

A favorable period for the development of endurance in schoolchildren aged 7-18 years

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Abstract

The aim of the study is to study the sensitive periods of endurance formation in school-age children.

Methods: The pedagogical experiment was organized at secondary school 60, Kirov city in Russia in the period from September 2022 to May 2023. The study involved 578 boys and 637 girls who were admitted by doctors to physical education classes at school. All children took the Cooper control test for 6 minutes at the beginning and at the end of the experiment. Physical education classes were held according to the standard program under the work of physical education teachers. The study used methods of mathematical statistics, the Student's T-test, the reliability was determined at $p > 0.05$.

Results: After the end of the pedagogical experiment, the students' performance improved on average in all classes. However, the improvement was uneven. Thus, the high increase in endurance was among schoolchildren from grade 2, grades 8-11 for boys, the indicators improved from 12 to 16% ($p < 0.05$). The indicators improved by 12-15% ($p < 0.05$) in girls from grades 2, from grades 9-11.

Conclusions: As a result of the experiment, we can say that the sensitive period for the development of endurance in girls is the age of 8-9 years, 15-18 years, and in boys 8-9 years and 14-18 years. It should be noted that there is a high increase in endurance indicators in children aged 10-11 years. The results of the study make it possible to adjust the educational process in schools and improve the training process in various sports for children aged 7-18 years.

Keywords: Schoolchildren, Physical education, Children's health, Physical Inactivity, Cooper's Test, Physical development.

Introduction

Great attention is paid to the health of children from birth and preschool age (Vale et al., 2011; Terrón-Pérez et al., 2021). Teaching a child at school is a time when the body grows and develops under the attention and influence of not only parents, but also teachers. Physical culture plays an important role in the normal growth and physical development of a child. Physical education of students is an integral part of the entire educational work of the school and occupies an important place in preparing students for life, for socially useful work. Physical education at school solves the tasks of not only preserving and strengthening health, but also increasing the level of sociability and social activity of the child. The importance of physical culture in the school period is to create the foundation for comprehensive physical development, health promotion, and the formation of a variety of motor skills (Kainov & Kuryerova, 2019). Unfortunately, the percentage of children who play sports outside of school is quite low (Oberle et al., 2020; Hu et al., 2021). Physical activity of children plays a very important role in the development of a child's motor skills, in the formation of nerve connections between the musculoskeletal system, central nervous system and internal organs, in the development of muscles and skeleton, in the formation of a child's posture, in the regulation of metabolic processes, blood circulation and respiration, in the development of the cardiovascular system. The development of technology in modern life and automation of work have led to the fact that people move much less than 100 years ago (Aliss et al., 2020; Heradstveit et al., 2020).

Physical inactivity is a condition characterized by insufficient physical activity and decreased muscle strength. Sedentary lifestyle or physical inactivity affects not only adults and adolescents, but also children in early childhood and preschool age. Most often, the causes of infantile inactivity are due to an incorrect lifestyle of the child. The beginning of school life reveals serious problems in the development of such children, both physically and mentally. Physical inactivity leads to serious disorders in the child's body, whose systems do not receive motor activity and do not develop properly. This has a negative effect on the work of the musculoskeletal system, respiration, blood circulation, digestion, and nervous system (Mannocci et al., 2020; Volmut et al., 2021):

- 1) reduced ability to work;
- 2) muscles weaken and atrophy, endurance and strength decrease;
- 3) there is a malfunction in the metabolism;
- 4) obesity and atherosclerosis develop;
- 5) the blood supply to tissues is disrupted, the supply of oxygen and nutrients to cells decreases;
- 6) the strength of heart contractions and vascular tone weakens.

Physical inactivity significantly reduces the body's resistance to pathogens of infectious diseases. Children can often get sick, and diseases can become chronic. Low mobility in children can lead to pronounced disorders of body functions, as well as to a decrease in not only physical, but also mental performance (Chen et al., 2021; Mikaelsson et al., 2021). The overall level of development of schoolchildren

is decreasing from year to year, and indicators of such physical qualities as endurance are becoming lower (Azevedo et al., 2021; Toshboyeva, 2022).

