

# Influence of Regular Basketball Practice in Adolescence on the Functional Capacity of the Heart

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## Abstract

The work was carried out on 36 clinically healthy young basketball players aged 17-21 years old, training in the basketball section for at least 3 years. The created control group consisted of 26 clinically healthy young men aged 17 to 21, who had not previously been involved in any kind of sports. In the study, the examined were subjected to ultrasound examination using an SSD-80 "Aloka" device (Japan) with an assessment of the morphological and functional characteristics of the heart. The statistical analysis of the obtained results of the study was carried out using a personal computer using the Student's t-criterion. Some signs of the development of left ventricular muscle hypertrophy were found in young basketball players. At the same time, the basketball players retained the optimum volume of the left cardiac ventricle. The youth basketball players also had a higher diastole rate compared to the control group. Regular basketball training can strengthen the body. They lead to an increase in the muscle mass of the left ventricle, which increases its functional potential and provides an optimal blood supply to internal organs.

**Keywords:** Basketball, Heart, Myocardium, Hemodynamics, Left ventricle, Physical training

## Introduction

Regular practice of any kind of sport stimulates all organs of life support of the body (Boldov, *et al.*, 2018; Makhov & Medvedev,

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2018b). Low physical activity always weakens the body and its heart (Amelina & Medvedev, 2009; Medvedev, 2018a). Regular physical activity of a feasible nature activates all vital processes in muscles and internal organs (Vorobyeva *et al.*, 2018a; Makurina *et al.*, 2020). This is due to an increase in the efficiency of adaptive processes in all tissues of the body and the intensification of metabolism (Mikhaylova *et al.*, 2021a; Makhov & Medvedev, 2021). At the same time, the effect of systematic basketball loads on the body requires additional assessment, especially in terms of their impact on physiological processes in the myocardium (Tkacheva & Medvedev, 2020a; Ibrahim *et al.*, 2021). The focus of attention of modern researchers is the dynamics of the contractile ability of the heart in the process of physical activity (Makhov & Medvedev, 2018c; Mal *et al.*, 2018a; Glamazdin *et al.*, 2021).

Often in long-term athletes, the volume of the myocardium, especially the left ventricle, increases, and sometimes its volume decreases (Karpov *et al.*, 2018; Wang *et al.*, 2021). At the same time, those who have started regular physical training may have a lower ejection volume than physically untrained people (Bespalov *et al.*, 2018a; Guo *et al.*, 2020; Makhov & Medvedev, 2020b).

Due to the great biological significance of the normal functioning of the heart, it is necessary to continue an active study of the adaptive mechanisms of its activity in conditions of regular basketball loads (Makhov & Medvedev, 2018d; Medvedev, 2018c). To optimize the process of basketball training, designed to ensure high professionalism of trainees, regular studies of various aspects of heart activity in basketball players should be carried out (Oshurkova & Medvedev, 2018a; Stepanova *et al.*, 2018).

Purpose: to assess the state of functional characteristics of the heart in young basketball players.

## Materials and Methods

The study was carried out on 36 clinically healthy young men aged 17 to 21 years. They regularly participated in basketball training at least 4 times a week. The previous experience of uninterrupted basketball training for all surveyed was at least 3 years. The control group consisted of 26 clinically healthy young



men aged 17 to 21 years. They experienced significant muscular loads only in a university setting at academic physical education classes 4 times a week.

All examined patients underwent ultrasound examination of the heart using an SSD-80 echocardiograph manufactured by Aloka (Japan). The diastolic volume of the heart was calculated by calculation. Using the standard method, the mass of the heart muscle was determined. The ratio of the degree of myocardial hypertrophy of the left cardiac ventricle and the degree of dilatation of its cavity was calculated. This was done by registering the value of the end-diastolic volume index of the heart muscle.

Statistical processing of the obtained results was carried out by computer by calculating the value of Student's t-test. The presence of differences between the observed groups was recognized as significant in the case of  $p < 0.05$ .

