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FITNESS LEVEL OF SECONDARY SCHOOL STUDENTS ENGAGED IN SPORTS

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Abstract. *School physical education is effective means of providing children with the knowledge for lifelong physical activity. The research was aimed to examine the influence of different sports activities (badminton, basketball, football) on fitness level of boys aged 10-11. 72 boys aged 10-11 were engaged in the research. Evaluation of children's fitness level involved anthropometric parameters of body length (cm); body mass (kg); hand dynamometry (kg). Cardiovascular and respiratory systems were also assessed: heart rate (HR, bpm) – method of palpation; blood pressure – systolic (SBP, mm Hg) and diastolic (DBP, mm Hg) – method of Korotkoff sounds; vital capacity of lungs (VC, L) – spirometer measuring. The Ruffier index, life index, strength index, the Robinson index and the Quetelet index were considered as well. Summing the points of five parameters, fitness levels were defined as low, below average, average, above average, and high. Comparative analysis of ball games influence on children's fitness level revealed the highest growth rate among badminton players, though their initial and final parameters were the lowest ones. Research findings made it possible to conclude that extramural engagement in ball games throughout school year had beneficial effect on fitness levels of boys aged 10-11.*
Keywords: *ball games, evaluation, influence, physical activity.*

Introduction

Today moving seems to have become a serious problem and yet we are predisposed to motion and activity, we interact with our environment through movement. The school, as an educational place, should contribute to the lowering of this percentage, educating and promoting a healthy lifestyle, in which motor activity plays a fundamental role (Pesce, Crova, Cereatti, Casella, & Bellucci, 2009; Lorås, Haga, & Sigmundsson, 2020). Factors, such as social change and increasing urbanization processes in the early years of the 21st century, have caused a reduction in the amount of time that youth devote to leisure activities; sedentary behaviors are on the rise (World Health Organization, 2019). Physical education is a key setting for children to engage in health-enhancing physical

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activity (Domville, Watson, Richardson, & Graves, 2019).

The school environment is a recommended setting for the promotion of physical activities among children and adolescents (Hollis et al., 2016). Physical education in school is the most effective and inclusive way of providing children with the skills, attitudes, values, knowledge, and understanding for lifelong participation in physical activities and sport (Hardman, Murphy, Routen, & Tones, 2014; Woynarowska, Mazur, & Oblacińska, 2015).

School-related physical activity interventions may reduce anxiety, increase resilience, improve well-being and increase positive mental health in children and adolescents. Considering the positive effects of physical activity on health in general, these findings may reinforce school-based initiatives to increase physical activity (Andermo et al., 2020). Games promote abstract knowledge, which in general situations these strategies can be used in different contexts (Pesce, Marchetti, Motta, & Bellucci, 2015; Tomporowski & Pesce, 2019). For children, both the functional (e.g. keep the activity running) and the social (e.g. practice with teammates) dimensions of game and practice seemed to be of equal importance, determining both the intensity and the meaning given to their participation (Dania & Harvey, 2020).

According to the researchers, the present school system of physical education is not able to provide the proper level of physical and intellectual capacity, which the current employment market will require from them and which will be necessary for them for further professional activity (Krutsevich, 2003; Galan et al., 2017; Andrieieva, Galan, Hakman, & Holovach, 2017; Nakonechnyi & Galan, 2017; Pasichnyk et al., 2018; Galan et al., 2019). So, after-school approaches offer a viable solution to the current challenge of physical inactivity among many adolescents (Roth, Brooks-Gunn, Murray, & Foster, 2003).

The research was aimed to examine the influence of different sports activities (badminton, basketball, football) on the fitness level of boys aged 10-11.

Material and methods

The study involved 72 boys aged 10-11 years attending sports classes in basketball, football and badminton. The number of children in each group was the same and comprised 24 people. All groups had a 1.5-hour training three times a week. During the summer holidays, all children had a break from sports classes for 30 days in July. The research methods of the study: analysis and synthesis of literature sources; pedagogical observation; H. Apanasenko method of evaluating an individual fitness level of children; mathematical statistics.

