ISRG Journal of Arts, Humanities and Social Sciences (ISRGJAHSS)

ISRG PUBLISHERS
Abbreviated Key Title: ISRG J Arts Humanit Soc Sci
ISSN: 2583-7672 (Online)
Journal homepage: https://isrgpublishers.com/isrgjahss
Volume – II Issue-VI (November-December) 2024
Frequency: Bimonthly

How Does Physical Activity Affect the Circulatory System?

Adam Popek

University of Physical Education in Krakow

| **Received:** 26.11.2024 | **Accepted:** 30.11.2024 | **Published:** 04.12.2024

***Corresponding author:** Adam Popek

University of Physical Education in Krakow

Abstract

Physical activity has profound effects on the circulatory system, promoting cardiovascular health through various physiological adaptations. This review explores the acute and chronic impacts of exercise on the heart, blood vessels, and blood components. Acute effects include increased heart rate, cardiac output, and vascular resistance modulation, optimizing oxygen delivery during physical exertion. Chronic physical activity, especially aerobic exercise, induces structural and functional cardiovascular changes, such as improved heart efficiency, enhanced vascular elasticity, and reduced systemic inflammation. Additionally, exercise lowers blood pressure, improves lipid profiles, and reduces the risk of atherosclerosis, contributing to overall circulatory system health. Understanding these mechanisms underscores the importance of regular physical activity in preventing and managing cardiovascular

Keywords: *physical activity, aerobic effort, anaerobic effort, circulatory system, cardiovascular health, exercise physiology, heart function, blood vessels*

Introduction

Physical activity is essential for maintaining overall health, and its impact on the circulatory system is profound. The circulatory system, composed of the heart, blood vessels, and blood, plays a crucial role in delivering oxygen and nutrients to tissues while removing waste products. Engaging in regular exercise triggers numerous physiological adaptations that enhance the system's efficiency and resilience. The circulatory system, consisting of the heart, blood vessels, and blood, is a cornerstone of human health, responsible for delivering oxygen and nutrients to tissues and removing waste products. Maintaining the optimal function of this system is vital for overall well-being, and physical activity is one of the most effective ways to achieve this. Whether through a brisk walk, a high-intensity workout, or regular endurance training, exercise has both immediate and long-term effects on the circulatory system [1,2,3].

From boosting heart rate and improving blood flow to promoting the formation of new blood vessels, physical activity triggers a cascade of physiological changes. These adaptations not only enhance performance during exercise but also protect against

DOI: 10.5281/zenodo.14274214

cardiovascular diseases, hypertension, and metabolic disorders. In this article, we delve into the science behind these processes, exploring how different types of physical activity impact the circulatory system and contribute to a healthier, more resilient body [4]. Regular exercise stimulates the production of nitric oxide, a molecule that relaxes blood vessels and promotes their flexibility. This reduces arterial stiffness, lowering the risk of atherosclerosis (hardening of the arteries) and hypertension. Physical activity enhances the formation of capillaries (angiogenesis) in muscles and tissues. This increased capillary network ensures efficient delivery of oxygen and nutrients while facilitating the removal of carbon dioxide and metabolic waste. Aerobic exercise is particularly effective in maintaining healthy blood pressure. By reducing vascular resistance and improving vessel health, physical activity lowers the risk of hypertension, a major contributor to cardiovascular disease [5,6].

Regular exercise is a cornerstone in preventing and managing cardiovascular diseases. Studies show that physically active individuals have a significantly lower risk of developing coronary artery disease, heart failure, and stroke. Exercise also mitigates the effects of other risk factors like obesity, diabetes, and metabolic syndrome [7].

Immediate Effects of Physical Activity on the Circulatory System

During exercise, the demand for oxygen and nutrients in the muscles increases. In response, the heart rate rises to pump more blood to the active tissues. This process is controlled by the autonomic nervous system, particularly the sympathetic branch, which stimulates the release of adrenaline. The heart, a vital organ in the circulatory system, is responsible for pumping blood throughout the body to supply oxygen and nutrients while removing waste products. Physical activity, a common part of daily life and essential for health, directly influences how the heart functions. One of the most noticeable effects of exercise is an increase in heart rate, a phenomenon crucial for meeting the body's heightened energy demands. In this article, we explore the science behind how physical activity increases heart rate, its mechanisms, and its significance. Heart rate refers to the number of times the heart beats per minute (bpm). At rest, the average adult heart rate ranges from 60 to 100 bpm, although it can be lower in well-trained individuals due to superior cardiovascular efficiency. During physical activity, heart rate increases significantly to accommodate the body's need for more oxygen and energy. When engaging in physical activity, muscles require more oxygen to produce the energy needed for movement. This increased oxygen demand triggers a cascade of physiological responses, ultimately leading to an elevated heart rate. Several interconnected mechanisms are at play: activation of the sympathetic nervous system, increase oxygen demand, vasodilation and redistribution of blood flow, respiratory influence, stroke volume adaptation [8,9,10].

