

NATIONAL SPORTS ACADEMY „VASSIL LEVSKI”

“THEORY OF PHYSICAL EDUCATION” DEPARTMENT

Kaloyan Kamenov Chernev

A study on the physical fitness of high school students

ABSTRACT

**of a dissertation for the award of the educational and scientific
degree "Doctor"**

S o f i a, 2022

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ABSTRACT

of a dissertation for the award of the educational and scientific degree "Doctor",
in the professional field 1.3. Pedagogy of Education, doctoral degree program
"Physical Education in the Educational System"

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The dissertation was discussed at the internal defense and proposed for official defense by the „Theory of physical education” Department at the National Sports Academy "Vassil Levski".

The dissertation contains 236 pages, illustrated with 45 tables and 47 figures. The bibliography includes 185 literary and documentary sources, of which 95 in Cyrillic, 90 in Latin, and Internet sources.

The public defense of the dissertation will take place on 20.09.2022 at 14:00h in Hall A3 of the National Sports Academy "Vassil Levski" (Studentski grad, Sofia) at a meeting of a specialized scientific jury. The materials for the defense of the dissertation are available in the library of the National Sports Academy "Vassil Levski".

INTRODUCTION

The subject „Physical Education and Sport“ is an established and important part of education at all stages and levels of the secondary education system. In turn, developing physical fitness is one of the guidelines for the subject's course, which is reflected in the curricula.

"Physical Education and Sport" is a subject with mainly practical application of the technique studied, the effective development of physical qualities and theoretical knowledge. Because of advancing scientific achievements, advancing professional sport, advancing sporting excellence methods and systems, advancing medicine and its practical application in sport and sports research, we see a new structure of sport. In physical education within the educational system, there are piecemeal and not-so-effective innovations or applications of proven research. These, in turn, are mostly administrative and often unnoticeable to the development of interest and quality of learning in students.

The Bulgarian population has a high rate of health problems, with a high rate of immobility among adults and a steadily increasing rate among children. As a result of many social and economic influences, Bulgarian children are in last place in terms of physical activity and have some of the lowest rates in the so important for the education system functional literacy indicators, mathematics, etc. This shows the great lack of awareness, referring to students and society in general, about the positive impacts of academic success.

Student development is a set of motor activities and learning abilities that are complementary. The positive impact of sport and physical activity on students, for their motor improvement as well as for their mental one, is undeniably proven. Bulgarian students' educational achievements are based on

their assessment in theoretical subjects and in „Physical Education and Sport“, mainly on their skills, their activity, or the development of their physical abilities. The assessment system for the subject „Physical Education and Sport“ in Bulgaria has not been updated for almost 30 years, which puts the subject in a state of inability to develop or innovate in-class work.

We observe tendencies of slowing down and speeding up in the development of high school students, a drop in their functional abilities, low motor culture, lack of interest in sports, and motivation to practice. The period of growth is associated with multiple physical changes. In the current dissertation, we focus on the changes within the high school stage in students from the city of Sofia. This is one of the few cities in Bulgaria having opportunities for practicing a large number of sports and for independent sports activities. The changes that can occur in adolescents in the urban environment are an important factor for their future growth- physical and healthy.

In our capacity as pedagogues, we must be familiar with the development of students at different ages, during their high school education, also to be familiar with their capabilities and whether there are difficulties, concerning their development. It is also essential to create the right attitude and awareness among students about the need for a good quality „PE and Sports“ training course conduction.

WORKING HYPOTHESIS

The review, analysis, and subsequent interpretation of documentary and literary sources aimed at clarifying problematic physical fitness and the peculiarities of its manifestation in age and gender aspects and the fact that in the last 40 years no focused and comprehensive research has been conducted in the country to clarify the structure, content, and peculiarities of the

manifestation of physical fitness give us the basis for the derivation and formulation of the working hypothesis of the present study. The above-mentioned generalizations give us grounds to assume that in the manifestation of individual motor qualities, which are the basis of physical fitness, several changes have occurred in terms of the peculiarities of their manifestation in students in age and gender aspects, which is the basis for the revision of many methodological recommendations for conduction of a "Physical Education and Sport" training course.

CHAPTER TWO

PURPOSE, TASKS, ORGANISATION, AND METHODOLOGY OF THE STUDY

METODOLOGY OF THE STUDY

TARGET, SUBJECT, AND CONTINGENT OF THE STUDY

The target of the present study is the physical fitness of secondary school students.

The subject of the present study is the changes in the different aspects of the physical fitness manifestation in high school students that have occurred over the past 40 years.

The study *contingent* consisted of 214 students in the age range 14-18 years from two schools located in the capital of Bulgaria - Sofia.

The study contingent

Table 1

Grade	BOYS	GIRLS	TOTAL
8	19	32	51
9	12	33	45
10	14	21	35
11	20	21	41
12	14	28	42
Total:	79	135	214

PURPOSE AND TASKS OF THE STUDY

The review and analysis of literature and documentary sources and the working hypothesis derived at the end of chapter one give us the reason to set the ***purpose*** of the study to establish the status and changes in physical fitness in students of the first and second stages of secondary education.

Achieving the purpose thus set implies solving the following *tasks*:

1. Research and analysis of issues, trends, and approaches in studies and physical fitness assessment from literature and documentary sources.
2. Selection of tests for physical fitness assessment, concerning the "Physical Education and Sport" curriculum, concerning high school students with Primary education.
3. Comparative analysis of the physical fitness state between students, included in the national studies conducted at the end of the 20th century and the students, target of our study, according to available indices.
4. Tracing changes in physical fitness indices in students of the first and second stage of secondary education in age aspect and inferring gender differences.
5. Developing a correlational structure of physical fitness in students in the first and second stages of secondary education.

METHODOLOGY OF THE STUDY

The physical fitness follow-up was conducted in two schools located in the capital, 157 High School with Foreign Languages Education "Cesar Vallejo" and 164 Spanish Language High School "Miguel de Cervantes", with students from the first and second high school education stages. Initially, to gain a preliminary understanding of the students' physical fitness status and to establish the status of the test battery used for measuring the physical fitness of students, we conducted measurements employing the test battery validated as of the year

2018. This took place during the PE and Sports class at the beginning of the school year.

From the results obtained it was found that the criteria set in the normative tables do not provide reliable and complete information for assessing the physical fitness of students on the one hand, and on the other hand are too high compared to the current state of motor abilities of modern students. Given this and bearing in mind that the existing test battery does not cover all aspects of physical fitness, we have supplemented the existing test battery to obtain sufficient information concerning our dissertation work.

We carried out the study as a one-time administration of a total of 19 indices, including three anthropometric and sixteen sports-pedagogical tests.

STUDY METHODS

To achieve the set purpose and solve the tasks we used the following scientific methods:

1. Research, analysis, and synthesis based on literature sources;
2. Pedagogical observation, testing, and preliminary analysis of the physical fitness of students from Grade 8 to Grade 12;
3. Sports - pedagogical testing;
4. Mathematical - statistical methods;
 - Calculus of variations;
 - Comparative analysis;
 - Dispersion analysis
 - Correlation analysis.

RESEARCH, ANALYSIS, AND SYNTHESIS OF LITERATURE SOURCES

The synthesis, analysis, and interpretation of literature and documentary sources that we carried out allowed us to trace changes and trends in the issues under consideration. Examination of the content and nature of previously developed batteries for measuring and assessing physical fitness assisted in the test selection we utilized to deal with the most essential tasks, regarding the current dissertation.

PEDAGOGICAL OBSERVATION AND ANALYSIS OF THE LEARNING PROCESS OF 8TH-12TH GRADE STUDENTS

Pedagogical observation as a research method was used in conducting a preliminary study. In a series of lessons, we observed the classes we wanted to be tested. This activity assisted in building further insight regarding our expectations of the current state of physical fitness in students at both high school stages.

The preliminary pedagogical observation, in addition to the extensive analysis, summary, and interpretation of literature sources created the necessary prerequisites for the derivation of the purpose and objectives of the study. Parallel to the pedagogical observation, a pre-testing was carried out using the existing test battery for physical fitness measuring at that time.

SPORTS - PEDAGOGICAL TESTING

To carry out the experimental work, we selected a total of 19 tests, which we divided into two groups - anthropometric and physical fitness tests, which are presented in Table 2.

We carried out the sport-pedagogical testing of the selected contingent in a set of classes. At the beginning of each class, we spent up to 10 minutes preparing the students for the upcoming testing. During the first class, we measured the students' height and weight. In the subsequent classes, we began testing using two of the tests listed in Table 2. The school playgrounds were used for the Medicine Ball Throw Test, 300/600 m Run, 30, 40, 50, 60 m Run, Beep Test, and Star Test, and the adjacent school gyms were used for the rest.

In the first group of anthropometric tests, we include the height and weight measurements with subsequent calculation of body mass index, which is typical of most studies of physical development and fitness. A large number of additional tests could be included, but we stick with the most basic ones, as well as tracing correlations, both within this group and the group of tests for a physical fitness assessment.