Evaluation of the individual fitness level of children by the method of H. Apanasenko (2000) involves the definition of the following anthropometric parameters: body length (cm); body mass (kg); dynamometry of dominant hand (kg). Anthropometric monitoring was performed with standard tools according to

the generally accepted methods. Due to the methods, cardiovascular and respiratory systems were also assessed on the following parameters:

- Heart rate (HR, bpm) – method of palpation;
- Blood pressure – systolic (SBP, mm Hg) and diastolic (DBP, mm Hg) – method of Korotkoff sounds;
- Vital capacity of lungs (VC, L) – spirometer measuring.

The Ruffier test was also carried out:

heart rate of the pupils was measured for 15 seconds in a sitting position after 5-minute rest (HR_1), for the first 15 seconds after performing 30 squats in 45 seconds (HR_2), and for the last 15 seconds of the first minute recovery after the exercise (HR_3).

The Ruffier index was calculated by this formula:

$RI = (4 \times (HR_1 + HR_2 + HR_3) - 200) : 10$ (points)

Additionally, the following parameters were considered:

Life index: LI = vital capacity of lungs/body mass (mL/kg)

Strength index: SI = hand dynamometry / body mass x 100 (%)

The Robinson index (double product):

$DP = HR_{rest} \times SBP / 100$ (relative units – r.u.)

The Quetelet index (ratio of body mass to body length – points by the table):

QI = body mass (g) / body length (cm)

All the parameters were calculated in points. Summing the points of the five parameters and comparing the result with the table scale, the fitness levels were determined as low, below average, average, above average, and high (Table 1).

Table 1 ***Express-evaluation of boys' fitness levels*** *(Apanasenko, 2000)*

N	Parameters	Fitness levels				
		low	below average	average	above average	high
1	Life index, mL/kg	45	46-50	51-60	61-69	70
	(points)	0	1	2	3	4
2	Strength index, %	45	46-50	51-60	61-65	66
	(points)	0	1	2	3	4
3	Robinson index, relative units	101	100-91	90-81	80-75	74
	(points)	0	1	2	3	4
4	Quetelet index, points	-3	-2	-1	0	0
5	Ruffier index, relative units	14	13-11	10-6	5-4	3
	(points)	-2	-1	2	5	7
	Points total	2	3-5	6-10	11-12	13

Results

The parameters of the pupils' fitness levels were defined at the beginning and at end of the study.

The initial research data analysis (Table 2) showed a higher index of the boys' body length among football players (142.4±0.7) as compared to badminton (140.2±0.7) and basketball (141.2±1.4) players.

Table 2 ***Initial parameters of physical development and functional state of boys aged 10-11 (M±m)***

Parameters of fitness level	Groups		
	Badminton players (n=24)	Football players (n=24)	Basketball players (n=24)
Body length (cm)	140.2±0.7	142.4±0.7	141.2±1.4
Body mass (kg)	35.9±0.6	36.1±0.8	37.7±1.2
HR_{rest} (bpm)	84.2±1.4	82.5±1.9	82±1.5
VC (mL)	1808.3±25.4	1666.6±31	1687±91.9
Hand dynamometry (kg)	15±0.4	17±0.7	20.87±0.63
SBP (mm Hg)	95.6±0.9	94.7±0.8	95.2±0.92
DBP (mm Hg)	62±0.5	61.25±0.4	62.08±0.51

The body mass index of the pupils engaged in badminton and basketball was of medium homogeneity (10%<V<20%), while the football players were homogeneous (V<10%). The average index was higher among the basketball players (37.7±1.2).

The HR index showed medium homogeneity among the football players (10%<V<20%), whereas the basketball and badminton players were homogeneous (V<10%). The average HR index was higher in the group of basketball players (84.2±1.4).

VC was homogeneous among the badminton and football players (V<10%), but the group of basketball players appeared to have medium homogeneity (10%<V<20%). The average index was higher among the badminton players (1808.3±25.4).

Hand dynamometry indicated medium homogeneity in the three groups (10%<V<20%). The basketball players had the highest average index (20.87±0.63), and the badminton players – the lowest (15±0.4).

The BP index revealed homogeneity in all the groups (V<10%). SBP of the badminton, football, and basketball players was within normal limits, ranging 90-100 bpm. DBP did not differ significantly, ranging 60-65 bpm.

However, the regular engagement in ball games resulted in substantial parameter improvement in the three groups of boys (Table 3).