The degree to which heart rate increases during exercise depends on the intensity, duration, and type of activity. Take into consideration **aerobic exercises**. Activities like running, cycling, or swimming engage large muscle groups and demand sustained oxygen delivery. Heart rate increases proportionally to the intensity of the exercise, reaching 50–85% of the maximum heart rate in moderate to vigorous activities. In **Anaerobic Exercises are included** high-intensity exercises like sprinting or weightlifting cause rapid heart rate spikes. These activities rely on short bursts of energy, which trigger the heart to pump blood quickly to replenish oxygen stores and remove metabolic byproducts. **Isometric exercises represent** static exercises, such as planking, lead to a moderate increase in heart rate. Although oxygen demand is lower, the pressure on blood vessels and muscles still prompts a cardiovascular response [11]. The benefits of heart rate increase during exercise are important to the body. Frequent increases in heart rate during exercise improve the heart muscle's strength and endurance, allowing it to pump blood more efficiently at rest. Exercise-induced heart rate increases lead to the growth of new capillaries in muscles, enhancing oxygen delivery and waste removal. Over time, the heart becomes better at returning to its resting rate after exercise, a sign of good cardiovascular fitness. Regular exercise reduces resting heart rate, indicating a stronger and more efficient heart [12,13,14].

Exercise causes a temporary increase in blood pressure as the heart pumps more forcefully to circulate blood. Systolic blood pressure (the pressure during heartbeats) rises significantly, while diastolic pressure (the pressure between beats) remains relatively stable or may slightly decrease during aerobic activity. To accommodate the increased blood flow, blood vessels, particularly arterioles, dilate in active muscles. This vasodilation helps optimize oxygen delivery and manage body temperature through heat dissipation. Muscle contractions during physical activity compress veins, aiding in the return of blood to the heart. This "muscle pump" effect is critical for maintaining circulation, especially during prolonged exercise. Regular physical activity induces beneficial changes in the circulatory system, collectively known as cardiovascular adaptations. These changes improve the efficiency and capacity of the system, reducing the risk of diseases [15,16].

Cardiac Adaptations

The human heart, a muscular organ at the core of the circulatory system, has a remarkable ability to adapt to varying physiological demands. One of the most profound influences on cardiac function and structure is regular physical activity. These adaptations, collectively known as **cardiac adaptations**, reflect the heart's capacity to become more efficient and resilient through exercise. Understanding these changes not only highlights the benefits of an active lifestyle but also explains how the heart supports athletic performance and overall cardiovascular health [17,18]. The human heart, a muscular organ at the core of the circulatory system, has a remarkable ability to adapt to varying physiological demands. One of the most profound influences on cardiac function and structure is regular physical activity. These adaptations, collectively known as **cardiac adaptations**, reflect the heart's capacity to become more efficient and resilient through exercise. Understanding these changes not only highlights the benefits of an active lifestyle but also explains how the heart supports athletic performance and overall cardiovascular health. Exercise, particularly endurance activities, causes the heart's left ventricle to enlarge and its walls to thicken, enabling it to pump more blood per beat (increased stroke volume). Enhanced cardiac efficiency reduces the need for a high resting heart rate, as the heart pumps more blood with fewer beats. Regular exercise promotes the release of nitric oxide, a molecule that improves blood vessel dilation and reduces the risk of atherosclerosis. The formation of new capillaries (angiogenesis) in muscles and other tissues enhances oxygen and nutrient delivery. Exercise helps regulate blood pressure by reducing arterial stiffness and improving the balance of the autonomic nervous system [19,20]. This effect is particularly pronounced in individuals with hypertension. Physical activity increases levels of high-density