Sport-Pedagogical Tests

Table 1

No.	Name	Augmentation direction	Measuring unit
<i>Anthropometric tests</i>			
1.	Standing height	+	cm.
2.	Weight	+	Kg.
3.	BMI	+	kg./cm.
<i>Physical fitness assessment tests</i>			
4.	Solid Ball Throw	+	cm.
5.	Long Jump	+	cm.
6.	Walking with eyes closed (balance stability in the absence of a visual analyzer)	+	cm.
7.	Vertical Jump	+	cm.
8.	20m Shuttle Run	-	sec.
9.	T-test	-	sec.
10.	300m Run (girls) and 600m Run (boys)	-	sec.
11.	30m Run	-	sec.
12.	40 m Run	-	sec.
13.	50m Run	-	sec.
14.	60m Run	-	sec.
15.	Plank	+	sec.
16.	Contraction and extension from a supine position	+	number
17.	Beep Test	-	sec.
18.	Small Ball Throw	+	cm.
19.	Star Test	-	sec.

Making a comparison with the work of N. Hadzhiev and colleagues (1974), the second group of physical fitness indices gives us information about the state of muscular strength, speed and endurance, and agility indices. We adopt the assumption that we are making an update of the performance between the periods reviewed in the literature glossary when similar studies were carried out and the current situation for students aged 14-18.

MATHEMATICAL-STATISTICAL METHODS

The resulting data were subjected to mathematical and statistical processing using specialized computer software IBM SPSS Statistics 23 and Microsoft Excel. Depending on the objectives of the study, calculus of variations, comparative, correlation, and percentile analysis were applied.

✓ **Calculus of variations** – the use of the method was aimed at establishing the average achievement values level of the examinees, measured in the testing. We established their degree of variability and homogeneity. We calculated the arithmetic means (\bar{x}); the nature of the variance of the variables through the standard deviations (S); the magnitude of the variance (through the range (R), the minimum (X_{\min}) and maximum (X_{\max}) values and the coefficients of variation ($V\%$) in the different groups of examinees.

✓ **Comparative analysis**– this method helped us to reveal the significance of the existing differences between each group of examinees. The differences between the arithmetic average achievement value studied by us and the ones from the national studies of physical fitness performed on examinees at the same age during the last four decades of the 20th century, we revealed utilizing the Student's t-criterion for independent samples, which we calculated using three statistical indices, arithmetic average, standard deviation and a number of the examinees in the different groups according to the formula:

$$temp = \frac{|\bar{x}_1 - \bar{x}_2|}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

While comparing the performance of the different age and gender groups for the contingent we tested in 2019, we applied the non-parametric Mann-Whitney test, which was necessitated by the lack of a normal distribution found.

✓ **Dispersion analysis** – To establish the influence of the factor “age“ on the five age groups divided by sex, we applied the non-parametric test criterion of Kerskal-Wallis as part of the analysis of variance.

✓ **Correlation analysis** – to establish the correlations between the individual test scores of the boys and girls we studied, we applied Pearson's simple linear correlation coefficient.

ORGANIZATION OF THE STUDY

The study was carried out in 157 High School with Foreign Languages Education “Cesar Vallejo“ and 164 Spanish Language High School "Miguel de Cervantes", with the Grade 8 students to Grade 12 students. In the process of developing the dissertation, we can distinguish four stages, within the academic years 2017/2018, 2018/2019, 2019/2020, and 2021/2022.

Phase 1 – from February 2018 to December 2018, the following activities were carried out:

- Study and analysis of literature sources related to general theoretical and specialized issues on the dissertation topic;
- Preliminary pedagogical observation and testing on some of the aptitude tests in the learning process;
- Selection of tests for control and evaluation of physical development and fitness of the examined persons;

Formulation of the purpose of the study.

Phase 2 – from December 2018 to June 2019, the following activities were performed:

- Organization and conduct of the pedagogical observation and measurement of physical ability;
- Measurement protocols development.

Phase III - from July 2019 to December 2020, the following activities were carried out:

- Data entry in tabular form;
- Mathematical and statistical processing, analysis, and data summarization ;

Phase IV - from December 2020 to April 2022, the following activities were carried out:

- Final writing and formatting of the dissertation.

RESULTS ANALYSIS

The analysis of indices from the analysis of variance begins with the data from the students' anthropometric indices of height and weight measurement, and the body mass index calculated on their basis. We choose this approach because of the claims many authors did, that the manifestation of physical fitness largely depends on the state of the above-mentioned signs of physical development of the individual.

Physical development data for 14 - 18-year-old boys

Table 3

Test	Age	N	R	X min	X max	X	V%	S	As	Ex
BMI	14 years	19	8,37	15,79	24,16	19,55	11,56	2,26	0,43	-0,36
	15 years	12	3,41	17,97	21,38	19,52	6,13	1,19	0,36	-1,37
	16 years	14	5,65	17,88	23,53	19,87	8,56	1,7	0,77	-0,12
	17 years	20	7,57	16,59	24,16	20,41	10,13	2,06	0,00	-0,84
	18 years	14	13,65	16,81	30,46	20,4	17,01	3,47	1,95	5,20
Height	14 years	19	27,00	162,00	189,00	173,57	5,03	8,73	0,27	-1,28
	15 years	12	37,00	152,00	189,00	171,83	5,81	8,91	-0,49	2,20
	16 years	14	27,00	160,00	187,00	176,85	3,92	6,93	-0,94	1,42
	17 years	20	28,00	160,00	188,00	172,9	3,85	6,66	-0,02	0,36
	18 years	14	42,00	148,00	187,00	176,85	6,91	12,21	-1,11	0,71
Weight	14 years	19	37,00	43,00	80,00	60,89	13,78	8,39	0,35	1,10
	15 years	12	24,00	45,00	69,00	59,33	0,10	6,02	-0,94	2,31
	16 years	14	24,00	48,00	72,00	66,14	9,15	6,05	-2,19	6,35
	17 years	20	19,00	56,00	75,00	65,85	9,05	5,96	0,06	-1,13
	18 years	14	36,00	40,00	76,00	67,50	13,42	9,06	-2,29	6,83

During the measurement, we investigated the status of anthropometric indices of height and weight and based on the obtained data we calculated the BMI values in different age-sex groups. Body mass index guided us to identify overweight or initial stages of increased overweight. Establishing it for each student would assist us in working with them and selecting exercises and teaching methodology that would change the values of the above-mentioned index. This would undoubtedly improve physical fitness and we believe that it would also affect the complex development of students' physical qualities.

We begin our analysis with student growth, which could be determined as a factor in performing a large number of motor actions well. Height increases with age, with the average being 173.57 cm for 14-year-olds and 176.57 cm for 18-year-olds. This indicates the prolonged period of growth in boys as we also observe the corresponding dynamics in the remaining years, which is supported by numerous studies related to physical changes in organisms during puberty. The coefficient of variation at all ages studied confirms the homogeneity of the groups, with the highest value found in 18-year-old students $V\% = 6,91$. Despite the low value of variance, which points us to a homogeneous group, the spread $R=42.00$ cm. shifts attention to the large difference in height between the shortest and the tallest student. Despite the homogeneity of the group, the asymmetry (As) and the excess (Ex), which do not exceed the critical values at some ages, have negative values, indicating a concentration of the indicators around the minimum value.

The weight of high school boys increases between the age of 14 and 18, as the average (X), varies between 59.33 kg for 15-year-olds and 67.50 kg for 18-year-olds. The difference between these ages, which determine the lowest and highest value, is 8.17 kg. with the highest increase observed between the ages of 15 and 16, 6.81 kg. which corresponds to the characteristics of pubertal development in boys. When compared with a study of the dynamics of changes in physical development for twenty years between 1960-1980 (Sunny, P. et.al., 1992), weight then had the highest increment in the age ranges 10-15 years and 25-30 years between 1.8 kg. to 7.0 kg., which is partially confirmed in our study. The arithmetical average shows the continuous change in weight across the ages studied with the groups ranging from homogeneous to approximately homogeneous. On the other hand, our spread values show the large weight

difference in the studied age groups of boys. We notice this in the 14-year-olds ($R = 37.00$ kg.) and 18-year-olds ($R = 36.00$ kg.), which we think brings information about the large individual difference in weight between different students.

The next indicator we will comment on is derived from the previous two and brings more complex information through which we will test the assumptions made. In the case of body mass index, the coefficient of variation is $V\%=6.13\%$ for 15-year-olds, and $V\%=17.01\%$ for 18-year-olds. We notice that the considered age period has a difference in the homogeneity of the examined groups of persons. After considering the values of the spread (R) we also find a constant increase in the differences with age. For 14-year-olds $R=8.37$ and 18-year-olds $R=13.65$. There is a rise in the values, which is considered to be normal after the analysis of height and weight.

The commented values of the different indices lead us to assume that the changes, concerning the studied contingent of students, that occur in the pubertal period, are regarded as a consequence of an individual ontogenetic program, rather than clear group changes, resulting from the implemented work during „Physical Education and Sports“ classes.