Endurance is understood as the capabilities of a person, providing him with a long-term performance of any motor activity without reducing its effectiveness (Sanjar & Maftuna, 2022; Khakimovich & Soyibjon, 2023). The level of development and manifestation of endurance depends on a number of factors (Rozmatovich & Maftuna, 2022; Nazirjonovich, 2023):

- 1) the availability of energy resources in the human body;
- 2) the level of functional capabilities of various body systems (cardiovascular, central nervous system, endocrine, neuromuscular and others);
- 3) the speed of activation and the degree of consistency in the operation of these systems;
- 4) the resistance of physiological and mental functions to adverse changes in the internal environment of the body (an increase in oxygen debt, an increase in lactic acid in the blood, and others);
- 5) the cost-effectiveness of using the energy and functional potential of the body;
- 6) fitness of the musculoskeletal system;
- 7) perfection of technical and tactical skills;
- 8) personal and psychological characteristics (interest in work, temperament properties, the level of maximum mobilization of such strong-willed qualities as: determination, perseverance, perseverance, endurance, patience).

Among other factors affecting human endurance, age, gender, morphological characteristics of a person and conditions of activity should be highlighted.

Quite a large number of researchers have been engaged in the problem of developing the endurance of schoolchildren. The authors note the leading importance of endurance for optimal growth and development of all human body systems (Azevedo et al., 2021; Abdullaevich, 2023).

Some pedagogical experiments that have been conducted in school institutions prove the effectiveness of a particular technique and emphasize the importance of endurance for the growth and development of schoolchildren in general (Sanjar & Maftuna, 2022; Khakimovich & Soyibjon, 2023).

It is known that a good level of endurance development is the foundation for the development of other physical qualities, such as special endurance, strength abilities, speed of movement, flexibility and coordination abilities (Faigenbaum et al., 1999; Mikkonen et al., 2023). Also, high levels of endurance have a positive effect on the result in individual and team sports (Doma et al., 2019; Yuliandra et al., 2020).

Many authors call endurance aerobic abilities of a person, and these abilities have a direct impact on intellectual abilities and mental growth and development of a person (Rozmatovich & Maftuna, 2022; Toshboyeva, 2022; Khakimovich & Soyibjon, 2023).

However, despite such a large number of studies, we were unable to find data that would indicate a favorable (sensitive) period of endurance development, for example, at school age.

Sensitive periods are periods of reduced genetic control and increased sensitivity of the body to environmental influences, including pedagogical and training ones. Taking into account favorable periods for the development of certain abilities is very important, the main thing is not to miss the moment when you can purposefully influence a particular physical ability in order to maximize and timely its development. In modern literature, the issues of sensitive periods of development of physical qualities are considered very limited. The authors note the high role of favorable periods for the development of physical qualities and recommend purposefully influencing each quality more intensively during the sensitive period for its development (Goldfield et al., 2012; Kabanov et al., 2019).

In Russia, several well-known experts have systematized and generalized the idea of sensitive periods of development of general endurance (Guzhalovsky, 1986; Kholodov & Kuznetsov, 2018; Solodkov & Sologub, 2018; Guba et al., 2021; Kuramshin, 2021; Matveev, 2021).

The famous physiologist Guzhalovsky in 1986, speaking about the aerobic capabilities of schoolchildren, argued that the age of 8-9 years, 10-11 years, 12-13 and 14-15 years would be a favorable age for the development of endurance in boys, while in girls it is the age of 9-10 years and 11-12 years (Guzhalovsky, 1986).

However, other physiologists believe that endurance develops more effectively between the ages of 15 and 17, both boys and girls (Solodkov & Sologub, 2018).

The authors of textbooks on the theory and methodology of physical culture and sports believe that the sensitive period for the development of endurance is the age from 8 to 10 years and from 12 to 15 years for boys, and for girls it is the age from 10 to 13 years and from 15 to 17 years (Kholodov & Kuznetsov, 2018).

Well-known experts in the field of physical education, as well as the authors of many books on the sensitive periods of different physical qualities of schoolchildren, agree that endurance is better developed in girls at 8-9 years old, and in boys at 8-9 years old, 10-11 years old, 14-15 years old and 15-16 years old (Guba et al., 2021; Kuramshin, 2021; Matveev, 2021).