DOI: 10.5281/zenodo.14274214

lipoprotein (HDL, the "good" cholesterol) and decreases low-density lipoprotein (LDL, the "bad" cholesterol), reducing the risk of plaque buildup in arteries. Different forms of exercise induce specific cardiac adaptations due to the varied demands they place on the cardiovascular system. These include: Aerobic activities like running, cycling, or swimming involve prolonged and rhythmic movements that increase oxygen demand. The heart adapts to these activities through **increased Stroke Volume**. The amount of blood pumped per beat increases, allowing the heart to circulate more blood with fewer beats. Another is **Eccentric Hypertrophy**. The heart's chambers, particularly the left ventricle, enlarge to accommodate a greater volume of blood, a process known as **cardiac remodeling**. **Lower Resting Heart Rate** is siginificaly observed in professional sportmens bodies. In some situation the rate at the level of 40-42 was checked. Enhanced efficiency reduces the need for frequent beats, even during rest. **Anaerobic (strength) exercise** like weightlifting or sprinting involve short bursts of high-intensity effort, requiring the heart to generate rapid responses. The adaptations include **Concentric Hypertrophy**. The walls of the left ventricle thicken to handle increased pressure during exertion. Also, **Improved Contractility**: The heart's ability to contract forcefully improves, ensuring adequate blood flow under high pressure. Mixed excercise, sports such as soccer, basketball, or tennis combine endurance and strength components, leading to a blend of the above adaptations [21,22,23].

Exercise and Blood Components

Physical activity induces immediate changes in blood composition as the body adapts to increased energy and oxygen demands. Inside short-term effects at first comes **hemoconcentration.** During exercise, plasma volume decreases due to fluid loss through sweating and shifts of water from blood to interstitial and intracellular spaces. This temporary reduction in plasma volume increases the concentration of red blood cells, hemoglobin, and other blood components, improving oxygen delivery to muscles. The second is **increased red blood cell deformability.** Physical activity enhances the flexibility of red blood cells, allowing them to navigate narrow capillaries more efficiently. This improves oxygen delivery to tissues, especially during high-intensity exercise. In parts of immuno-system main role plays **leukocyte mobilization.** Exercise stimulates the release of white blood cells into circulation, particularly neutrophils and lymphocytes, as part of the body's stress response. This transient increase in leukocytes supports immune surveillance and repair processes. Exercise can temporarily increase platelet activity, promoting clot formation to prevent bleeding in case of injury. However, this effect is regulated to avoid excessive clotting [24,25,26].

Health Benefits of Exercise on the Circulatory System

The circulatory system, comprising the heart, blood vessels, and blood, plays a critical role in maintaining the body's overall health by transporting oxygen, nutrients, and waste products. Exercise is one of the most effective ways to enhance the efficiency and resilience of this vital system [27,28]. Regular physical activity not only strengthens the heart but also improves vascular function and blood composition, offering a wide array of health benefits. In this article, we explore the profound and multifaceted impact of exercise on the circulatory system. Regular physical activity lowers the likelihood of conditions like coronary artery disease, heart attack, and stroke. Exercise helps maintain a healthy weight, reducing strain on the heart and blood vessels. Physical activity enhances the body's ability to use glucose, reducing the risk of diabetes, a major contributor to cardiovascular disease. Exercise reduces stress hormones like cortisol, indirectly benefiting blood pressure and heart health. Exercise is a cornerstone of circulatory health, offering benefits that range from a stronger heart to better blood composition and enhanced vascular function. By incorporating regular physical activity into your routine, you can significantly reduce the risk of cardiovascular diseases, improve overall circulation, and enhance your quality of life [29]. Whether it's a brisk walk, a swim, or a weightlifting session, every bit of movement contributes to a healthier circulatory system. In contrast to the benefits of exercise, a sedentary lifestyle poses significant risks to the circulatory system. Lack of physical activity contributes to decreased cardiac efficiency, poor vascular health, including reduced nitric oxide production, increased risk of blood clots and chronic diseases such as hypertension and atherosclerosis.

Conclusion

Physical activity has profound and wide-ranging effects on the circulatory system. By improving heart function, blood vessel health, and overall circulation, exercise acts as a powerful tool in preventing and managing cardiovascular diseases. Both immediate and long-term adaptations underscore the importance of regular movement for maintaining a healthy circulatory system. Whether through aerobic exercises, strength training, or a mix of both, staying active is one of the best ways to ensure the circulatory system functions optimally throughout life. Physical activity has a profound impact on the circulatory system, improving its efficiency, resilience, and overall health. The circulatory system, which includes the heart, blood vessels, and blood, is essential for transporting oxygen, nutrients, and waste products throughout the body. Exercise prompts immediate responses in this system and, over time, leads to long-term adaptations that benefit cardiovascular health.

