September 2022.

Research method

Measurements of basic somatic characteristics were recorded by analysing students' health cards from school nurses' records.

The main criterion for estimating the moderate physical activity (MPA) of the surveyed boys was attendance during physical education classes (formally four times a week; 45 minutes each).

Physical fitness was determined by the International Physical Fitness Test [7], which consists of eight tests: speed (a 50m run from a low start); power (long jump from a standing start); endurance (600 m run); static strength (dynamometric measurement of hand grip strength); relative arm strength (hang on a bar – this variant in these studies – or ('bending arms in an overhang'); agility (4×10 m shuttle run with carrying blocks); dynamic strength (bends from lying to sitting in 30 seconds – in Tables 'sit-ups from lying down'); flexibility (forward bending of the trunk while standing – in Tables 'torso bend').

Procedure

All tests were carried out indoors according to the aforementioned order, under conditions that ensured the uniformity of the tests performed, as well as good motivation of the subjects to exert themselves. The tests were preceded by detailed verbal instruction, demonstration and warm-up. The endurance run was conducted on a different day from the other tests. All subjects and their legal guardians gave written consents to participate in the study. The project received a favourable opinion from the local ethics committee.

Statistical analysis

Stat Soft statistical methods package was used for data analysis. Basic descriptive statistics were calculated. Then, using Student's t-test and the LSD (last significant differences) test, after first assessing the homogeneity of the variance with the F-test, the significance of intergroup differences was calculated, for $p<0.05$.

RESULTS

The boys with postural defects were taller (p<0.03) and more massive (p<0.02). Statistically significant differences were noted between healthy children and children with postural defects in shuttle running (for row score p<0.003 and for points results p<0.005) (Table 1).

Differences were noted between children with spinal defects and children with scapular defects in sit-ups from lying backwards and in forward trunk bending while standing. In addition, a difference was noted between children with spinal defects and children with foot defects in hanging on a bar. In addition, a trend was noted that healthy children had better average scores than children with postural defects (Table 2).

DISCUSSION

The present study did not unquestionably find that healthy students showed better physical fitness in relation to the performance of students characterized by particular postural defects. In most cases, the differences between the studied groups were not statistically significant. But in general, healthy boys dominated in some trials, while boys with postural defects dominated in others. This means that their fitness level is at a similar level, but not the same. This is due to the age of the test subjects by the manifestations of their psychosomatic development. On the other hand, postural defects relate to their lifestyle. In the school environment, it will be the adjusted benches and chairs to the children's corporeality. Also relevant is the problem of heavy school bags that children must carry on their backs

Personal safety – a justified sense of survival ability in various emergency situations, either of external nature (e.g. violence, aggression, unintended fall, fire, tsunami) or internal nature (e.g. stress, disease, fear) [18].

Table 1. Comparison of mean values of indicators of healthy children (n = 30) and children with postural defects (n = 30).

Variable	Average				ANOVA		Detailed comparisons (post-hoc) with LSD test					
	healthy (n = 30)	spinal defect (n = 8)	shoulder blades (n = 13)	foot defect (n = 9)	F	p	healthy-spinal defect	healthy-shoulder blades	healthy – foot defect	spinal defect-shoulder blades	spinal defect-foot defect	shoulder blades – foot defect
age [years]	10.60	10.25	10.54	10.67	1.23	0.307	0.083	0.712	0.7264	0.203	0.0911	0.5557
somatic indicators												
height [cm]	145.03	148.25	151.38	150.22	1.90	0.139	0.366	**0.035**	0.129	0.435	0.649	0.763
weight [kg]	38.88	44.88	42.69	44.94	2.11	0.110	0.070	0.166	0.056	0.554	0.986	0.527
BMI indicator	18.36	20.13	18.54	19.79	1.84	0.150	0.059	0.812	0.109	0.132	0.764	0.218
Rohrer's indicator	1.27	1.36	1.23	1.32	1.43	0.244	0.149	0.456	0.356	0.070	0.640	0.170
moderate physical activity (MPA)												
MPA minutes/week	633.71	776.39	649.59	724.80	1.64	0.191	0.054	0.794	0.193	0.127	0.562	0.345
general fitness test (indicator) according to International Physical Fitness Test (raw score)												
50m run [s]	9.03	9.09	9.64	9.19	0.98	0.411	0.881	0.097	0.698	0.270	0.856	0.346
long jump from a standing start [cm]	165.57	174.38	156.00	161.78	1.10	0.358	0.349	0.224	0.674	0.087	0.274	0.572