The problem of the study lies in the fact that all over the world teachers and coaches are trying to effectively develop the physical qualities of schoolchildren, but favorable periods for their development have not been studied enough.

Thus, a review of the literature on the problem shows that there is no consensus on sensitive periods for the development of endurance, which underlines the relevance of this study.

The aim of the study is to determine favorable age periods for the development of endurance in schoolchildren aged 7-18 years.

Research objectives:

1. To study the current state of the issue on the problem of endurance development and optimize the available data on sensitive periods for the development of endurance in schoolchildren.

2. To conduct a large-scale study with the participation of schoolchildren in grades 1-11 (7-18 years old) to determine favorable periods of endurance development at different ages.

3. Compare the data obtained with the results of previous studies on the issue of favorable periods for the development of endurance and formulate conclusions.

Methods

Study participants:

Schoolchildren of grades 1-11 (boys and girls aged 7-18) participated in the pedagogical experiment. A total of 1,215 children (578 boys and 637 girls) participated in the study. From the first to the ninth grade, the school has 5 classes of students (for example, 1 "A" class, 1 "B", 1 "C", 1 "D" and 1 "E" class). In grades 10 and 11, there are 3 classes of students (10 "A", 10 "B", 10 "C"). On average, there are 30-33 students in each class.

Ethical Statement

It should be noted that all procedures were carried out in accordance with the ethical standards of the Helsinki Declaration of 1964 and approved by the special Ethics committee of the University

Inclusion criteria:

1. Students who were healthy at the beginning of the school year and were admitted by a doctor to physical education classes in the general group.

2. Children whose parents were aware of the pedagogical experiment and gave their written informed consent to the child's participation. It should be noted that children pass the endurance control standards for the physical education program at school every year. Nevertheless, parents of schoolchildren were warned that according to the results of the study, the data of the control standards will be taken into account in scientific research.

3. Students who do not engage in any kind of sport, as a physical culture and sports organized activity can actively influence the results of the study and make them distorted and unreliable.

Exclusion criteria:

1. Children who had illnesses and did not have a doctor's admission to physical education classes in the general group and permission to comply with control standards.

2. Students whose parents have not signed an informed consent to participate in a pedagogical study.

3. Children who play sports or other types of active physical activity that somehow affect endurance performance during the study period.

The research procedure:

The pedagogical research was conducted on the basis of 60 schools in the city of Kirov, Russian Federation from September 15, 2022 to May 23, 2023.

The Physical Education lesson at school takes place 3 times a week for 40 minutes each lesson. All physical education lessons are equally (sequentially) distributed during the six-day school week, in some classes physical education lessons were on Monday, Wednesday and Friday, and in others it was Tuesday, Thursday and Saturday.

All children were engaged in the standard school physical education program at school (Kainov & Kuryerova, 2019). The program consists of the following sections:

1. September is athletics.
2. October and November are outdoor and sports games.
3. December and January are ski training.
4. February is gymnastics and martial arts.
5. March and April are outdoor and sports games
6. May is athletics.

The sections in the physical education program are the same, but they get more complicated from year to year, and students' skills improve.

Control tests

All children passed the control standards at the beginning of the school year (September 15, 2022) and at the end of the school year (May 23, 2023), which show the level of development of physical qualities. The control standard "Cooper Test", which determines the level of endurance development, is a long run for 6 minutes. The result of the test is the distance that the student will cover in 6 minutes (meters). The use of this standard for schoolchildren is optimal and is used in many studies (Jaakkola et al., 2016; Alvero-Cruz et al., 2017).

Statistical analysis:

All the results of the students at the beginning and at the end of the study were recorded in an Excel spreadsheet, which determined the arithmetic mean in each class, the standard deviation of the arithmetic mean and the increase in endurance indicators from the beginning to the end of the school year.

With the help of a special program "Biostatistics-2022", we determined the reliability of the results from the beginning to the end of the study according to the Student's T-criterion. The level of significance and reliability was determined at $p < 0.05$.