## Results and Discussion

The study revealed the differences in the indicators taken into account in basketball players and in boys who made up the control group (**Table 1**). The greatest differences between these two groups taken into the study were in the morphological parameters of the myocardium of the left cardiac ventricle, which

was explained by the presence of regular physical activity (Makhov & Medvedev, 2019; Skoryatina & Medvedev, 2019).

The diameter of the left atrium in the observed basketball players exceeded the value in the control by 9.0%. This indicated a high degree of adaptation of the myocardium to stress (Mal *et al.*, 2018b; Glagoleva & Medvedev, 2020; Hao *et al.*, 2020). In basketball players, the diameter of the left ventricle in the anteroposterior projection during diastole tended to increase (by 6.3%) compared with the level in physically untrained boys. This change was a consequence of the anabolic processes of the heart muscle (Bespalov *et al.*, 2018b; Karpov *et al.*, 2020).

In basketball players, the thickness of the left ventricle in the region of its posterior wall at the time of diastole exceeded by 18.3% this indicator in the control group boys ( $p < 0.05$ ). This was explained by the fact that it is the left ventricle in the heart that does the most work (Makhov & Medvedev, 2018a; Medvedev, 2018b). Diastolic volume in basketball players tended to decrease in comparison with the control level (by 9.3%). The magnitude of the stroke volume in those observed in both groups was comparable, which indicated the optimum function of the heart in all subjects (Vorobyeva & Medvedev, 2019; Agronina *et al.*, 2020; Tkacheva & Medvedev, 2020b).

**Table 1.** Cardiac indicators in the surveyed

Indicators of cardiac activity	Group of basketball players, M±m, n=36	Control group, M±m, n=26
Diastolic ventricular wall thickness posteriorly, cm	1.23±0.14	1.04±0.06 $p < 0.05$
Diastolic end volume of the heart, cm <sup>3</sup> / kg	1.82±0.23	1.99±0.17
The maximum speed of the process of relaxation of the wall of the left ventricle from behind, cm/s	13.7±1.86	10.2±0.56 $p < 0.05$
The ratio of diastolic end volume to myocardial mass, cm <sup>3</sup> /kg	0.63±0.14	0.94±0.10 $p < 0.01$
Impact volume, cm <sup>3</sup> /kg	1.12±0.18	1.07±0.09
Myocardial mass, cm <sup>3</sup> /kg	2.61±0.25	2.12±0.18 $p < 0.05$
Release amount, %	61.62±1.33	60.10±0.75
The diameter of the left atrium, cm/m <sup>2</sup>	1.93±0.11	1.77±0.12
Anterior-posterior diastolic size of the left ventricle, cm	5.39±0.19	5.07±0.06
Decrease in the anterior-posterior size of the left ventricle, %	34.62±0.54	32.81±0.79

Note: p – is the mathematical significance of the differences in indicators between the groups.

The mass of the myocardium turned out to be greater (by 23.1%) in basketball players than in young men included in the control group (Medvedev, 2018f; Mikhaylova *et al.*, 2021b). This indicated the development of moderate hypertrophy of the heart muscle during regular basketball physical activity (Makhov & Medvedev, 2020a; Tkacheva & Medvedev, 2020c; Mikhaylova *et al.*, 2021c). At the same time, it did not affect the value of the systolic ejection fraction of the heart (Oshurkova & Medvedev, 2018b; Hu & Li, 2019; Vorobyeva & Medvedev, 2020a). Its volume was comparable in both groups of observed young men,

indicating the optimum heart function (Vorobyeva *et al.*, 2020b; Medvedev *et al.*, 2021b).

The maximum rate of relaxation of the posterior part of the left ventricle of the heart was noted in basketball players. In them, this indicator exceeded the control level by 34.3%, which was a consequence of an increase in the volume of cardiomyocytes (Medvedev, 2018a; Medvedev, 2021).

The ratio of end-diastolic volume and heart muscle mass in basketball players was lower than in control by 49.2 %. This is due to the high sensitivity of this indicator to systematic physical activity of aerobic nature (Vorobyeva & Medvedev, 2020c; Medvedev *et al.*, 2021a).