Physical development data for 14 - 18-year-old girls

Table 2

Test	Age	N	R	X min	X max	X	V%	S	As	Ex
BMI	14 years	32	7,44	15,15	22,59	19,57	9,76	1,91	-0,32	-0,50
	15 years	33	5,39	17,19	22,58	19,63	6,48	1,27	0,18	0,18
	16 years	21	6,18	18,43	24,61	21,49	7,82	1,68	-0,02	-0,5
	17 years	21	9,22	16,04	25,26	19,83	12,81	2,54	0,29	-0,46
	18 years	28	11,93	16,65	28,58	20,62	14,89	3,07	1,18	0,98
Height	14 years	32	34,00	150,00	184,00	165,81	4,36	7,23	-0,06	0,72
	15 years	33	22,00	151,00	173,00	164,75	3,22	5,31	-0,65	0,52
	16 years	21	21,00	156,00	177,00	166,48	3,42	5,7	-0,05	-0,78
	17 years	21	19,00	154,00	173,00	165,00	3,05	5,04	-0,45	0,16
	18 years	28	18,00	157,00	175,00	165,61	3,14	5,195	-0,18	-1,05
Weight	14 years	32	35,00	35,00	70,00	52,87	13,05	6,9	-0,16	0,94
	15 years	33	22,00	44,00	66,00	52,84	10,26	5,42	0,62	0,15
	16 years	21	22,00	46,00	68,00	57,19	10,26	5,87	-0,31	-0,53
	17 years	21	14,00	42,00	56,00	49,81	7,25	3,61	-0,68	0,15
	18 years	28	32,00	45,00	77,00	54,61	13,71	7,485	1,19	1,96

We start the analysis of the girls' physical development indicators with the height and weight data. In the case of girls' height, we concentrate on the coefficient of variation (V%), which has values lower than 5% during the entire study period between 14 and 18 years. The low coefficient of variation draws attention to the prevailing negative values of the coefficient of asymmetry (As) and excess (Ex), through which it is established that the resultant data is concentrated around the low scores recorded. Considering the spread as the next

component of our analysis, we observe a difference in growth that has constantly varying values tending to a constant drop in the difference. In the case of the 14-year-olds, the height has a range of 22.00 cm, while in the case of the 18-year-olds, it drops to 18.00 cm. All the indices lead us to find a steady decline in the height of girls as they move from one age to another. We can make a comparison with the studies made in the work of B. Penev et al. (1992) that growth in girls reaches a maximum level around the age of 15, and between the ages of 17 and 18, a cessation of the growth process is found. We find similarities by looking at the arithmetic average, which does not change significantly and remains in the range $X = 164.75$ cm. and $X = 166, 48$ cm. The maximum value of the growth index for girls is $X_{\max} = 184.00$ cm. and the minimum value $X_{\min} = 150.00$ cm. both of which we report in 14-year-olds, showing us a lack of persistence at this age, in our opinion leading from the still ongoing intense individual growth processes.

Continuing our analysis of the weight results for girls, we note the fluctuations in the coefficient of variation $V\%=13.05\%$ for 14-year-olds, $V\%=7.25\%$ for 17-year-olds, and $V\%=13.71\%$ for 18-year-olds, which draw attention to the difference in the homogeneity of the groups of girls studied at the analyzed ages. We notice an approximate homogeneity in the ages 15 and 16, where the coefficient of variation is $V\%=10,26\%$. This directs our reasoning towards the formation of a plateau in this period, followed by abrupt changes that we associate with the end of pubertal development in girls and approaching adult norms

Considering the spread (R), we mark the age of 14 as the most heterogeneous due to the difference of 35 kg. This allows us to describe the weight change in the studied girls' ages as a sum of abrupt rise processes,

periods of plateau followed by periods of abrupt drop and stabilization. Weight continues to be a highly dependent variable on the lifestyle and activity of each individual, and we cannot express with complete confidence the hypothesis that Physical education and sports classes contribute to its regulation, especially in girls.

The analysis brings us to the complex expression of body mass index (BMI). The index follows the movements of our previously analyzed indices (height and weight) in the direction of a wavy and chaotic movement of values as an indicator of the conclusion drawn from the coefficient of variation, whose value for 15-year-old girls is $V\%=6.48\%$ and in 18-year-old girls is $V\%=14.89\%$. The arithmetic average value varies between $X=19,57$ and $X=21,49$, which according to the normative criteria places the subjects in the normal weight distribution category. Observing the low deviations from the critical value of the results of asymmetry (As) and excess (Ex), we could say that most results have a strong fluctuation in their values and a definitive opinion cannot be given.

Body mass index in girls is an important component of the study because it includes height and weight, which have significant differences. These discrepancies can lead to difficulties with performing several basic exercises in PE and sports classes, injuries, low self-esteem, and others.

Our commentary on the anthropometric data in girls provides us with the following guidelines for reasoning: girls between the ages of 14 and 18 years are in a period of constant changes, in which phases of abrupt increases in height and weight, abrupt drops, and plateaus are observed. From the resultant data, there is no smoothness in the changes during this age period, but a mostly

heterogeneous process accompanied by many individual differences and variations that we cannot record in detail or describe precisely.

ANALYSIS OF CHANGES IN SOME FITNESS INDICES, OCCURRED IN 60 YEARS

After analyzing the data from the performed studies, we recognize that we have some limitations in comparing some of the tests, performed 40 years ago with those we applied in the present study. We are able to make a complete comparison in the tests "Long jump with two legs from a standing position", "50 m Run", "60 m Run", and "A maximum number of standing up from a supine position to a sitting position in 30 s", „600 m Run for men and 300 m Run for women".

We set out to uncover the patterns and the dynamics of change in the examined physical fitness indices for boys and girls by comparing the arithmetical average values of performance on six tests present in the test batteries of the studies in 1965, 1970, 1982, and our study in 2019. To reveal the reliability of the differences, we applied the Student's t-criterion for independent samples, which we calculated using three statistics, the arithmetic average, the standard deviation, and the number of subjects in each group. We present the tables of comparisons in the appendixes.

We will analyze the results by comparing the data from the tests we performed with those, performed during the different periods of population fitness follow-up where we have matches in the performance methodology and test. The comparisons were made only on the results of tests performed with students from the city of Sofia.

The results presented in Figure 1 provide information on the boys' performance from the 2019, 1965, 1970, and 1982 tests in the 60m Run test. Making a comparison between the four tests, we should note the improvement of the smooth results between the different ages in the years 1965, 1970, and 1982 tests, with the best result of 9.00 sec. , recorded in the year 1982 for the 17-year-old boys. Comparing these data with those from our study, we should note that nowadays we notice a deterioration trend in the students' performance between the ages of 14 and 15, after which there is improvement throughout the study period up to the age of 18, where the best performance occurs.

To track changes throughout the 60 years, we will examine the values of the Stewart t-criterion utilizing comparing the data from the 1965 and 2019 years studies. At the age of 14, today's boys achieve a score of 9.06 sec, while those from the year 1965 - 9.81 sec. The difference of 0.75 sec is in favor of the group of boys we studied. The value of the Student's t-criterion resulting from the comparison is 2.52. Comparing it with the tabular value which is 1.96, we find that the resultant difference in performance is statistically significant.

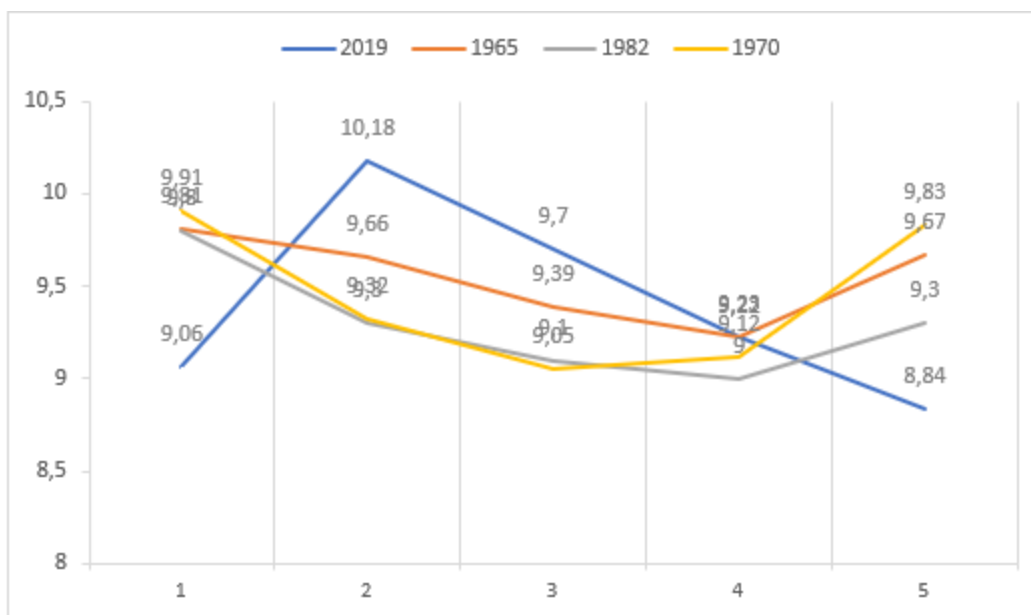


Figure 1. Dynamics of the results of the 60 m smooth running test of girls aged 14-18 years from Sofia tested in 1965, 1970, 1982 and 2019

For the 15-year-old boys, the performance difference was 0.56 s in favor of the boys studied in 1965, which has been considered statistically unreliable. We notice the same differences for the 16-year-old examinees. At the age of 17, the contingent of the two studies shows identical achievements. At the age of 18, the difference is 0.84 s in favor of our male subjects, which has the required statistical significance.