Variable	Average				ANOVA		Detailed comparisons (post-hoc) with LSD test					
	healthy (n = 30)	spinal defect (n = 8)	shoulder blades (n = 13)	foot defect (n = 9)	F	p	healthy-spinal defect	healthy-shoulder blades	healthy – foot defect	spinal defect-shoulder blades	spinal defect-foot defect	shoulder blades – foot defect
600m run [s]	217.60	185.50	210.08	178.89	2.03	0.119	0.100	0.641	**0.039**	0.262	0.779	0.142
hand strength [kG]	16.12	16.81	15.39	12.17	1.36	0.265	0.754	0.692	0.066	0.569	0.090	0.186
hang on a bar [s]	37.48	42.89	33.00	20.61	1.96	0.130	0.519	0.523	**0.039**	0.298	**0.033**	0.178
4×10m run with carrying blocks [s]	11.47	12.19	12.72	12.50	3.35	**0.025**	0.175	**0.006**	**0.046**	0.382	0.642	0.699
sit-ups from lying down [number]	23.10	26.00	21.62	22.44	1.45	0.239	0.134	0.355	0.720	**0.047**	0.133	0.692
torso bend [cm]	1.75	7.69	1.00	2.78	2.17	0.102	**0.022**	0.723	0.672	**0.023**	0.117	0.521
general fitness test (indicator) according IPFT (after decomposing the raw score into points)												
50m run [s]	54.27	55.13	47.00	52.11	1.00	0.401	0.873	0.110	0.675	0.185	0.647	0.386
long jump from a standing start [cm]	56.40	62.13	52.00	54.33	1.37	0.261	0.213	0.251	0.636	0.054	0.166	0.640
600m run [s]	35.13	47.13	37.00	48.89	2.19	0.099	0.082	0.743	**0.038**	0.191	0.832	0.113
hand strength [kG]	46.10	49.75	45.08	38.22	1.49	0.228	0.443	0.796	0.086	0.384	**0.050**	0.188
hang on a bar [s]	64.53	67.50	60.85	51.11	1.95	0.131	0.645	0.493	**0.032**	0.361	**0.041**	0.169
4×10m run with carrying blocks [s]	61.67	55.88	51.00	52.56	3.04	**0.036**	0.229	**0.009**	**0.050**	0.368	0.570	0.765
sit-ups from lying down [number]	50.97	57.50	48.08	49.56	1.60	0.200	0.102	0.382	0.703	**0.031**	0.103	0.731
torso bend [cm]	51.47	60.50	50.15	53.00	2.14	0.105	**0.024**	0.688	0.682	**0.022**	0.121	0.506
results of IPFT (points)												
total	420.53	455.50	391.15	399.78	1.46	0.236	0.236	0.233	0.459	0.056	0.123	0.787
average	52.57	56.94	48.89	49.97	1.46	0.236	0.236	0.232	0.459	0.056	0.123	0.787

$\overline{X}$ weighted average; **s** sample standard deviation; **v** coefficient of variation; **t** distribution; **p** significance level

Table 2. Detailed comparison of the values of the average indicators of healthy children (n = 30) and children with postural defects (n = 30).