Results

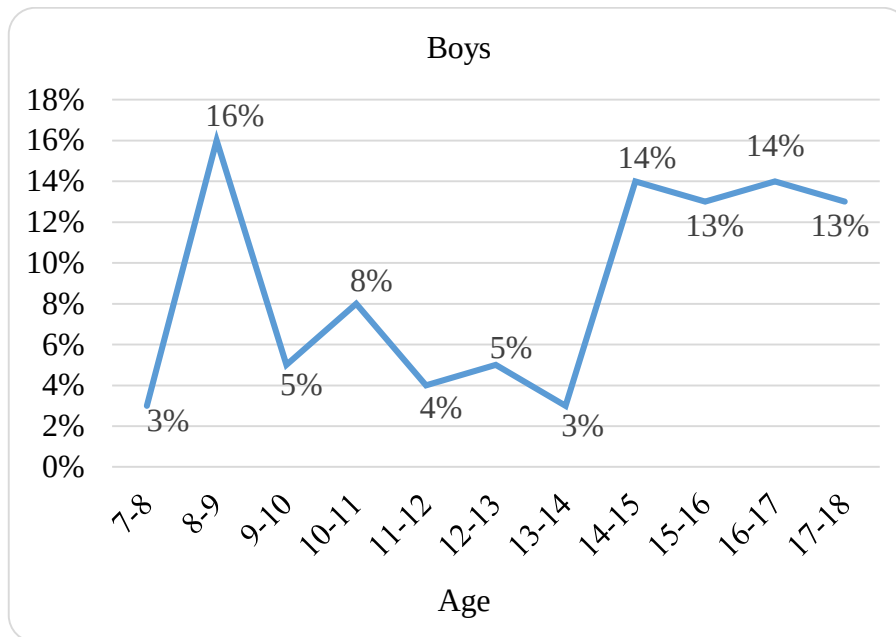
At the beginning of the next school year (September 15, 2022), all the students who participated in the study passed the control standard "Cooper Test", this allowed us to record the initial data of each student, determine the arithmetic mean and standard deviation in each classroom. At the end of the school year (May 23, 2023), the children took the same test again. The average results in each age group and the percentage increase in indicators are shown in table 1.

Table 1. Students' results in the Cooper test at the beginning and at the end of the study

Class	Age	Gender	Amount of children	Before M±m	After M±m	p	Growth in %
I	7-8	Boys	58	941±7	969±8	>0,05	3%
		Girls	67	844±10	886±9	>0,05	5%
II	8-9	Boys	51	956±10	1109±8	<0,05	16%
		Girls	68	851±8	978±7	<0,05	15%
III	9-10	Boys	56	1081±9	1135±7	>0,05	5%
		Girls	64	898±11	933±10	>0,05	4%
IV	10-11	Boys	58	1109±8	1198±10	>0,05	8%
		Girls	59	926±10	1009±9	>0,05	9%
V	11-12	Boys	52	1192±8	1240±9	>0,05	4%
		Girls	64	997±10	1047±8	>0,05	5%
VI	12-13	Boys	57	1201±10	1261±8	>0,05	5%
		Girls	62	1021±9	1052±11	>0,05	3%
VII	13-14	Boys	61	1255±7	1293±8	>0,05	3%
		Girls	54	1084±9	1127±8	>0,05	4%
VIII	14-15	Boys	56	1259±10	1435±9	<0,05	14%
		Girls	60	1102±8	1157±7	>0,05	5%
IX	15-16	Boys	59	1322±9	1493±11	<0,05	13%
		Girls	56	1083±8	1213±9	<0,05	12%
X	16-17	Boys	37	1349±11	1538±9	<0,05	14%
		Girls	41	1096±7	1239±8	<0,05	13%
XI	17-18	Boys	33	1372±8	1550±10	<0,05	13%
		Girls	42	1132±10	1268±9	<0,05	12%