The performed observation showed the similarity in both groups of examined young men of the size of the left atrium, the value of the total volume of the left ventricle, and the volume of its cavity (Vorobyeva & Medvedev, 2018b; Medvedev *et al.*, 2021c). In the outcome, all examined young men showed comparable indicators of central hemodynamics and the severity of myocardial contractility (Makhov & Medvedev, 2020a). The value of the ratio of the value of the end diastolic volume of the heart to the index of myocardial mass on the background of regular basketball training significantly decreased due to an increase in the volume of the heart muscle, especially in the posterior part of the left cardiac ventricle. The decrease in the ratio of diastolic final volume to myocardial mass to  $0.63 \pm 0.14$  in basketball players is a consequence of the prevalence of cardiac wall hypertrophy in them over the process of expansion of cardiac cavities (Medvedev, 2018e; Mal *et al.*, 2020).

We can say that regular basketball loads contribute to the hypertrophy of the muscle elements of the left ventricle. This was indicated by a tendency towards its thickening and an increase in its mass in its posterior part with the optimal value of the volume of the cavity of the left ventricle (Xu *et al.*, 2019; Medvedev, 2021).

There is a point of view that the high rate of myocardial relaxation in basketball players is only for those who systematically train in any kind of sport (Medvedev, 2018d). This is confirmed by the high rate of relaxation of the left cardiac ventricle in the posterior part found in them at the same time, this parameter is very changeable during the ultrasound examination and can change even in the course of one examination. For this reason, this indicator cannot be regarded as sufficiently reliable, which requires additional observations.

## Conclusion

Regular sports loads during basketball training significantly stimulate the heart and increase hemodynamics. Long-term basketball loads lead to an increase in the volume of the left ventricular muscle while maintaining the volume of its cavity and the functional capabilities of the heart. At the same time, under conditions of regular basketball training, athletes experience a reduction in the time of relaxation of the left ventricle, which greatly facilitates the work of the left ventricle, especially in the region of the posterior wall.

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## References

- Agronina, N. I., Belozerova, T. B., Gorbatenko, S. A., Krasnova, N. P., Medvedev, I. N., & Savchenko, A. P. (2020). Homelessness and neglect of children in modern Russia: literature-based analysis. *Bioscience Biotechnology Research Communications*, 13(2), 475-481.
- Amelina, I. V., & Medvedev, I. N. (2009). Transcriptional activity of chromosome nucleolar organizing regions in population of Kursk region. *Bulletin of Experimental Biology and Medicine*, 147(6), 730-732.
- Bespalov, D. V., Medvedev, I. N., Mal, G. S., & Polyakova, O. V. (2018a). Physiological capabilities of the vascular endothelium with the developing arterial hypertension in people of different ages who had long had low physical activity. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, 9(2), 972-976.
- Bespalov, D. V., Medvedev, I. N., Mal, G. S., & Makurina, O. N. (2018b). Functional activity of the vascular endothelium in patients with initial signs of atherosclerosis against the background of regularly dose-related exercise stress. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, 9(2), 1020-1024.
- Boldov, A., Karpov, V., & Gusev, A. (2018). Study on the level of physical development and physical fitness in students of university of psychology and education. 34th International Scientific Conference on Economic and Social Development / 18th International Social Congress (ISC). Moscow, RUSSIA. International Scientific Conference on Economic and Social Development, 354-366.
- Glagoleva, T. I., & Medvedev, I. N. (2020). Physiological features of aggregation of the main formed elements of blood in calves at the beginning of early ontogenesis. *BIO Web of Conferences*, 17(5), 00161. doi:10.1051/bioconf/20201700161
- Glamazdin, I. G., Medvedev, I. N., Sysoeva, N. Y., Goryacheva, M. M., Kryukovskaya, G. M., & Maryushina, T. O. (2021). The Severity of Changes in the Levels of Formed Elements in the Blood of Pigs with Different Types of Higher Activity in the Conditions of their Use of Eleovite. *Bioscience Biotechnology Research Communications*, 14(1), 161-171.
- Guo, F., Fei, R., Wang, Y. M., Shi, Y. B., Cao, W. H., Chi, A. P., & Cao, B. (2020). Screening of different metabolites in teenage football players after exercise fatigue. *Zhongguo Ying Yong Sheng li xue za zhi= Zhongguo Yingyong Shenglixue Zazhi= Chinese Journal of Applied Physiology*, 36(5), 465-470.
- Hao, L., Sun, X. G., Song, Y., Liu, F., Tai, W. Q., Ge, W. G., Li, H., Zhang, Y., Chen, R., Zou, Y. X., & Ma, M. X. (2021). Effect of different work rate increasing rate on the overall function evaluation of cardiopulmonary exercise testing II-