Based on the reviewed literature explaining the structure of quality speed and the results presented in Figure 2, we can deduce the assumption that the genetic conditioning, periods of development, and the social situation in recent decades in the country, affect the overall work with students and athletes, updated work methods for Physical education and sports classes have been introduced, which we find effective in the development of speed in the 60 meter Run, regarding boys from the city of Sofia.

In the smooth 50m Run for boys aged 14-18, we compared the results of tests done in 1982 and 2019 and the average observed result for 14-year-old

boys in 1982 was 8.5 sec, while in 2019 the result was 7.58 sec. The difference of 0.92 sec in favor of the group of boys tested in 2019 shows us improved speed capabilities in today's 14-year-old boys. We can also offer the claim that speed has improved based on the statistical analysis, which shows us Stewart's t-criterion value of 3.78 that exceeds the tabulated value of 1.96. Despite the improved performance at age of 14, we observe a leveled performance at ages 15 and 16, where the results are almost identical. The result for 15-year-olds is 7.9 sec and 7.8 sec for the 16-year-olds. This similarity of results is supported by the lack of statistical significance when using the Student's t-criterion, where the resulting values of 0.14 for the 15-year-olds and 0.37 for the 16-year-olds do not exceed the tabulated values of 1.96. At the age of 17, we observe a new correction of the results, which in our study group has improved to 7.23 s. This compares with an average of 7.7 s in 1982, a similar improvement in speed ability. Examining the t-criterion values, we see that the obtained value of 2.21 exceeds the tabulated one and shows us that the improvement in the results is statistically significant. Reaching the end of our study period at the age of 18, we see that the results drop again in both 1982 and 2019. The average value for 2019 is 7.57 sec and in 1982 it reaches 8 sec. Statistically, the improvement in 2019 does not prove to be significant when using the t-criterion, as the resulting value of 1.72 does not exceed the tabulated value.

We find a tendency for students' abilities concerning the manifestation of speed in the 15-17 years period to be of a fluctuating and unpredictable nature. We observe an improvement in the performance of 14-year-old boys, by approximately 1 second relative to their peers in 1982. Over the next two age periods, we observe a plateau, then again an improvement for 17 and 18 year-olds. In our 2019 study, we note a good initial result of 7.58 sec, followed by a

plateau in the speed development and improvement in distance running times at ages 17 and 18, where we also note the best result between the two studies of 7.23 sec in the 17-year-old boys in 2019. The boys' results in our study are unpredictable, whereas those from 1982 have a clear direction of improvement at ages 15,16, and 17, whereas in 2019 we note an abrupt improvement, regarding the 17 year - old boys group. This unpredictability is in our view due to polygamy factors, but we note improved performance results relative to 1982.

We do not consider the obtained comparative results definitive, but we might note that despite the overall physical inactivity deficiency in the population and among students, there is a trend for current high school students to improve their speed capabilities later in their development.

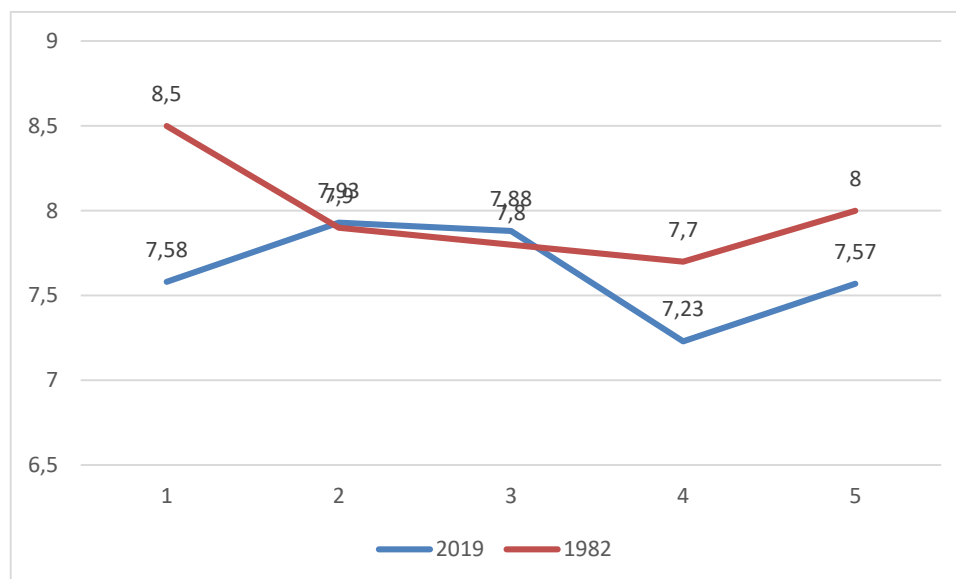
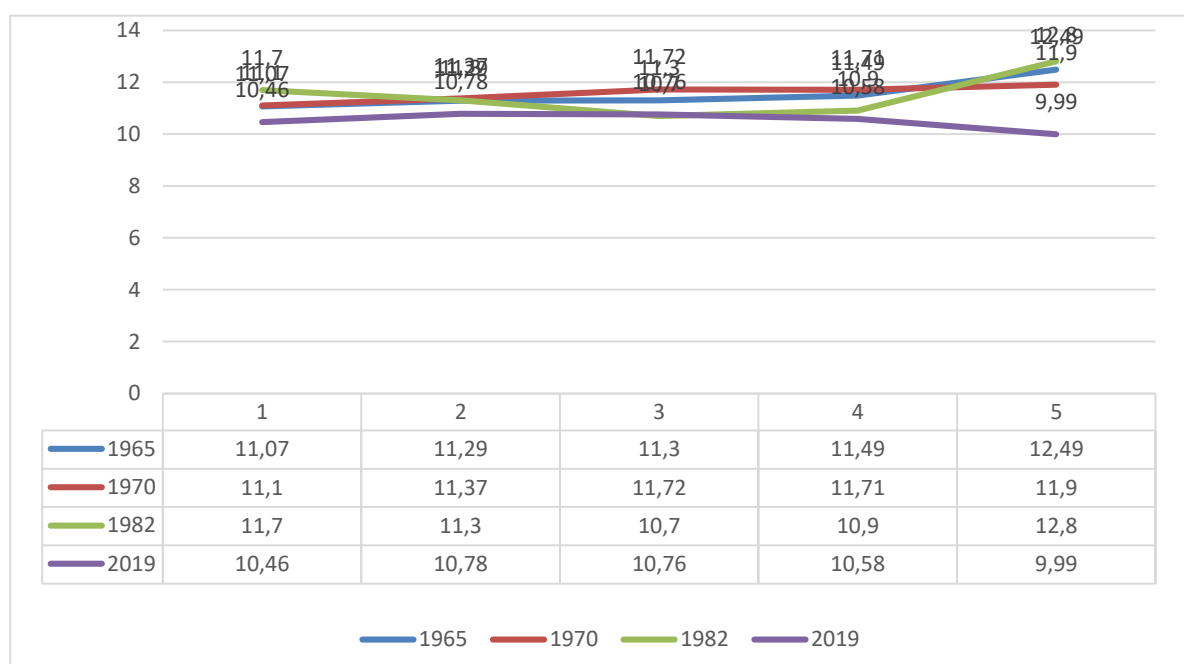


Figure 2. Dynamics of 50 m smooth running test results of boys aged 14-18 from Sofia tested in 2019 and 1982

Regarding 15-year-old girls, there was a deterioration in the score in all tests, reaching 11.3 s in 1965, 1970, and 1982. In 2019, girls have an average result of 10.78 sec. The ages 16 and 17 can be summarised in two groups. Before 1982 and after 1982. In the first group, before 1982, we observe a continued deterioration. In the second group, we observe a dramatic improvement in the average values, with the average performance of 16-year-old girls in 1982 being 10.7 sec, which is identical to the performance of our



study group in 2019. Statistically, we have no confidence in the use of the t-criterion as its value remains below the tabular value. For 17-year-old girls, we see a continued deterioration in performance as our study group saw an improvement in the average result of 10.58 sec. Compared to the average result in 1982, which was 10.9 sec, we revealed no

Figure 3. Dynamics of the results of the 60 m smooth running test of girls aged 14-18 years from Sofia tested in 1965, 1970, 1982 and 2019

statistically significant differences. We see a significant improvement in the result of 18-year-old girls examined by us in 2019 of 9.99 sec, which is the best average result in the comparison made with all years and ages from 1960 to 2019. The statistically significant difference when using the t-criterion compared to the second best average result of 11.9 sec in 1970 we believe may point us towards the assumption of an improvement in speed in girls at a later stage of their development in today's living conditions.