Table 3 ***Parameters of physical development and functional state of boys at the end of academic year (M±m)***

Parameters of fitness level	Groups		
	Badminton players (n=24)	Football players (n=24)	Basketball players (n=24)
Body length (cm)	142±1.03	143.2±1.3	145±0.7
Body mass (kg)	36.1±0.9	37.3±1.2	38.9±0.4
HR_{rest} (bpm)	82.5±1.5	82.8±1.8	82.08±1.5
VC (mL)	1895±29.7	1916.7±39.1	1725±86.5
Hand dynamometry (kg)	17.3±0.4	17.9±0.59	21.9±0.98
SBP (mm Hg)	95.4±0.9	97.3±1.4	95.2±1.06
DBP (mm Hg)	62.08±0.7	62.3±1.2	61.9±0.78

Some changes occurred in the physical development and functional state of adolescents during the year. In particular, statistically significant changes ($p<0.05$) in the indices of VC and hand dynamometry were found in the group of badminton players. A minor increase was observed in the indices of body length and body mass, though they are statistically insignificant ($p>0.05$) and correspond to the age-related changes in the boy's organism. No considerable changes occurred in HR and BP indices of the cardiovascular system. All parameters of the group became homogeneous (V<10%).

The boys of group 2, engaged in football, had statistically significant changes ($p<0.05$) in the index of VC, with an increase by 15%. Other changes were age-related. All parameters of the group became homogeneous (V<10%).

The pupils of group 3, engaged in basketball, appeared to have statistically significant changes ($p<0.05$) in the indices of body length, VC, and hand dynamometry. No considerable changes, except age-related, occurred in other parameters of physical development and functional state of the body systems.

Thus, the comparative analysis of the initial and final parameters of physical development and functional state of the boys revealed statistically significant changes ($p<0.05$) in the VC indices of the three groups. In addition, badminton players were found to have statistically significant changes in the indices of dynamometry, and basketball players – in the indices of body length and dynamometry.

Initial results of the Ruffier test in group 1, engaged in badminton, indicated a low level among 58% of the boys, and below average – 42%. The average in the Ruffier index in this group was 11,94±0.43. Group 2, engaged in football, displayed low level among 12% of the players, below average – 62%, average – 22%, and above average – 4%. The average in the Ruffier index in this group was 11,03±0.48. Group 3, engaged in basketball, showed a low level among 8% of the pupils, below average – 62%, and average – 30%. The average in the Ruffier index in this group was 11,26±0.46.

At the end of the year, the Ruffier test results were improved significantly

($p<0.05$) in all the groups and were better in all three groups. In the first group (badminton players), the average value of the Ruffier index became 9.97±0.44; in the second group (football players) 9.66±0.45; in the third group (basketball players) 9.89±0.49. Hence, low level was presented by only 4% of the badminton players. Below average level was demonstrated by 33% of the badminton players, 29% of the football players, and 25% of the basketball players. The average level was shown by 46% of the badminton players, 50% of the football players, and 63% of the basketball players. Above average level was displayed by 17% of the badminton players, 17% of the football players, and 12% of the basketball players. The dynamics of the Ruffier index indicate an improvement in the body's adaptation mechanisms of boys aged 10 - 11 to intense physical load.

At the beginning of the academic year, the estimated parameters of the boys in all groups (life index, strength index, the Robinson index, and the Quetelet index) were within the low, below average and average levels. Engagement in sports classes enhanced the boys' parameters: decreased ratio of low and below average levels, increased number of above average level, and emergence of pupils with high level of development. The most substantial changes were found in life index, grounded on statistically significant changes ($p<0.05$) in the VC indices of the boys in all groups.