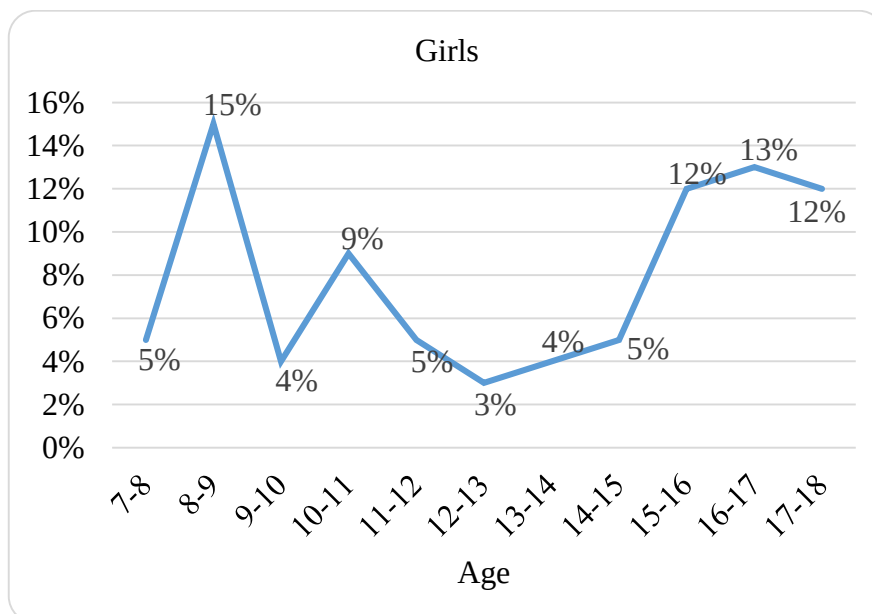
M – Arithmetic average; m – Standard deviation

Table 1 shows that the average indicators in each age group increased during the academic year, however, the increase in indicators in each class was different. For example, a slight increase in endurance indicators (3-5%) was observed in boys and girls in grades 1, 3, 5, 6 and 7 and in girls in grades 8. Despite the fact that the increase in indicators in the 4th grade, both for boys and girls, was not reliable ($p < 0.05$), the results improved by 8% and 9%, respectively, over the year. A significant increase in indicators in the Cooper test was observed in boys and girls of grades 2, 9, 10 and 11, as well as in boys from grades 8, indicators improved by 12-16% ($p < 0.05$). Such results allow us to conclude that there are favorable age periods for the development of endurance in both boys (Graph 1) and girls (Graph 2).



Graph 1. Favorable periods for the development of endurance in boys

Graph 1 shows that the most favorable periods for the development of endurance in boys include the ages of 8-9 years (2nd grade), 14-15 years (8th grade), 15-16 years (9th grade), 16-17 years (10th grade) and 17-18 years (11th grade). Also, a high increase in endurance indicators in boys is observed at the age of 10-11 years (4th grade).



Graph 2. Favorable periods for the development of endurance in girls

Graph 2 shows that the most favorable periods for the development of endurance in girls can be attributed to the age of 8-9 years (2nd grade), 15-16 years

(9th grade), 16-17 years (10th grade) and 17-18 years (11th grade). Also, a high increase in endurance indicators in girls is observed at the age of 10-11 years (4th grade).

Discussion

Special attention should be paid to physical activity of students. In recent years, due to the high academic load at school and at home and other reasons, most schoolchildren have insufficient motor activity, which causes the appearance of hypokinesia, which can cause a number of serious changes in the student's body. Schoolchildren not only have to limit their natural motor activity, but also maintain an uncomfortable static position for them for a long time while sitting at a desk or study table (Aliss et al., 2020; Heradstveit et al., 2020; Chen et al., 2021; Mikaelsson et al., 2021; Volmut et al., 2021). Sufficient motor activity is a necessary condition for the harmonious development of personality. Physical exercises contribute to the good functioning of the digestive system, helping the digestion and assimilation of food, activate the activity of the liver and kidneys, improve the endocrine glands. Constant training of the circulatory system leads to its functional improvement, increases the vital capacity of the lungs, improves the mobility of the chest (Piñeiro-Cossio et al., 2021; de Bruijn et al., 2022).