In the 50m Run for girls aged between 14 and 18, we were able to compare the tests done in 1982 with the testing we have done in 2019. We note a significant difference for 14-year-old girls with the average result in 1982 being 10.1 sec and in 2019 - 8.28 sec. The difference between the two averages is 1.82 sec. and is statistically confirmed after calculating the Student's t-criterion, where we obtain a value of 9.06 that exceeds the tabulated value. While examining the data from this test, we note again the trend of persistence of performance over the age periods 15, 16, and 17 years in both studies considered. The averages in 1982 were between 9.3 and 9.6 sec. , and in 2019 approximately between 8.5 and 8.6 sec. After examining the critical values of the t-criterion, we believe that the achievements recorded in 2019 can be considered reliable. In the case of 18-year-old girls, we observe a deterioration of the result in 1982 to 11 sec, while in 2019 we record a repeated improvement of 8.38 sec. The t-criterion value of 11.57, tells us that the differences are credible in favor of the girls tested in 2019.

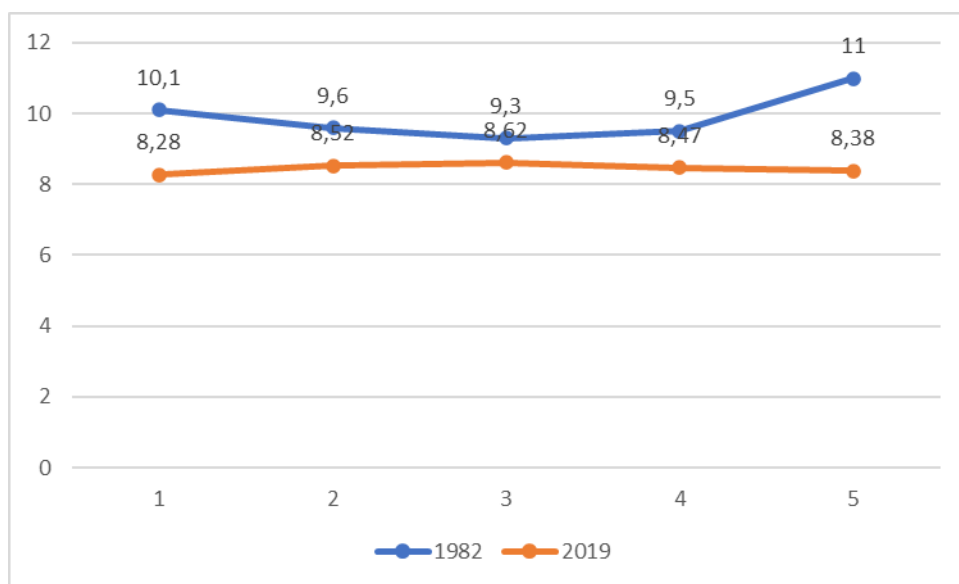


Figure 4. Dynamics of the results of the 50 m smooth running test of girls aged 14-18 from Sofia tested in 2019 and 1982

In our opinion, there is an improvement in the methodology of speed work and also in the elements of PE and sports class work concerning its development, but we cannot consider the improvement in our study as definitive and completely reliable. We can define the main age periods for work on speed as 14 and 18 years for girls, which are formed as the main periods for the development of speed abilities.

ANALYSIS OF 14-18-YEAR-OLD STUDENTS' PHYSICAL FITNESS STATUS

Because of the stated purpose and objectives of the study, it is necessary to establish the current state of physical fitness in high school students. We did the study in 2019 with students from the city of Sofia. To examine the influence of age on the performance of individual tests in the contingent of subjects, we applied the non-parametric criterion of Kruskal-Wallis, which was dictated by the lack of a normal distribution of the values of the individual tests. The next step of the study was aimed at revealing the differences between the different

groups of the study contingent. We compared the two leading groups of male and female subjects in terms of age using the non-parametric Mann-Whitney statistical criterion. The final step of this part of the analysis was to compare the arithmetic average of our study contingent performance results with the current physical performance assessment tables created by O. Miladinov et al. (2019) and functioning in secondary education system since the fall of that year.

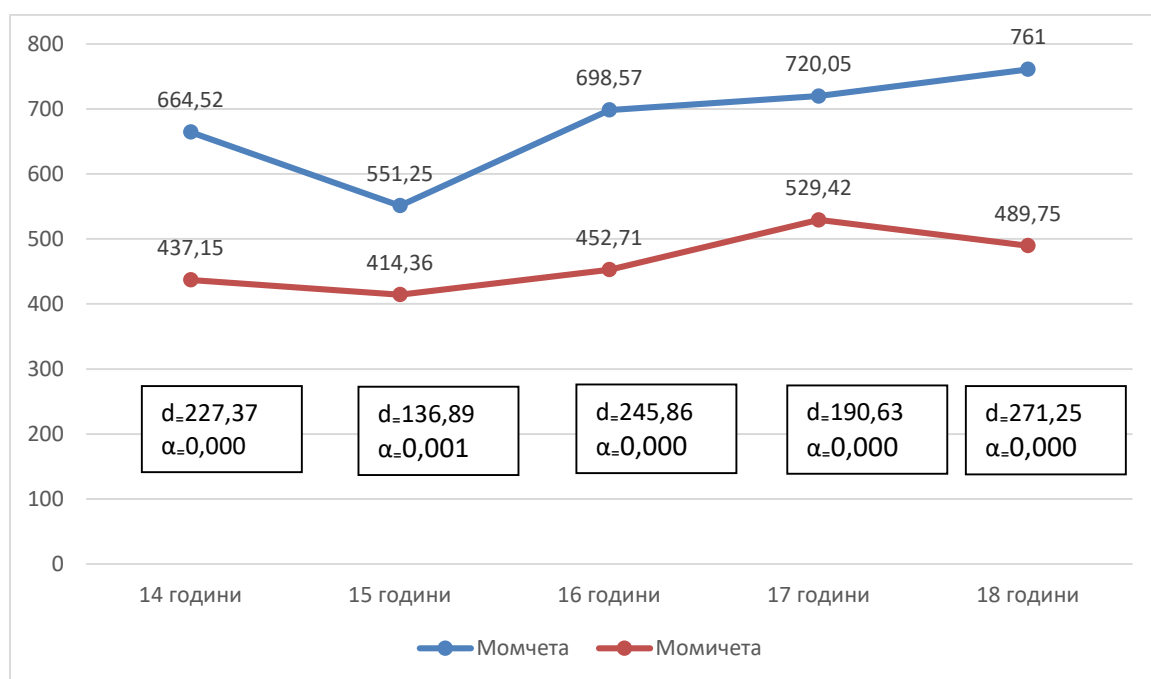


Figure 5: Arithmetic mean result indices and gender differences for the Throwing a solid ball with two hands above the head test

	Age	X	Difference	Uemp	U α
Solid Ball Throw	14 years	664,52	-113,27*	57	65
	15 years	551,25			
	15 years	551,25	147,32*	28	45
	16 years	698,57			
	16 years	698,57	21,48	109	83
	17 years	720,05			
	17 years	720,05	40,95	139	83
	18 years	761,00			
Small Ball Throw	14 years	3386,84	-820,18	67	65
	15 years	2566,66			
	15 years	2566,66	1254,76*	35	45
	16 years	3821,42			
	16 years	3821,42	-206,42	126,5	83
	17 years	3615,00			
	17 years	3615,00	577,86	115	83
	18 years	4192,86			

$$U_{emp} \leq U_{\alpha}$$

The average students' performance results on the Solid Ball Throw test presented in Figure 5 show a trend of improvement after the age of 15 for both genders, with the graphs moving parallel except for the period between the ages of 17 and 18 for girls, where we notice a deterioration. Employing the Kruskal-Wallis criterion, we have revealed a statistically valid influence on the average performance results of the different groups relative to the age-based rationing for both girls and boys. Applying the same statistical method to the Small Ball Throw test, we revealed an age-related influence on achievement only for males, where the value of 2 was $11.916 > 22;0.05 = 9.4877$. To test which age groups' reliable differences exist we also applied the Mann-Whitney criterion.

Results of the comparative analysis in age aspect for boys on the tests "Solid Ball Throw with two hands above the head" and "Small Ball Throw"

Table 5

The comparisons made and presented in Table 5 shows statistically significant differences for boys between their performances in the Throwing a Solid Ball test between the ages of 14 and 15, where there was a decrease in score by 113.27 cm, followed by an improvement between the ages of 15 and 16 by 147.32 cm. A similar statistically significant increase in the results of male subjects was observed in the Small Ball Throw test. Between 15 and 16 years, they improved their average performance result by 1254.76 cm.