- sub-peak parameters. *Zhongguo Ying Yong Sheng li xue za zhi= Zhongguo Yingyong Shenglixue Zazhi= Chinese Journal of Applied Physiology*, 37(2), 120-124.
- Hu, Z. Q., & Li, Z. H. (2019). The effects of 12 week core strength training on balance control ability and physical function of basketball college students. *Chinese Journal of Applied Physiology*, 35(6), 510-512.
- Ibrahim, S., Ahmed, S. A., Ahmed, S. M., & Ahmed, S. K. (2021). Does weight machines protocol actuate contradistinction on strength variables among BMI categories of male college students?. *International Journal of Pharmaceutical Research & Allied Sciences*, 10(3), 20-24. doi:10.51847/dQnVOIpHg0
- Karpov, V. Yu., Pilosyan, N. A., Stepanova, O. N., & Bakulina, E. D. (2018). Physical rehabilitation of preschoolers with cerebral paralysis by means of hippotherapy. International Conference on Research Paradigms Transformation in Social Sciences. Tomsk Polytechn Univ, Tomsk, RUSSIA. *European Proceedings of Social and Behavioural Sciences*, 35, 529-535.
- Karpov, V. Yu., Medvedev, I. N., Dorontsev, A. V., Svetlichkina, A. A., & Boldov, A. S. (2020). The state of cardiac activity in greco-roman wrestlers on the background of different options for weight loss. *Bioscience Biotechnology Research Communications*, 13(4), 1842-1846.
- Makhov, A. S., & Medvedev, I. N. (2018a). Functional mechanisms to ensure the reactivity of the organism. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, 9(6), 924-929.
- Makhov, A. S., & Medvedev, I. N. (2018b). Physiological basis of maintaining the body's reactivity. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, 9(6), 825-830.
- Makhov, A. S., & Medvedev, I. N. (2018c). The effect of physical activity on neurophysiological processes in students. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, 9(6), 968-972.
- Makhov, A. S., & Medvedev, I. N. (2018d). The physiological reaction of the body of adolescents to the classroom. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, 9(6), 947-951.
- Makhov, A. S., & Medvedev, I. N. (2019). Functional characteristics of children with Down syndrome and possibilities of their correction with the help of athletic activity in Russia. *Bali Medical Journal*, 8(2), 587-591. doi:10.15562/bmj.v8i2.1097
- Makhov, A. S., & Medvedev, I. N. (2020a). Physiological and morphological peculiarities of children with Down's syndrome: A brief review. *Bali Medical Journal*, 9(1), 51-54. doi:10.15562/bmj.v9i1.1099
- Makhov, A. S., & Medvedev, I. N. (2020b). Parent's motivations on sports participation of their children with Down's syndrome in Russia. *Bali Medical Journal*, 9(1), 47-50. doi:10.15562/bmj.v9i1.1111
- Makhov, A. S., & Medvedev, I. N. (2021). Physiological effects of regular football training in adolescents using visual analyzer pathology. *Bioscience Biotechnology Research Communications*, 14(2), 853-857.