General endurance plays an essential role in optimizing vital activity, acts as an important component of physical health and, in turn, serves as a prerequisite for the development of special endurance (Azevedo et al., 2021; Rozmatovich & Maftuna, 2022; Sanjar & Maftuna, 2022; Toshboyeva, 2022; Khakimovich & Soyibjon, 2023; Nazirjonovich, 2023).

The authors of some studies that deal with the issues of favorable periods for the development of physical qualities, including endurance, are unanimous in the opinion that the most significant changes in the development of physical qualities of children occur in preschool and primary school age. They emphasize that systematic training has an impact on the development of physical qualities even in non-sensitive periods, but it is believed that the most effective effect of training is precisely during periods of intensive development of physical quality (Goldfield et al., 2012; Kabanov et al., 2019).

However, despite the fact that experts are unanimous in the opinion that the school period, in general, is quite favorable for the development of all physical qualities, but we could not find an unambiguous answer to the question of the sensitive period of development of general endurance.

The results of our study showed certain age periods for the purposeful development of endurance.

If we consider the primary school age (grades I-IV), then for both boys and girls, the optimal period for the development of endurance is the age of 8-9 years (grade II), the increase in endurance indicators in this age range was significantly positive. It should also be noted the age of 10-11 years (grade IV), the result in the Cooper test from the beginning to the end of the study was not reliable, but the natural increase in endurance indicators was at the level of 8-9%. Such results

coincide with the data of previous studies conducted by some authors (Guzhalovsky, 1986; Kholodov & Kuznetsov, 2018; Guba et al., 2021; Kuramshin, 2021; Matveev, 2021).

In secondary school age (grades V-VIII) According to the results of our study, there is a slight increase in endurance in both boys and girls. The indicators increased on average from 4% to 5% ($p > 0.05$). Only boys in grades VIII have a sharp increase in endurance indicators of 14% ($p < 0.05$). Such results coincide with some previous studies (Guzhalovsky, 1986; Guba et al., 2021; Kuramshin, 2021; Matveev, 2021).

Senior school age (grades IX-XI) It is characterized by a sharp jump in endurance indicators in both boys and girls. During the period of our study, the indicators increased by an average of 12-14% ($p < 0.05$). These data coincide with some previously conducted studies by some authors (Kholodov & Kuznetsov, 2018).

Thus, to date, there is no consensus on the sensitive periods of endurance development at school age. Despite the fact that there are some points of contact regarding specific age periods for the development of general endurance, in a detailed analysis, the authors of the studies point to different ages, which are favorable for a targeted impact on the endurance of schoolchildren. Our study with the participation of schoolchildren in grades I-XI showed certain age periods in which the increase in endurance indicators is significant.

Of course, the design of the study could be improved by adding additional tests to determine endurance in schoolchildren, and it is also possible to study favorable periods for the development of other physical qualities in different age periods.

Conclusion

There are several studies that show the effectiveness of endurance development in schoolchildren in the fight against physical inactivity. It is also known about favorable periods for the development of endurance, but data on the age and gender of schoolchildren differ significantly in different studies. According to the results of this study, we can say that a favorable period for the development of endurance in boys is the age of 8-9 years (grade II) and from 14 to 18 years (grades VIII to XI), and in girls 8-9 years (grade II) and from 15 to 18 years (grades IX-XI). Also, a high manifestation of endurance indicators is observed at the age of 10-11 years (grades IV) both boys and girls.

Acknowledgment

Эта исследовательская статья может быть хорошо выполнена благодаря помощи учителей в проведении уроков по физической культуре и приёме контрольных тестов, а также работе учеников школы номер 60, город Киров, мы выражаем благодарность всем участникам исследования.

Conflict of interest

None. The authors declare no conflict of interest

Author contributions

Author Contribution: Study design; Data collection; Statistical analysis; Manuscript Preparation; Funds Collection – Georgiy Polevoy.

Funding

This research received no external funding.