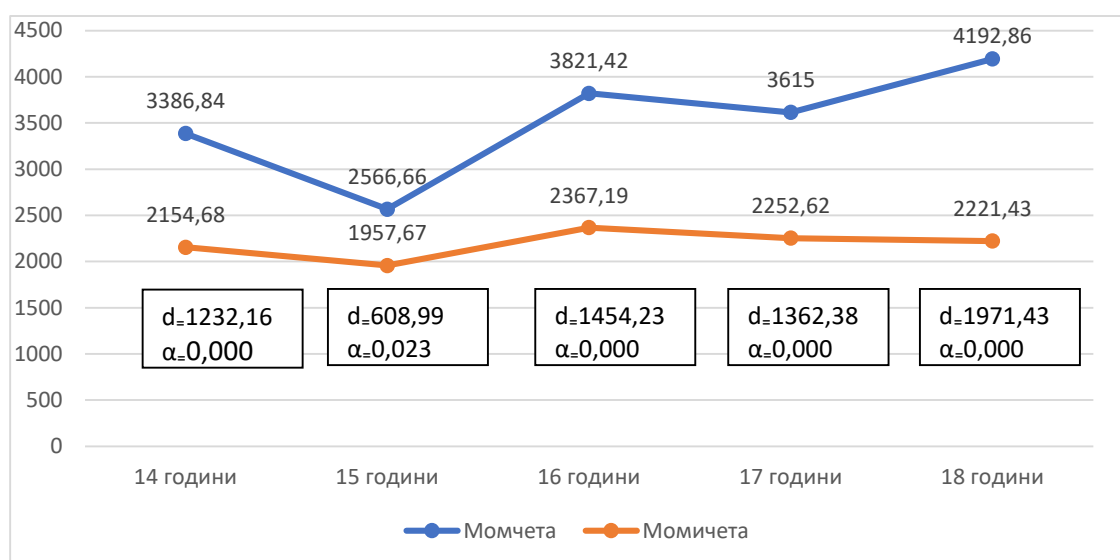
The results cited above allow us to assume that in terms of the development of explosive power of the upper limbs in high school students, the age of 15-16 years is appropriate, where the age-gender features of development suggest a rapid improvement in the results of boys.

	Age	\bar{X}	Difference	Zemp	Za
Solid Ball Throw	14 years	437,16	22,8	1,109	1,96
	15 years	414,36			
	15 years	414,36	38,35	1,473	1,96
	16 years	452,71			
	16 years	452,71	76,73*	2,039	1,96
	17 years	529,43			
	17 years	529,43	-45,68	1,839	1,96
	18 years	483,75			
Small Ball Throw	14 years	2154,68	-197,01	1,954	1,96
	15 years	1957,67			
	15 years	1957,67	409,52*	2,490	1,96
	16 years	2367,19			
	16 years	2367,19	-114,57	0,517	1,96
	17 years	2252,62			
	17 years	2252,62	-31,19	0,122	1,96
	18 years	2221,43			

Zemp \geq Za

Results of the comparative analysis in age aspect for girls on the tests "Solid Ball Throw with two hands above the head" and „Small Ball Throw"

In contrast to boys, for girls, the highest results occur later. In the Solid Ball Throw test at the age of 17, the increment between 16 and 17 years was 76.73 and possessed the required level of statistical significance. As can be seen in Figure 6 presented below, gender differences are evident in the performance of the subjects on the Small Ball Throw test aimed at assessing upper limb strength. The best performance result for girls was administered at the age of 16



years, and it is also a consequence of the largest revealed increment between two adjacent ages, 409, 52 cm from 15 to 16 years of age, respectively. After the age of 16 years, it is also appropriate to note the continuous, albeit statistically unreliable result deterioration until age 18. In contrast, boys show a marginal and statistically significant improvement in mean achievement between the ages of 17 and 18, with a peak in mean achievement at age 18, which is 4192, 86 cm.

Figure 6: Arithmetic mean result indices and gender differences for Small Ball Throw test

The result indices of the five groups of girls in all age comparisons with boys showed lower result indices on the two tests that carry information about upper limb explosive power. Except for age 15 in the Small Ball Throwing test, where the difference of 608.99 cm does not have the required level of significance, at all other ages in both tests the value of $\alpha \leq 0.005$. This confirms the difference revealed by many authors in terms of upper limb explosive power between girls and boys in the high school stage. In practice, this implies differentiation of work to develop explosive power in the gender aspect in students of the upper school stage.

In this regard, we suggest that in the physical education and sports classwork, considerable attention be paid to the means and methods of developing upper limb strength in girls aged 15-16 and boys aged 16-17. The periods indicated in both genders suggest better results aimed at upper limb strength capabilities.

Solid Ball Throw test grades according to the accepted normative tables

Table 7

Age	Boys		Girls	
	Result	Grade	Result	Grade
14 years	664,52	Good 4	437,16	Good 4
15 years	551,25	Good 4	414,36	Good 4
16 years	698,57	Good 4	452,71	Good 4
17 years	720,05	Good 4	529,43	Good 4
18 years	760,00	Good 4	483,75	Good 4

Assessing the "Throwing a solid ball with two hands above the head" average test performances with the current physical fitness assessment tables, which results are presented in Table 7, the grade for all groups is "Good 4", which confirms the reserves in terms of the development of speed-strength capabilities of the upper limbs in boys and girls in the considered age period, which is a consequence of their increasing capabilities during the high school period.

STUDENTS' TEST DATA CORRELATION ANALYSIS RESULTS CLASSIFICATION

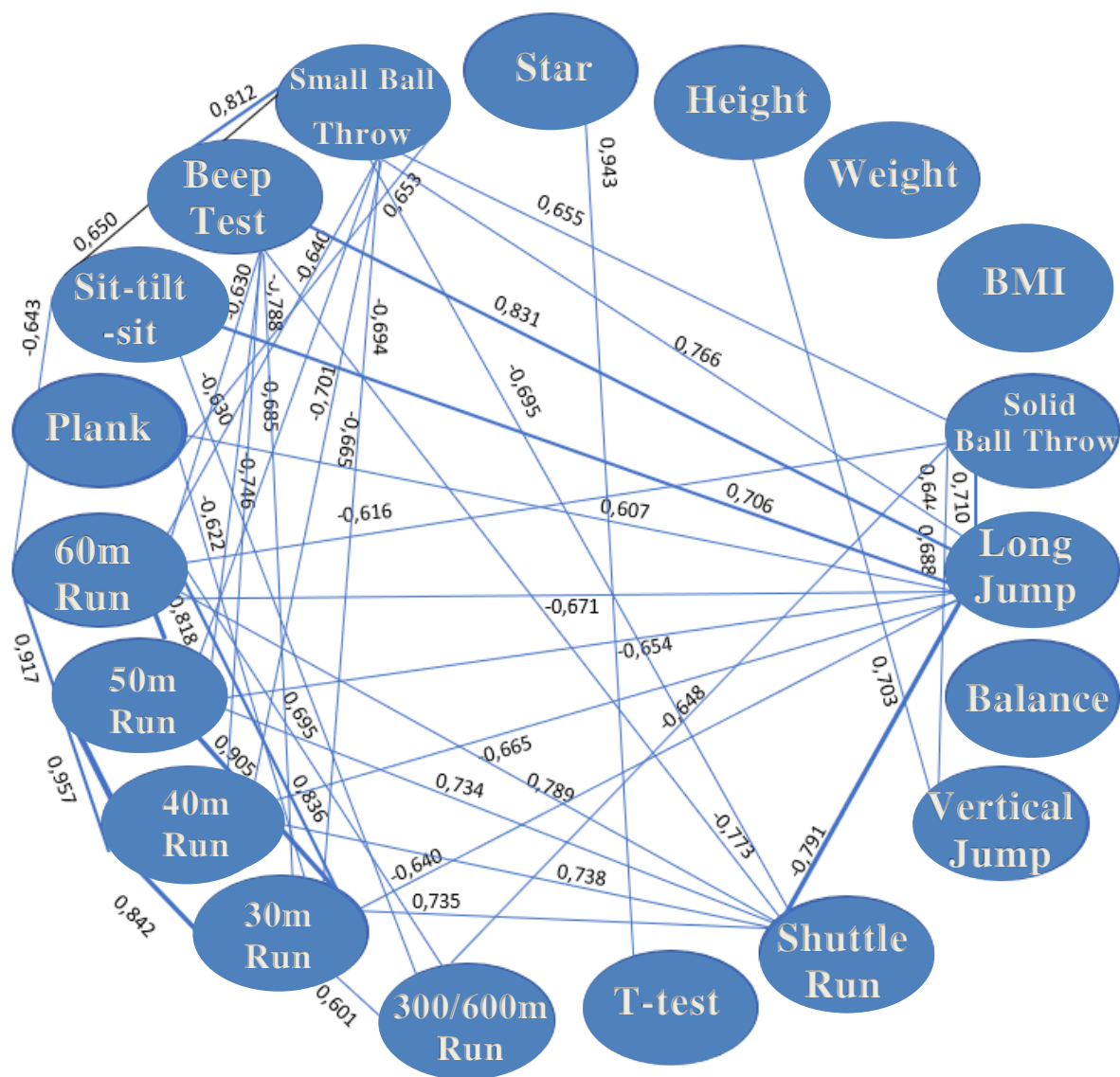
Correlation analysis is a statistical method aimed at revealing the strength and direction of correlation between the indicators under study. In the particular case of our study, the correlation analysis was performed on the entire dataset divided by two attributes, gender, and age. This approach allows us to reveal changes in the correlation structure of physical development and motor abilities of the students included in the study. In this way, we will be able to trace the changes in some specific indicators and features of the impacts that the means and methods used during the application in the physical education and sports classwork have had.