- Makurina, O. N., Fayzullina, I. I., Vorobyeva, N. V., & Tkacheva, E. S. (2020). The ability to correct a persons posture with regular exercise. *Bioscience Biotechnology Research Communications*, 13(3), 1088-1093.
- Mal, G. S., Vorobyeva, N. V., Makhova, A. V., Medvedev, I. N., & Fayzullina, I. I. (2018a). Features of physical rehabilitation after myocardial infarction. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, 9(6), 280-285.
- Mal, G. S., Kharitonov, E. L., Vorobyeva, N. V., Makhova, A. V., & Medvedev, I. N. (2018b). Functional aspects of body resistance. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, 9(6), 60-65.
- Mal, G. S., Medvedev, I. N., & Makurina, O. N. (2020). The prevalence of extreme severity of autoaggression among residents of Russia. *Bioscience Biotechnology Research Communications*, 13(4), 2125-2129.
- Medvedev, I. N. (2018a). Functional parameters of platelets in young men practicing in the football section. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, 9(6), 1315-1320.
- Medvedev, I. N. (2018b). Functional properties of platelets in amateur tennis players aged 18-35 years. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, 9(6), 1370-1375.
- Medvedev, I. N. (2018c). Functional features of intravascular platelet activity in adolescents with high normal blood pressure, overweight or a combination of them against the background of regular physical exertion. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, 9(6), 1258-1265.
- Medvedev, I. N. (2018d). Physiological response of intravascular platelet activity in boys with high normal blood pressure to regular physical exercise. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, 9(6), 1244-1250.
- Medvedev, I. N. (2018e). The physiological properties of platelets in people 18-35 years old, trained in the section of general physical training. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, 9(6), 1277-1283.
- Medvedev, I. N. (2018f). Dynamics of functional parameters of platelet hemostasis in young people with hemodynamic and metabolic disorders on the background of regular physical activity. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, 9(6), 1217-1222.
- Medvedev, I. N. (2021). Dynamics of functional indicators of adolescents against the background of regular volleyball trainings. *Bioscience Biotechnology Research Communications*, 14(2), 714-718.
- Medvedev, I. N., Karpov, V. Yu., Eremin M. V., Boldov A. S., Shalupin V. I., Voronova N. N., & Malyshev, A. V. (2021a). The functional characteristics of the organism of physically inactive students who have started regular physical training. *Journal of Biochemical Technology*, 12(2), 33-37.
- Medvedev, I. N., Karpov, V. Yu., Eremin, M. V., Rysakova, O. G., Dorontsev, A. V., & Ivanov, D.A. (2021b).