References:

- Abdullaevich, Z. A. (2023). Development of Endurance Qualities of Young Football Players with The Help of Types of Athletics Running. *European Journal of Economics, Finance and Business Development*, 1(9), 7-12.
- Aliss, E. M., Sutaih, R. H., Kamfar, H. Z., Alagha, A. E., & Marzouki, Z. M. (2020). Physical activity pattern and its relationship with overweight and obesity in Saudi children. *International Journal of Pediatrics and Adolescent Medicine*, 7(4), 181-185. DOI: 10.1016/j.ijpam.2020.03.007
- Alvero-Cruz, J. R., García, M. G., & Carnero, E. A. (2017). Reliability and accuracy of Cooper's test in male long distance runners. *Revista Andaluza de Medicina del Deporte*, 10(2), 60-63. <https://dx.doi.org/10.1016/j.ramd.2016.03.001>
- Azevedo, R. D. A., Silva-Cavalcante, M. D., Lima-Silva, A. E., & Bertuzzi, R. (2021). Fatigue development and perceived response during self-paced endurance exercise: state-of-the-art review. *European journal of applied physiology*, 121, 687-696. DOI: 10.1007/s00421-020-04549-5
- Chen, P., Wang, D., Shen, H., Yu, L., Gao, Q., Mao, L., ... & Li, F. (2020). Physical activity and health in Chinese children and adolescents: expert consensus statement (2020). *British journal of sports medicine*. DOI: 10.1136/bjsports-2020-102261
- de Bruijn, A. G., Mombarg, R., & Timmermans, A. C. (2022). The importance of satisfying children's basic psychological needs in primary school physical education for PE-motivation, and its relations with fundamental motor and PE-related skills. *Physical Education and Sport Pedagogy*, 27(4), 422-439. DOI: 10.1080/17408989.2021.1906217
- Doma, K., Deakin, G. B., Schumann, M., & Bentley, D. J. (2019). Training considerations for optimising endurance development: an alternate concurrent training perspective. *Sports medicine*, 49, 669-682.
- Faigenbaum, A. D., Westcott, W. L., Loud, R. L., & Long, C. (1999). The effects of different resistance training protocols on muscular strength and endurance development in children. *Pediatrics*, 104(1), e5-e5. DOI: 10.1542/peds.104.1.e5
- Goldfield, G. S., Harvey, A., Grattan, K., & Adamo, K. B. (2012). Physical activity promotion in the preschool years: a critical period to intervene. *International journal of environmental research and public health*, 9(4), 1326-1342. doi: 10.3390/ijerph9041326
- Guba VP, Bulikina LV, Achkasov EE, Bezuglov EN. Sensitive periods of children's development. Definition of sports talent. Moscow, Russia: Sport, 2021; p. 176.

- Guzhalovskiy AA. Fundamentals of the theory and methodology of physical education: Textbook for institutes of physical culture. Moscow, Russia: Fizicheskaya kultura i Sport, 1986; p. 351.
- Heradstveit, O., Haugland, S., Hysing, M., Stormark, K. M., Sivertsen, B., & Bøe, T. (2020). Physical inactivity, non-participation in sports and socioeconomic status: A large population-based study among Norwegian adolescents. *BMC Public Health*, 20(1), 1-9. <https://doi.org/10.1186/s12889-020-09141-2>
- Hu, D., Zhou, S., Crowley-McHattan, Z. J., & Liu, Z. (2021). Factors that influence participation in physical activity in school-aged children and adolescents: a systematic review from the social ecological model perspective. *International journal of environmental research and public health*, 18(6), 3147. DOI: 10.3390/ijerph18063147
- Jaakkola, T., Yli-Piipari, S., Huotari, P., Watt, A., & Liukkonen, J. (2016). Fundamental movement skills and physical fitness as predictors of physical activity: A 6-year follow-up study. *Scandinavian Journal of Medicine & Science in Sports*, 26(1), 74-81. DOI: 10.1111/sms.12407
- Kabanov, Y. M., Venskovich, D. A., Trushchenko, V. V., & Koloshkina, V. A. (2019). Sensitive periods in human ontogenesis. *Theory and Practice of Physical Culture*, (12), 4-4.
- Kainov AN, Kuryerova GI. Working programs. Physical culture. Grades 1-11. A comprehensive program of physical education for school children. Moscow, Russia: Teacher, 2019; p. 169.
- Khakimovich, K. S., & Soyibjon, I. M. (2023). Development of Students' Endurance Quality in Physical Culture Classes (in the Case of Grades 5-6). *Best Journal of Innovation in Science, Research and Development*, 2(5), 181-183.
- Kholodov ZhK, Kuznetsov VS. Theory and methodology of physical culture and sports. Textbook for universities. Moscow, Russia: Academia, 2018; p. 496.
- Kuramshin YuF. Theory and methodology of physical culture: Textbook. Moscow, Russia: Sport, 2021; p. 464.
- Mannocci, A., D'Egidio, V., Backhaus, I., Federici, A., Sinopoli, A., Ramirez Varela, A., ... & La Torre, G. (2020). Are there effective interventions to increase physical activity in children and young people? An umbrella review. *International Journal of Environmental Research and Public Health*, 17(10), 3528. doi: 10.3390/ijerph17103528
- Matveev LP. Theory and methodology of physical culture. Textbook. Moscow, Russia: Sport, 2021; p. 520.
- Mikaelsson, K., Rutberg, S., Lindqvist, A. K., & Michaelson, P. (2020). Physically inactive adolescents' experiences of engaging in physical activity. *European Journal of Physiotherapy*, 22(4), 191-196. <https://doi.org/10.1080/21679169.2019.1567808>
- Mikkonen, R. S., Ihalainen, J. K., Hackney, A. C., & Häkkinen, K. (2023). Perspectives on Concurrent Strength and Endurance Training in Healthy Adult Females: A Systematic Review. *Sports Medicine*, 1-24. <https://doi.org/10.1007/s40279-023-01955-5>