Interpreting the data from the correlation analysis of the results, we start with the boys aged 14, illustrated in Figure 7. Only statistically significant correlations between the indicators are depicted, which are confirmed by an α value of 0.05 or 0.01.

As it is obvious from the figure, there are multiple statistically significant correlations between the individual parameters, with their values ranging between 0.6 and 0.9, i.e. the strength of the correlation between the considered parameters varies between significant and high. In boys aged 14, we notice some

correlations between anthropometric parameters and those that carry information about the state of motor skills. Growth correlates with the vertical rebound, and we have a result of 0.703. Considering this result, we can argue that at this age, growth is fundamental to achieving a better result than the development of explosive capabilities. The other two anthropometric indicators "Weight" and "Body Mass Index" does not correlate with the other measurements.

Figure 7. A correlational model of the PD and motor abilities of boys aged 14 years



We proceed to the analysis of the physical fitness tests regarding 14-year-old boys, starting with the "Solid Ball Throw" test. The test has significant correlations with the "Small Ball Throw" test and "Long jump" and negative values with "60 meters Run" and "600 meters Run". This proves that there is a correlation between the development of upper limb and back strength and the improvement of performance in throws, jumps, and runs at different distances.

"Long Jump" has correlations with "Small Ball Throw" with a value of $r = 0.766$, "Beep Test" $r = 0.831$, "Sit - Standing", "Plank", "Shuttle Run - 80 meters", negative correlations in "60 meters Run", "50 meters Run", "40 meters Run", "30 meters Run". We see that the development of lower limb explosive power is related to both the improvement of upper body motor actions and the possible development of running performance. In the "Walking in a straight line with eyes closed" test, we find no correlations with some of the other tests.

In the „Shuttle Run - 80m“ test, there were negative correlations with the „Long Jump“, „Small Ball Throw“ and „Beep Test“ and the correlations were significant with scores between -0.695 and -0.791. The negative correlations show us the influence of speed-strength capabilities on the explosive capabilities and strength endurance of students. We have positive correlations in all the speed runs we have used between "30 meters Run" and "60 meters Run" with results without exceptions being positive and between 0,734 and 0,789. This was an index of the inverse correlation between the use of similar tests and the drop in results in the above-mentioned age group.

The "T-test" has a single correlation with the other similar "Star" test as their correlation is very strong (0.943) and we believe that such tests contribute to the improvement of movements with direction change and reaction speed.

The " 600 m Run" test regarding boys aged 14 years has a negative correlation with the "Solid Ball Throw" test and the "Abdominal crunches from the back bench" test with the values of the correlations varying between -0,630 and -0,648. The negative correlations are proved to be an index of the correlation between strength endurance and power capabilities in throwing where strong abdominal musculature is also involved. There is a significant correlation between the 30 and 60-meter Runs, where strength endurance is realized in the long distance, and more motor units are involved in the 30-meter run, which may contribute to improved performance.

We will combine the runs between 30 and 60 meters. We'll start by noting that there are very large correlations between the 30-40-50-60 meter distances, between 0.818 and 0.957, making running these distances favorable for each of the others. Regarding the runs, we also notice a correlation with two other tests: the "Small Ball Throw", where the correlations have a negative value between 0.6 and 0.7, and the "Beep Test", where the significances are similar but positive. This means the throws are affected by running short to medium distances and we obtain an improvement in the results by decreasing the running time. The faster the students run, the larger the significance will be in the other test with significant correlations, the "beep test", where the speed of recovery will also be important to be able to get a better result. In the " 60 meters Run" we have another significant correlation with the "Solid Ball Throw" (- 0, 616), which specifically for this distance proves to be a useful motor action for students to improve their speed-strength abilities.

"Plank" is a test that has significant correlations of 0.6 with "Long Jump" and "Small Ball Throw" tests, and we believe that such a trend indicates the importance of the development of trunk strength in students and the ability to

activate the abdominal musculature in motor actions related to rebounding, where the abdominal muscles are involved in stabilizing the body, and in throwing, where they are involved in turning the body. There is a negative value of 0.622 with the "30m Run" which we have already mentioned above.

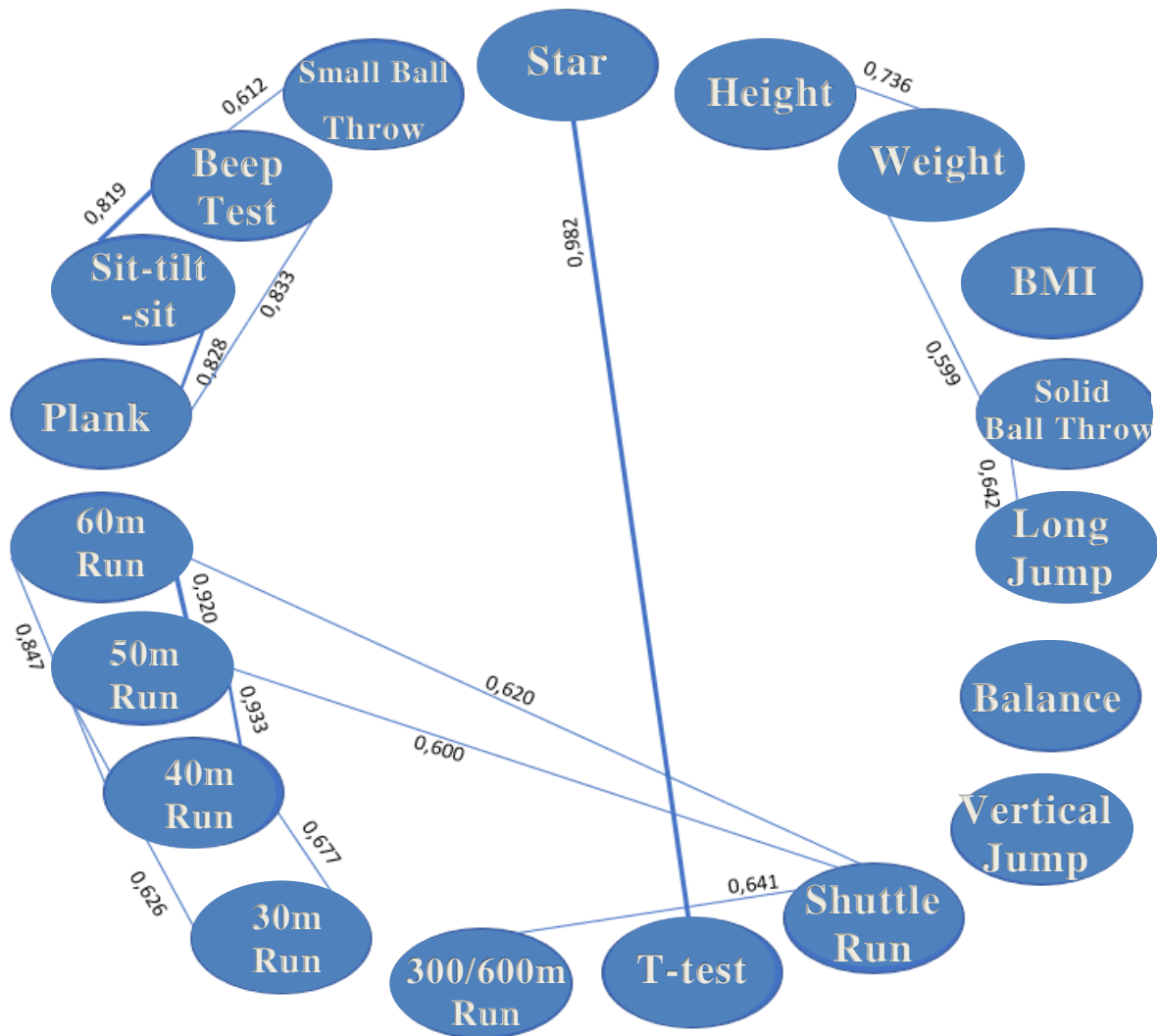


Figure 8. Correlation model of physical development and motor abilities of girls aged 14 years

Considering girls aged 14, we notice the following correlations. Height and weight for girls have a significant correlation of 0.736. Weight also correlates with the results from the „Solid Ball Throw” test - 0.599. There is a correlation between the results of the tests "Shuttle Run - 80 meters" and "300 meters Run" the value of $r=0.641$, with the results of the test "50 meters Run" $r=0.600$ and „60 meters Run" $r=0.620$. It is considered proven that the speed-power runs are correlated and this is an indicator that girls at this age can be targeted to improve their middle-distance running ability. In the 30-40-50-60m runs, we have very strong dependencies from 0.6 to 0.933 with again an impressive correlation between the 40-50m and 50-60m distances where more strength qualities are required. In the „Plank“ and the Twisting and Extending the „Trunk from the Back Squat“ tests, the Pearson correlation coefficient value $r=0.828$ indicates the commonality between the two tests concerning the abdominal wall muscles strength manifestation. At the same time, we also observed a strong correlation between the „Plank“ and „Beep“ tests, where the r value was 0.833. "Trunk flexion and extension from supine position" has a strong correlation with the "beep test" as in the "Plank test" and this brings us information about the importance of a well-developed abdominal region, which is important for girls to be able to withstand greater loads.