Variable	Healthy			With postural defects			t-Student	
	$\overline{X}$	s	v	$\overline{X}$	s	v	t	p
age [years]	10.60	0.50	4.70	10.50	0.51	4.84	0.77	0.445
somatic indicators								
height [cm]	145.03	8.02	5.53	150.20	9.44	6.29	–2.28	0.026
weight [kg]	38.88	7.31	18.80	43.95	8.75	19.91	–2.43	0.018
BMI indicator	18.36	2.18	11.85	19.34	2.48	12.82	–1.63	0.108
Rohrer's indicator	1.27	0.14	11.21	1.29	0.16	12.73	–0.58	0.561
moderate physical activity (MPA)								
MPA minutes/week	633.71	161.89	25.55	705.96	201.60	28.56	–1.53	0.131
general fitness test (indicator) according to International Physical Fitness Test (raw score)								
50m run from a low start [s]	9.03	1.03	11.39	9.36	1.17	12.45	–1.18	0.243
long jump from a standing start [cm]	165.57	21.46	12.96	162.63	25.67	15.78	0.48	0.633
600m run [s]	217.60	50.27	23.10	194.17	46.69	24.05	1.87	0.066
dynamometric measurement of hand grip strength [kG]	16.12	5.80	36.00	14.80	5.39	36.44	0.91	0.366
hang on a bar [s]	37.48	22.76	60.73	31.92	20.12	63.03	1.00	0.321
4×10m run with carrying blocks [s]	11.47	1.09	9.55	12.51	1.50	12.00	–3.08	0.003
sit-ups from lying down [number]	23.10	4.74	20.54	23.03	5.03	21.86	0.05	0.958
torso bend [cm]	1.75	6.87	392.31	3.32	6.19	186.72	–0.93	0.357
general fitness indicators according IPFT (after decomposition of the raw score into points)								
50m run from a low start [s]	54.27	12.23	22.54	50.70	14.61	28.82	1.03	0.309
long jump from a standing start [cm]	56.40	10.56	18.72	55.40	12.61	22.77	0.33	0.740
600m run [s]	35.13	17.62	50.15	43.27	16.77	38.77	–1.83	0.072
dynamometric measurement of hand grip strength [kG]	46.10	13.02	28.23	44.27	11.06	24.99	0.59	0.559
hang on a bar [s]	64.53	16.96	26.28	59.70	15.90	26.63	1.14	0.259
4×10m run with carrying blocks [s]	61.67	10.68	17.32	52.77	12.91	24.46	2.91	0.005

Variable	Healthy			With postural defects			t-Student	
	$\overline{X}$	s	v	$\overline{X}$	s	v	t	p
sit-ups from lying down [number]	50.97	9.73	19.09	51.03	10.47	20.52	–0.03	0.980
torso bend [cm]	51.47	10.60	20.59	53.77	9.57	17.80	–0.88	0.381
results of IPFT (points)								
total number of points	420.53	66.12	15.72	410.90	82.29	20.03	0.50	0.619
average points	52.57	8.27	15.72	51.36	10.29	20.03	0.50	0.619

F result of analysis of variance; **p** significance level

in schools. In the family environment, the problem of postural defects relates primarily to the use of modern technology in the wrong positions. Prolonged use of computers, consoles, social communicators is not conducive to children's health. The importance of mental health should also be emphasized. Children with mental disorders or diseases often withdraw from peer and family relationships. Their illnesses cause somatic disorders that lead to postural defects. For example: anxiety reactions through excessive food intake led to excessive fatness of the body, which translates into flat feet; lowered mood promotes tendencies to avoid eye contact, so that an ill child walks with a bowed head and exacerbates kyphosis in the upper spine. That is why specialists in physical education play such an important role [8]. Through rationally selected physical activity they direct the health of children. It should be noted that people with postural defects through appropriate exercises compensate for their physical fitness. And by training a particular sport, they raise their physical fitness to an even higher level [9]. This translates into their high motor skills [10] and personal safety [11].

The conducted studies and the described considerations do not exhaust the whole issues related to physical fitness among boys with postural defects. They are only one of many issues raised in the ongoing global discussion. The results obtained provide opportunities for further research work against the background of 21st century phenomena. This is particularly important for researchers in medical sciences, health sciences and physical culture sciences.

Although in line with the basic assumption that we studied non-training boys, a significant limitation is the knowledge about moderate physical activity (MPA) estimated only on the basis of time (in minutes) devoted to exercise. It is true that time (estimated by various indicators: seconds, minutes, hours, etc.) is the basic criterion of 'workload volume' and the most frequently mentioned indicator informing about the body's effort load. However, the use of the term 'volume' in this case is criticized from the perspective of logic, after all, it is a unit of measurement strictly defined in the SI system – see glossary: 'training load'. There is no unanimous recommendation among scholars regarding 'training intensity' (also see glossary).

CONCLUSIONS

In the study population, healthy boys presented little higher average values of physical fitness than the group of study boys with postural defects (they were statistically significantly superior to boys with postural defects only in the agility trait). These boys, however, were identified by significantly higher levels of height and weight. Spinal defects were found to affect the level of flexibility; scapular defects affected the level of agility; foot defects affected the level of endurance, relative arm strength and agility. Therefore, the conjunction of these results does not justify a general conclusion that body posture defects in young boys are a factor that significantly reduces overall physical fitness.

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Cite this article as: Witkowski K, Michalik A, Piepiora P. Physical fitness vs. postural defects in boys at age 10. Arch Budo Sci Martial Art Extreme Sport 2023; 19: 123-129