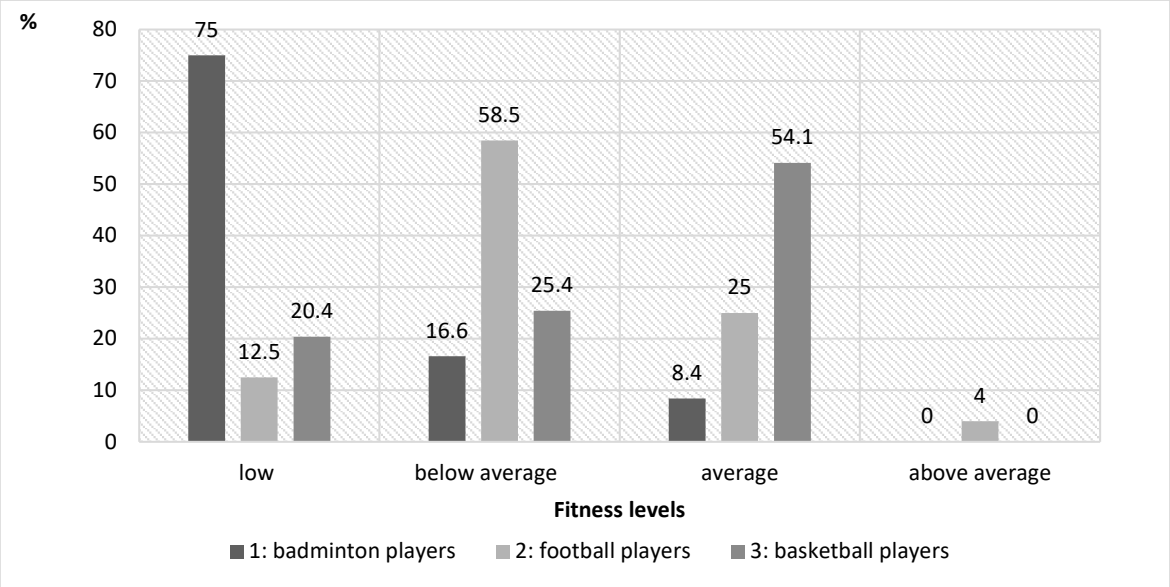

Figure 1 ***Fitness levels of boys in different groups at the beginning of academic year***

The results revealed that fitness levels of most school boys aged 10-11 engaged in sports classes were low and below average at the beginning of academic year (Fig. 1). So, the boys in the first group (badminton players) had an average fitness level 2.6 points, in the second group (football players) 4.6 points and in the third group (basketball players) 5.1 points, which corresponded to the below average level. Only 4% of the boys engaged in football had above average

fitness level. No boys in the three groups were found to have high fitness level.

Due to the improvement of parameters in physical development and functional state, the pupils' fitness level increased as well. Fitness levels of the boys in all three groups improved significantly during the study (Fig. 2). The boys in the first group (badminton players) had an average fitness level 6.7 points, in the second group (football players) 7.8 points and in the third group (basketball players) 7.2 points, which corresponded to the average level. No pupils demonstrated low fitness level. Below average level was displayed by 33% of the badminton players, 29% of the football players, and 37% of the basketball players. The ratio of average level increased in each group: 54% of the badminton players, 29% of the football players, and 53% of the basketball players. Above average level was mostly presented by the football players – 21%, also the basketball players – 8%, and the badminton players – 13%. At the end of the experiment high fitness level was revealed among the football players – 13% and the basketball players – 2%.