The results of the "Beep Test" are correlated with the results of the "Small Ball Throw" test of 0.612, which leads us to the assumption that the two tests have a correlation with each other in the speed-strength components of girls. "Star" has a very strong correlation with "T-test" 0.982 as this high value proves to us the dependence in the development of agility, strength, and speed in girls, regarding girls in the above-mentioned age group.

CONCLUSIONS AND RECOMMENDATIONS

The implementation of the individual activities in connection with the development of the dissertation and the results obtained and analyzed as a result allows us to draw some conclusions and recommendations.

1. The retrospective analysis of literary sources gave us the opportunity to trace the formation and changes in several theories related to the manifestation and development of motor skills in adolescents. Even theories that would cancel many of the approaches and methods that we apply today in the field of physical performance and motor training. This gives rise to the need for continuous monitoring of the condition and peculiarities in the manifestation of motor qualities.

2. The working hypothesis derived at the end of the first chapter was checked and proved. As a result of which we can claim that concerning the peculiarities of the manifestation of the individual sides of the physical capacity in terms of age and gender, a number of changes have occurred, which are a prerequisite for updating the methodological recommendations for work in the lesson work on physical education with high school students stage.

3. The comparisons made between the results of our measurements of individual motor qualities with those realized in three consecutive decades at the end of the last century allowed us to make the following generalizations, which would be a starting point for physical education and sports teachers in connection with planning work to develop motor skills during the classwork. The main changes that we should summarize are the following:

➤ Positive changes are observed in the manifestation of the motor quality speed in boys and girls. The results of the three tests since the end of the last century show an improvement in average achievement between the ages of 14 and 17, after which there is a decline. For the students we studied in 2019, there was a drop in achievement between the ages of 14 and 15, followed by an increase throughout the rest of the period until the age of 18.

➤ As positive, we can define the changes over the last 60 years that occur in the manifestation of the explosive power of the lower limbs, measured by the "Long jump with two legs from a standing" test. The contingent of students studied by us shows a continuous increase in average achievements, which for girls is up to 17 and for boys up to 18 years of age. As a consequence of this growth dynamics at the end of the studied period, both genders demonstrate higher average achievements, and the differences in achievements with those of the students studied with the same test at the end of the 20th century are confirmed with the necessary level of guarantee probability.

➤ This is not the case with Small Ball Throw test results. Here, we observe a significant deterioration in achievement for boys, and for girls, there are almost no differences between studies. This shows a significant drop in upper extremity explosive power parameters.

➤ Regarding the age dynamics in the manifestation of abdominal wall muscles explosive force for the tracked 60-year period, we found the preservation of the trend in the inter-age changes in the achievements, which have a wave-like character in both genders. At the same time, the average achievements of the boys and girls from the city of Sofia tested in 2019 are significantly better compared to the students tested at the end of the last century.

➤ Tracked changes in motor endurance manifestation show a significant improvement in the average achievements of the girls studied by us, compared to the achievements of the girls of the three national studies conducted at the end of the last century.

4. Comparisons made between boys and girls in different age periods show many peculiarities in the manifestation of individual motor qualities, such as:

➤ In the manifestation of the explosive power of the upper limbs in today's students, we reveal clear age and gender differences. For this, it is necessary to differentiate both the means and methods for development and the periods in which to develop purposefully. For girls, this period is between 16 and 17 years of age, and for boys between the ages of 15 and 16.

➤ Regarding the explosive power of the lower limbs, we believe that the period between 14 and 16 years, which coincides with the first high school stage, is key in terms of the considered motor ability. There are also clear age prerequisites for purposeful development of quality in boys and girls.

➤ When the equilibrium resistance is manifested, differences between the two genders are apparent. The results of the conducted tests show the better results of the girls compared to the boys, as well as the presence of the influence of the features of age development on the manifestation of the considered motor ability.

➤ Based on the results presented and analyzed in the third chapter, we believe that the implementation of the various means and methods aimed at developing speed endurance in students from the first high school stage does not need to be differentiated by gender. Only after about age of 16 years, which period coincides with the second high school stage and grades 11 and 12, is it

necessary to differentiate by gender both the means and methods, as well as the dosage when planning and applying physical exercises aimed at developing speed endurance at students. We also believe that the period between the ages 15 and 17 is key in terms of developing the considered motor quality in students.

➤ The manifestation of the motor endurance in the students tested by us is characterized by reaching normal for the considered age levels for girls. Boys' results showed a deterioration throughout the period under review.

➤ The analysis and interpretation of the data from the comparative analysis reveal a lack of age prerequisites for the purposeful development of motor speed for both genders.

5. The three correlation matrices, presented in subchapter three show significant differences between boys and girls. A significant difference in this connection is the small number of correlations between the individual tests for girls, which we observe in all the studied ages. Contrary to them, for boys, we observe a significant number and strong correlations at the ages of 14, 16 and 18 years.

6. The better results of girls in some of the tests when compared with the national studies at the end of the 20th century and the small number of correlations between the results of individual tests lead us to the assumption that they have a higher level of motor skills compared to boys.

RECOMMENDATIONS

The analyzes and subsequent conclusions give us reason to make the following recommendations:

1. Because of tests results that bring information about the state of the explosive power of the lower limbs and the observation that we carried out during the testing, we suggest that the development of this quality is carried out

with physical exercises that are specific to the studied sport or sports discipline, pays special attention to the technique of performing the exercises.

2. The low achievement levels on tests that provide information on the status of upper extremity explosive power and the significantly lower results of students of the same age included in national studies of the last 30 years of the last century allow us to recommend planning and targeted work to develop of upper extremity explosive power concerning boys and girls of both high school stages.

3. We find a reserve in terms of dexterity only in Grade 12 students, where we could recommend the development of targeted influences for its development.

4. Based on the results of the boys' 600-meter Run test and the observed decline in achievement throughout the high school period, we can recommend that Physical Education professionals reconsider the means and methods they apply to develop endurance to improve the above mentioned quality for boys.

5. The low achievement on several tests and the multiple correlations between the individual tests in the boys indicate a significant reserve regarding their physical fitness level in both high school stages. This conclusion gives us reason to recommend to the teachers of "Physical Education and Sports" a review of the applied methods and means aimed at developing the motor qualities of boys during the period under review.

CONTRIBUTIONS

1. Individual motor qualities measurements were carried out utilizing 19 tests used for control and evaluation of the achieved results in high school

students of the secondary education level, which were compared with those realized in three consecutive decades at the end of the last century.

2. Summaries have been made in connection with planning the classwork activities for motor skills development.

3. Recommendations and summaries for Physical Education teacher concerning the age of 14-18 years are presented.

4. Many gender-age characteristics were revealed in the manifestation of individual motor qualities, which are directly related to the Physical Education practice.

LIST OF PUBLICATIONS RELATED TO THE DISSERTATION

1. Naydenova, K., Chernev, K., Study on age and gender differences in motor speed manifestation in 14 - 18-year-old students, Yearbook of the National Sports Academy "Vassil Levski" (Sofia). - Sofia: NSA PRESS, 2020, pp.403-409., ISSN: 2682-9908, Volume 1
2. Naydenova, K., Chernev, K., State of the ability to run short distances with frequent change of direction in Grade 8 to Grade 12 students, Yearbook of the National Sports Academy "Vassil Levski" (Sofia). - Sofia: NSA PRESS, 2020, pp. 232-239., ISSN 2682-9908, Volume 1
3. Chernev, K., Establishing the motor endurance state employing a beep test in high school students, Yearbook of the National Sports Academy "Vassil Levski" (Sofia). - Sofia : NSA PRESS, 2020, pp. 410-418, ISSN 2682-9908, Volume 1
4. Chernev, K., Balance stability test analysis in high school students aged 14-18, Yearbook of the National Sports Academy "Vassil Levski" (Sofia). - Sofia: NSA PRESS, 2020, pp. 305-311., ISSN 2682-9908, Volume 1