- Hematological parameters in mature age men who have begun regular sports walking. *Bioscience Biotechnology Research Communications*, 14(3), 1015-1019.
- Medvedev, I. N., Karpov, V. Yu., Pryanikova, N. G., Dorontsev, A. V., Voronova, N. N., & Bakulina, E. D. (2021c). Effects of regular jogging on functional capabilities of the cardiovascular system in students. *Bioscience Biotechnology Research Communications*, 14(3), 1124-1127.
- Mikhaylova, I. V., Medvedev, I. N., Bakulina, E. D., Petrova, M. A., & Rysakova, O. G. (2021a). Evaluation of the effectiveness of training Russian chess players with musculoskeletal disorders. *Journal of Biochemical Technology*, 12(3), 42-46. doi:10.51847/Z9woHiHWFc
- Mikhaylova, I. V., Medvedev, I. N., Bakulina, E. D., Petrova, M. A., & Rysakova, O.G. (2021b). Evaluation of the main problems of adaptive chess sport in Russia. *Journal of Biochemical Technology*, 12(2), 78-82. doi:10.51847/IvquLViPsQ
- Mikhaylova, I. V., Medvedev, I. N., Makurina, O. N., Bakulina, E. D., Ereshko, N. Y., & Eremin, M. V. (2021c). The effect of playing chess on an aging or pathological organism. *Journal of Biochemical Technology*, 12(3), 47-52. doi:10.51847/CwcjG5IstX
- Oshurkova, Ju. L., & Medvedev, I. N. (2018a). Functional features of platelets in newborn calves Ayrshire breed. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, 9(6), 313-318.
- Oshurkova, Ju. L., & Medvedev, I. N. (2018b). Physiological indicators of platelets in Ayrshire calves during the dairy feeding phase. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, 9(6), 171-176.
- Skoryatina, I. A., & Medvedev, I. N. (2019). Correction of aggregation level of basic regular blood elements in patients with hypertension and dyslipidemia receiving rosuvastatin and non-medicinal treatment. *Bali Medical Journal*, 8(1), 194-200.
- Stepanova, O. N., Stepanova, D. P., Pirogova, A.A., & Karpov, V. Yu. (2018). Women's weight lifting as sport discriminated against on grounds of gender. International Conference on Research Paradigms Transformation in Social Sciences. Tomsk Polytechn Univ, Tomsk, RUSSIA. *European Proceedings of Social and Behavioural Sciences*, 35, 1325-1332.
- Tkacheva, E. S., & Medvedev, I. N. (2020a). Functional features of vascular hemostasis in piglets of milk and vegetable nutrition. *IOP Conference Series: Earth and Environmental Science*, 421(2), 022041. doi:10.1088/1755-1315/421/2/022041
- Tkacheva, E.S., & Medvedev, I.N. (2020b). Physiological and biochemical status of newborn piglets. *IOP Conference Series: Earth and Environmental Science, Innovative Development of Agri-Food Technology*, 548(8), 082090. <https://iopscience.iop.org/article/10.1088/1755-1315/548/8/082090>
- Tkacheva, E. S., & Medvedev, I. N. (2020c). The severity of the disaggregation function of blood vessels in piglets of plant nutrition. *Bioscience Biotechnology Research Communications*, 13(3), 1174-1178.
- Vorobyeva, N. V., Mal, G. S., Skripieva, E. V., Skripiev, A. V., & Skoblikova, T. V. (2018a). The Combined Impact of Amlodipin and Regular Physical Exercises on Platelet And Inflammatory Markers In Patients With Arterial Hypertension. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, 9(4), 1186-1192.
- Vorobyeva, N. V., & Medvedev, I. N. (2018b). Physiological features of platelet functioning in calves of holstein breed during the newborn. *Research Journal of Pharmaceutical, Biological, and Chemical Sciences*, 9(6), 129-135.
- Vorobyeva, N. V., & Medvedev, I. N. (2019). Functional activity of platelets in newborn calves of black-marked breed. *Bulgarian Journal of Agricultural Science*, 25(3), 570-574.
- Vorobyeva, N. V., & Medvedev, I. N. (2020a). Functional platelet activity in Dutch newborn calves. *IOP Conference Series: Earth and Environmental Science*, 421(2), 022042. doi:10.1088/1755-1315/421/2/022042
- Vorobyeva, N. V., Mal, G. S., Tkacheva, E. S., Fayzullina, I. I., & Lazurina, L. P. (2020b). Endothelial functions in people with high normal blood pressure experiencing regular exercise. *Bioscience Biotechnology Research Communications*, 13(2), 451-455.
- Vorobyeva, N. V., & Medvedev, I. N. (2020c). Platelet function activity in black-motley calves during the dairy phase. In *BIO Web of Conferences*, 17(5), 00167. doi:10.1051/bioconf/20201700167
- Wang, T. F., Tsai, S. F., Zhao, Z. W., Shih, M. M. C., Wang, C. Y., Yang, T. T., & Kuo, Y. M. (2021). Exercise-induced increases of corticosterone contribute to exercise-enhanced adult hippocampal neurogenesis in mice. *Chinese Journal of Physiology*, 64(4), 186-193.
- Xu, S. J., Xu, L., Jia, W., Tian, D., Huang, H. S., Wang, J. Z., Yang, J., & Ma, J. Z. (2019). Effects of sustained military physical related activity on balance ability. *Zhongguo Ying Yong Sheng li xue za zhi= Zhongguo Yingyong Shenglixue Zazhi= Chinese Journal of Applied Physiology*, 35(5), 460-463.