- Nazirjonovich, K. Z. (2023). Improving endurance from physical qualities in student youth. *Open Access Repository*, 9(9), 115-118.
- Oberle, E., Ji, X. R., Kerai, S., Guhn, M., Schonert-Reichl, K. A., & Gadermann, A. M. (2020). Screen time and extracurricular activities as risk and protective factors for mental health in adolescence: A population-level study. *Preventive Medicine*, 141, 106291. DOI: 10.1016/j.ypmed.2020.106291
- Piñeiro-Cossio, J., Fernández-Martínez, A., Nuviala, A., & Pérez-Ordás, R. (2021). Psychological wellbeing in physical education and school sports: A systematic review. *International Journal of Environmental Research and Public Health*, 18(3), 864. DOI: 10.3390/ijerph18030864
- Rozmatovich, U. S., & Maftuna, I. (2022). Development of students'endurance in physical culture lessons. *Asia pacific journal of marketing & management review*, 11(10), 102-106.
- Sanjar, U., & Maftuna, I. (2022). Developing students'endurance quality in physical education classes (on the example of grades 5-6). *International journal of research in commerce, it, engineering and social sciences*, 16(06), 24-28.
- Solodkov AS, Sologub EB. *Human Physiology. General. Sports. Age group. Textbook*. Moscow, Russia: Sport, 2018; p. 624.
- Terrón-Pérez, M., Molina-García, J., Martínez-Bello, V. E., & Queralto, A. (2021). Relationship between the physical environment and physical activity levels in preschool children: a systematic review. *Current Environmental Health Reports*, 8(2), 177-195. DOI: 10.1007/s40572-021-00318-4
- Toshboyeva, M. B. (2022). Wellness exercises for human endurance development. *Web of Scientist: International Scientific Research Journal*, 3(4), 1214-1220.
- Yuliandra, R., & Fahrizqi, E. B. (2020). Development of endurance with the ball exercise model in basketball games. *Jurnal Pendidikan Jasmani, Olahraga Dan Kesehatan*, 4(1), 61-72. DOI: 10.33503/jp.jok.v4i1.980
- Vale, S., Santos, R., Soares-Miranda, L., Silva, P., & Mota, J. (2011). The importance of physical education classes in pre-school children. *Journal of Paediatrics and Child Health*, 47(1-2), 48-53. DOI: 10.1111/j.1440-1754.2010.01890.x
- Volmut, T., Pišot, R., Planinšec, J., & Šimunič, B. (2021). Physical activity drops during summer holidays for 6-to 9-year-old children. *Frontiers in public health*, 8, 631141. <https://doi.org/10.3389/fpubh.2020.631141>