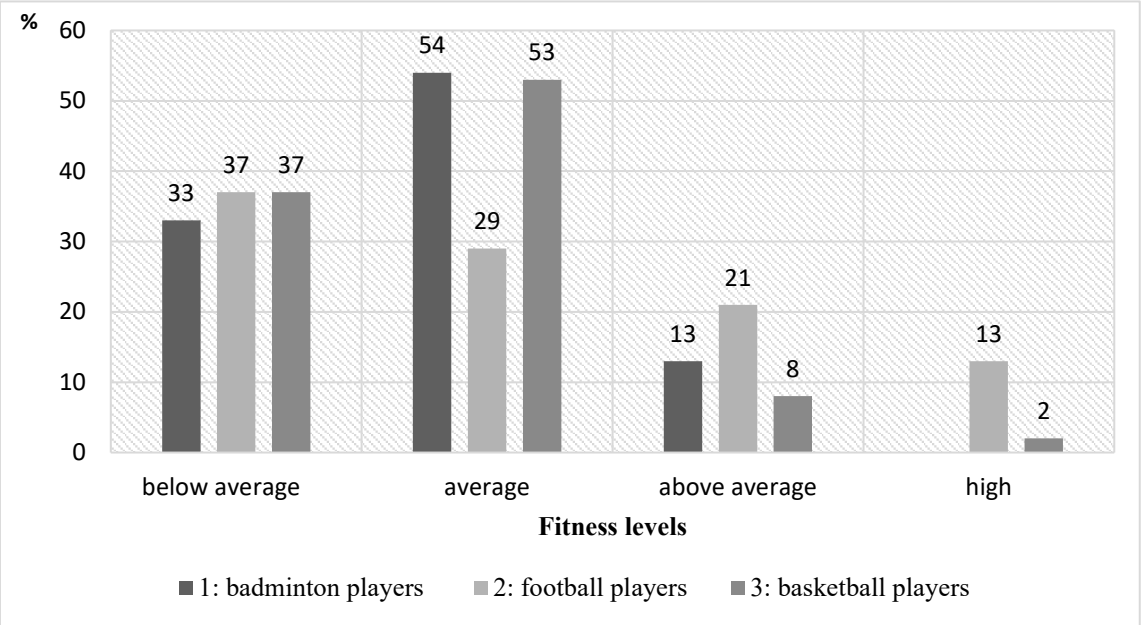

Figure 2 ***Final fitness levels of the boys***

Fitness levels in all three groups of the boys were enhanced as a result of the improved parameters such as the Ruffier index and the Robinson index, thus indicating the beneficial effect of extramural sports classes on the cardiovascular system. The parameters of strength index (hand dynamometry) and life index (VC) increased as well.

The comparative analysis of the effects of different extramural sports classes on the state of the pupils' health showed the highest fitness level among the football and basketball players, and the lowest parameters were found among the badminton players.

In the course of our research, the following growth rate of fitness levels was observed in all three groups of boys (Fig. 3). The badminton players demonstrated a 200% decrease of low level and the increase of other fitness levels: below average – 66%, average – 146%, above average – 200%.

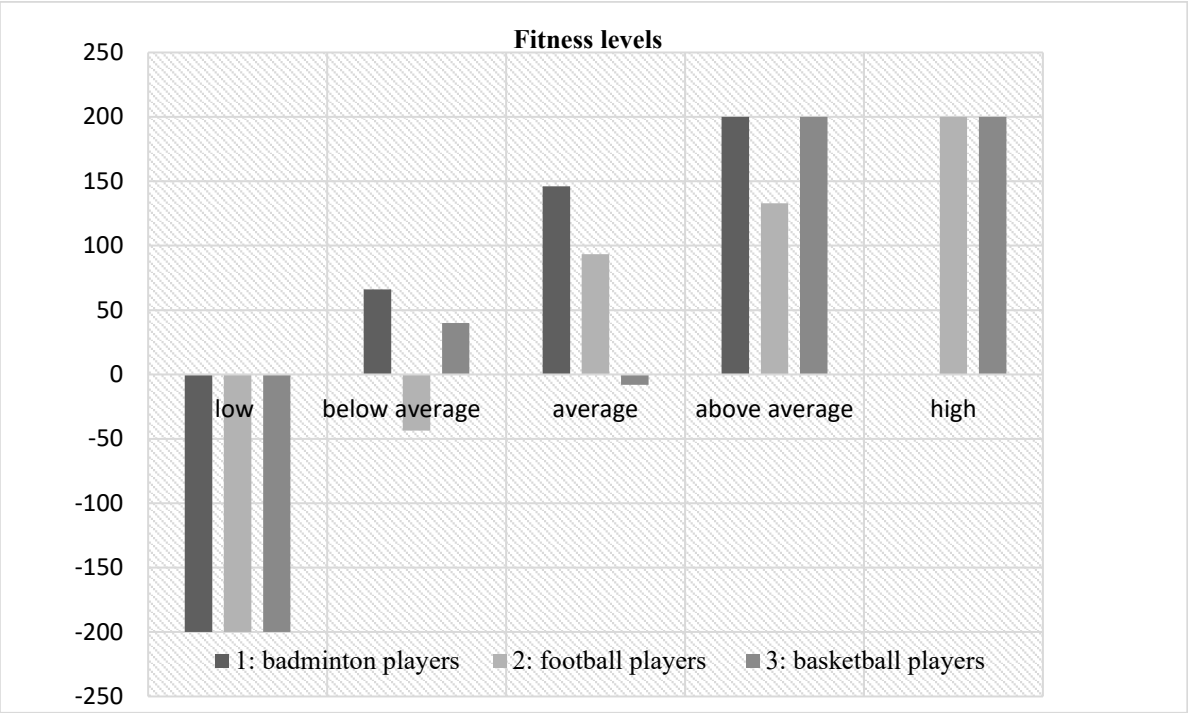

Figure 3 ***The growth rate of boys' fitness levels due to their sports classes***