During physical activity, the heart pumps faster and stronger to meet the increased oxygen demand of working muscles. This elevated workload improves cardiac output—the amount of blood the heart pumps per minute—and enhances oxygen delivery to tissues. Blood vessels expand (vasodilation) to improve circulation, and red blood cells become more effective in delivering oxygen. These acute responses prepare the body for increased activity and lay the groundwork for long-term improvements [30,31].

With regular exercise, the heart undergoes structural and functional adaptations, such as increased size and strength, which allow it to pump more blood with each beat (increased stroke volume). Resting heart rate decreases as the heart becomes more efficient. Blood vessels also adapt by becoming more flexible and efficient, reducing arterial stiffness and improving blood pressure regulation. Additionally, exercise stimulates the production of red blood cells, increases plasma volume, and improves the balance of cholesterol in the blood.

Physical activity also lowers the risk of cardiovascular diseases by reducing blood pressure, preventing the buildup of arterial plaques, and enhancing blood flow. It helps regulate platelet activity, reducing the likelihood of blood clots, and supports the immune system by improving the movement of white blood cells.

Different types of exercise—such as aerobic activities, strength training, and flexibility exercises—offer unique benefits to the circulatory system. Aerobic activities improve endurance and heart health, while strength training enhances vascular function and

DOI: 10.5281/zenodo.14274214

blood pressure regulation. Flexibility exercises reduce stress, indirectly benefiting circulation.

Overall, regular physical activity is crucial for maintaining a healthy circulatory system, reducing the risk of chronic diseases, and enhancing quality of life. It underscores the importance of an active lifestyle for long-term cardiovascular health and well-being [32,33].

References

1. Chomiuk, T., Folga, A., Wełnicki, M., Śliż, D., & Mamcarz, A. (2015). The effect of systematic physical exercise limited by pulse on circulatory system parameters and adrenergic activity in the elderly. Polish Journal of Sports Medicine, 31(1).
2. Erdem Eyuboglu, F. (2023). Circulatory System and Its Adaptation to Exercise. In Functional Exercise Anatomy and Physiology for Physiotherapists (pp. 447-471). Cham: Springer International Publishing.
3. Golbidi, S., & Laher, I. (2012). Exercise and the cardiovascular system. Cardiology research and practice, 2012(1), 210852.
4. Kim, J. H. (2022). Heart and circulatory system. In Recent Advancements in Microbial Diversity (pp. 229-254). Academic Press.
5. Elgazzar, A. H., Alenezi, S. A., & Elfawal, M. A. (2022). Circulatory System (Cardiovascular and Lymphatic Systems). The Pathophysiologic Basis of Nuclear Medicine, 323-383.
6. El Assar, M., Álvarez-Bustos, A., Sosa, P., Angulo, J., & Rodríguez-Mañas, L. (2022). Effect of physical activity/exercise on oxidative stress and inflammation in muscle and vascular aging. International Journal of Molecular Sciences, 23(15), 8713.
7. Winzer, E. B., Woitek, F., & Linke, A. (2018). Physical activity in the prevention and treatment of coronary artery disease. Journal of the American Heart Association, 7(4), e007725.
8. Ford, E. S., Greenlund, K. J., & Hong, Y. (2012). Ideal cardiovascular health and mortality from all causes and diseases of the circulatory system among adults in the United States. circulation, 125(8), 987-995.
9. Popek, A. (2024) Revolutionizing Health Care. The Impact of Emerging Technologies. Journal of Arts, Humanities and Social Sciences, 2(6), 117-121.
10. Marinus, N., Hansen, D., Feys, P., Meesen, R., Timmermans, A., & Spildooren, J. (2019). The impact of different types of exercise training on peripheral blood brain-derived neurotrophic factor concentrations in older adults: a meta-analysis. Sports medicine, 49, 1529-1546.
11. Mazic, S., Lazic, J. S., Dekleva, M., Antic, M., Soldatovic, I., Djelic, M., ... & Suzic, S. (2015). The impact of elevated blood pressure on exercise capacity in elite athletes. International journal of cardiology, 180, 171-177.
12. Zada, F. S. M., Naseri, K., & Zalmai, M. R. (2024). Effects of exercise training on blood circulation system. Sprin Journal of Arts, Humanities and Social Sciences, 3(5), 87-90.
13. Soares-Miranda, L., Siscovick, D. S., Psaty, B. M., Longstreth Jr, W. T., & Mozaffarian, D. (2016). Physical activity and risk of coronary heart disease and stroke in older adults: the cardiovascular health study. Circulation, 133(2), 147-155.
14. Piercy, K. L., & Troiano, R. P. (2018). Physical activity guidelines for Americans from the US department of health and human services: Cardiovascular benefits and recommendations. Circulation: Cardiovascular Quality and Outcomes, 11(11), e005263.
15. Florido, R., Kwak, L., Lazo, M., Nambi, V., Ahmed, H. M., Hegde, S. M., ... & Ndumele, C. E. (2018). Six-year changes in physical activity and the risk of incident heart failure: ARIC study. Circulation, 137(20), 2142-2151.
16. Perry, A. S., Dooley, E. E., Master, H., Spartano, N. L., Brittain, E. L., & Pettee Gabriel, K. (2023). Physical activity over the lifecourse and cardiovascular disease. Circulation Research, 132(12), 1725-1740.
17. Obeagu, E. I., Obeagu, G. U., & Odo, E. (2016). A Review on exercise and blood cells. Int. J. Adv. Multidiscip. Res, 3(11), 70-75.
18. Sun, J., & Song, X. (2018, October). Effects of clothing pressure on blood circulation during gymnastics sport. In 2018 9th International Conference on Information Technology in Medicine and Education (ITME) (pp. 780-784). IEEE.
19. Nystoriak, M. A., & Bhatnagar, A. (2018). Cardiovascular effects and benefits of exercise. Frontiers in cardiovascular medicine, 5, 408204.
20. Erdem Eyuboglu, F. (2023). Circulatory System and Its Adaptation to Exercise. In Functional Exercise Anatomy and Physiology for Physiotherapists (pp. 447-471). Cham: Springer International Publishing.
21. Ruegsegger, G. N., & Booth, F. W. (2018). Health benefits of exercise. Cold Spring Harbor perspectives in medicine, 8(7), a029694.
22. Green, D. J., & Smith, K. J. (2018). Effects of exercise on vascular function, structure, and health in humans. Cold Spring Harbor perspectives in medicine, 8(4), a029819.
23. Kramer, A. (2020). An overview of the beneficial effects of exercise on health and performance. Physical Exercise for Human Health, 3-22.
24. Kümmel J, Kramer A, Giboin L-S, Gruber M (2016) Specificity of balance training in healthy individuals: a systematic review and meta-analysis. Sports Med 46(9):1261–1271
25. MacInnis MJ, Gibala MJ (2017) Physiological adaptations to interval training and the role of exercise intensity. J Physiol 595(9):2915–2930
26. Serman, T. (2022). Influence of Respiratory Exercises on the Functional State of the Cardiovascular System Under Different Physical Activities of Students. Journal of Vasyl Stefanyk Precarpathian National University, 9(1), 219-226.
27. Valenzuela, P. L., Ruilope, L. M., Santos-Lozano, A., Wilhelm, M., Kränkel, N., Fiuza-Luces, C., & Lucia, A. (2023). Exercise benefits in cardiovascular diseases:

DOI: 10.5281/zenodo.14274214

from mechanisms to clinical implementation. European Heart Journal, 44(21), 1874-1889.

28. Kumboyono, K., Chomsy, I. N., Firdaus, D. H., Setiawan, M., & Wihastuti, T. A. (2022). Protective cardiovascular benefits of exercise training as measured by circulating endothelial cells and high-density lipoprotein in adults. Journal of Taibah University Medical Sciences, 17(4), 701-706.
29. Conti, A. A., & Macchi, C. (2013). Protective effects of regular physical activity on human vascular system. La Clinica Terapeutica, 164(4), 293-294.
30. Franklin, B. A., Rusia, A., Haskin-Popp, C., & Tawney, A. (2021). Chronic stress, exercise and cardiovascular disease: placing the benefits and risks of physical activity into perspective. International journal of environmental research and public health, 18(18), 9922.
31. Segreti, A., Celeski, M., Guerra, E., Crispino, S. P., Vespasiano, F., Buzzelli, L., ... & Grigioni, F. (2024). Effects of Environmental Conditions on Athlete's Cardiovascular System. Journal of Clinical Medicine, 13(16), 4961.
32. Haferanke, J., Baumgartner, L., Willinger, L., Schulz, T., Mühlbauer, F., Engl, T., ... & Oberhoffer-Fritz, R. (2024). The MuCAYAplus Study—Influence of Physical Activity and Metabolic Parameters on the Structure and Function of the Cardiovascular System in Young Athletes. CJC Open.
33. Sari, L. P., Santosa, H., & Kuan, G. (2024). The Effect of Physical Activity on the Prevention of Degenerative Diseases of the Cardiovascular System. Window of Health: Jurnal Kesehatan, 310-319.

DOI: 10.5281/zenodo.14274214