The boys engaged in football had a significant reduction of low fitness level by 200%, and an equal 200% increase of high level as well. Below average level of the football players' fitness decreased by 43.5%, with the related growth of other levels: average – 93.3% and above average – 133%.

The group of basketball players displayed such growth rate of fitness levels: low – 200% decrease, average – 8% increase, above average, and high – 200% increase.

Thus, the sports classes in badminton, football, and basketball appeared to have a beneficial effect on the health of boys aged 10-11. This was confirmed by a significant increase in the fitness level of badminton players (61%), football players (16%) and basketball players (27%). The impact peculiarities of different ball games on children's fitness level revealed the highest growth rate in the group of badminton players, even though their initial and final results were the lowest.

Discussion

The results of systematic review indicate that school-related interventions aiming to promote physical activity can reduce anxiety, increase resilience, increase well-being, and improve positive mental health of children and young people. Considering the positive effects of physical activity on health in general, these findings may reinforce school-based initiatives to increase physical activity. (Andermo et al., 2020).

Middle-aged childhood, from 6 to 12 years old, is often referred to as the "forgotten years" of development because most research focuses on early childhood development or adolescent growth. However, middle childhood is rich in potential for cognitive, social, emotional, and physical progress. During this period, the brain is actively subjected to synaptic cutting and, as such, becomes more and more refined, a process that largely depends on the environment of a child. This discovery opens the door to optimizing the experiences a child has to provide a solid foundation for maturity (Mah & Ford-Jones, 2012).

We agree with this point of view, as our research testifies to the importance of sports for children of middle school age when the rapid growth and development of the body are actually observed. The researches have shown a favorable influence of regular engagement in ball games on fitness level improvement for boys aged 10-11 (Nakonechnyi et al., 2023; Luvei et al., 2022; Khanikiants et al., 2021; Andrieieva et al., 2020).

Athletes, competing in different sports and sports disciplines, differ in their physical and physiological characteristics (Stojanovic et al., 2016).

Since each sport has its own specific demands, every athlete should have specific anthropometrical characteristics and body composition related to the sports disciplines involved. (De Oliveira-Junior et al., 2016).

We share and confirm the scholars' opinions with the results of our research. It showed the contribution of regular engagement in badminton and basketball to the active development of muscle strength in the boys' upper extremities.

Anthropometrical characteristics and body composition of athletes have been the subject of many investigations as many researchers have hypothesized that athletes in training might be expected to exhibit structural and functional characteristics that are specifically favorable to the sports they play (Singh, Singh & Singh, 2010). The need to investigate data obtained from the investigation of anthropometrical characteristics and body composition of soccer and volleyball players is as important as adequate body composition and body mass which, among other factors, contribute to optimal exercise routines and performance (Massuça & Fragoso, 2011).

We support this thesis, as our research has shown a higher increase in the boys' body length among basketball players as compared to the boys engaged in football and badminton. Changes in the dynamometry parameters of the boys are

more significant among badminton and basketball players. These differences are due to the impact specifics of different sports.

Conclusions

Pupils' engagement in sports classes appeared to greatly advance fitness levels in the three groups of boys. In view of primarily low and below average fitness levels of pupils at the initial stage of research, the parameters were much higher in the final part of the study, with prevalent average and above average levels of fitness. In addition, no boys with low fitness level were found in any of the groups, while the football and basketball groups displayed to have boys with a high fitness level.

The comparative analysis of ball games' influence on children's fitness level revealed the highest growth rate in the group of badminton players, though their initial and final parameters were the lowest.

On the grounds of the research findings, it is possible to conclude that extramural engagement in ball games throughout the school year had a beneficial effect on the fitness levels of boys aged 10-11.

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