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THE IMPACT OF OBESITY ON CARDIOVASCULAR RISK. REVIEW OF THE LITERATURE

Ewa Wieczorkiewicz *(Corresponding Author, Email: ewa.wieczorkiewicz96@gmail.com)*
Medical University of Lublin, Lublin, Poland
ORCID ID: 0009-0009-9828-1456

Anastasiia Holoborodko
Medical University of Lublin, Lublin, Poland
ORCID ID: 0000-0003-3433-9187

Eliza Garbacz
Jan Kochanowski University, Kielce, Poland
ORCID ID: 0009-0009-2647-5884

Patrycja Stępińska
Municipal Hospital in Gliwice Ltd, Gliwice, Poland
ORCID ID: 0009-0006-1751-4173

Agnieszka Pocheć
Jan Kochanowski University, Kielce, Poland
ORCID ID: 0009-0009-0258-8032

Bartosz Lautenbach
Antoni Jurasz University Hospital No. 1 in Bydgoszcz, Bydgoszcz, Poland
ORCID ID: 0009-0002-8008-156X

Dariusz Nędza
Regional Hospital No. 3 in Rybnik, Rybnik, Poland
ORCID ID: 0009-0003-6220-2214

Klaudia Wojciech
Medical University of Silesia in Katowice, Katowice, Poland
ORCID ID: 0009-0008-8755-6461

Anhelina Loputs
University Hospital in Wrocław, Wrocław, Poland
ORCID ID: 0009-0008-0002-2126

Wiktoria Błaszczyk
Andrzej Frycz Modrzewski Cracow University, Cracow, Poland
ORCID ID: 0009-0000-6340-7957

ABSTRACT

Background: Obesity is a global health problem due to its increasing prevalence over the past several decades. It is strongly associated with an elevated risk of cardiovascular diseases, both directly through metabolic mechanisms affecting the circulatory system and indirectly through traditional risk factors such as hypertension, dyslipidemia, and type 2 diabetes.
Aim: This review discusses the pathological changes occurring in the cardiovascular system under the influence of obesity. It presents the mechanisms linking obesity with selected cardiovascular diseases and outlines the role of physical activity in obesity.
Methods: The review was conducted using the PubMed, Web of Science and Google Scholar databases, limited to full-text, open-access publications from the years 2013–2025.
Results: As body weight increases, the risk of cardiovascular diseases such as heart failure, hypertension, and arrhythmias also rises. Weight reduction helps lower the risk of developing these disorders. Combined aerobic and resistance training (CART), as well as High-Intensity Interval Training (HIIT), has a beneficial effect on well-being and the condition of the cardiovascular system.
Conclusion: Obesity and the metabolic disturbances it causes are strongly associated with an increased risk of cardiovascular diseases. Obesity is not only a co-existing factor but also an independent risk factor for cardiovascular conditions. Effective intervention requires an individual approach.

KEYWORDS

Obesity, Cardiovascular Risk, Cardiovascular Diseases, Physical Activity, Cardiovascular Health

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Introduction

Obesity is a complex metabolic disease and currently represents a global health issue. The prevalence of obesity is increasing even in the pediatric population, which may ultimately contribute to a higher risk of cardiovascular diseases in adulthood. (Powell-Wiley et al. 2021) According to WHO data, in 2022, obesity among adults worldwide had more than doubled since 1990 and obesity among teenagers had increased fourfold. (Phelps Nowell et al. 2024) Obesity plays an important role in the pathogenesis of many cardiovascular diseases. It is a major risk factor for several chronic diseases such as type 2 diabetes, hypertension, dyslipidemia, sleep disorders, chronic kidney disease, and certain types of cancer. (Welsh et al. 2024; Powell-Wiley et al. 2021)

The Body Mass Index (BMI) is the most commonly used measure to assess the degree of obesity. However, it does not provide information about fat distribution, which is crucial when evaluating cardiovascular risk. (Csige et al. 2018) To better characterize the type of obesity (abdominal, central), additional indicators have been introduced, such as waist circumference and the waist-to-hip ratio. Waist circumference is a reliable marker of obesity. Elevated values, even in individuals with normal body weight, may indicate a higher risk of cardiovascular events. It is also a predictive factor for mortality. (Piché et al. 2018; Sahakyan et al. 2015) Another indicator used to assess obesity is the waist-to-hip ratio (WHR). It has been shown that WHR predicts cardiovascular mortality independently of BMI. According to data from the National Health and Nutrition Examination Survey (NHANES), individuals in the U.S. population with a WHR indicating central obesity had a higher risk of cardiovascular mortality compared with individuals of the same BMI but without central obesity. (Sahakyan et al. 2015; Coutinho et al. 2013)

Aim of the publication

This review analyzes the complex interaction between obesity and cardiovascular diseases. It discusses the pathological changes occurring in the cardiovascular system in the course of obesity. The mechanisms linking obesity with cardiovascular diseases are presented, with particular emphasis on heart failure, atrial fibrillation, and hypertension. The role of physical activity in reducing cardiovascular risk in obesity is also discussed.

Methodology

A literature review was conducted to examine the current state of knowledge regarding the relationship between obesity and cardiovascular risk, the impact of obesity on the course of selected cardiovascular diseases and the role of physical activity in reducing cardiovascular risk in individuals with obesity. Relevant publications were searched using the PubMed, Web of Science and Google Scholar databases. The review includes literature published between 2013 and 2025. In our review, we used the full-text and open-access articles. Search terms included: "obesity and cardiovascular diseases," "obesity and cardiovascular risk," "obesity and heart failure," "obesity and atrial fibrillation," "obesity and hypertension" and "role of physical activity in obesity." This review is based on various systematic reviews, meta-analyses, randomized controlled trials, prospective cohort studies and several additional studies to present a comprehensive overview of current knowledge concerning obesity and its association with cardiovascular diseases.

Pathophysiological changes in obesity

Obesity induces pathophysiological changes in numerous organs, which are associated with metabolic disorders and various diseases. The increased risk of cardiovascular diseases results from excessive accumulation of adipose tissue in the myocardium and blood vessels, leading to structural and functional pathological alterations. Obesity contributes to the development of cardiovascular conditions both directly and indirectly. On one hand, individuals with obesity experience enlargement of tissues and organs. On the other hand, obesity serves as a risk factor for other conditions such as hypertension, atherosclerosis, dyslipidemia, and sleep apnea. (Elagizi et al., 2020)

Adipose tissue is an active endocrine organ capable of synthesizing and releasing into the circulation a variety of biologically active molecules known as adipokines. These include numerous hormones, chemokines, and cytokines. Obesity increases the production of pro-inflammatory adipokines, leading to endothelial dysfunction. These involve: tumor necrosis factor-α, interleukin-6, interleukin-18 and resistin. (Oikonomou & Antoniades, 2019; Carbone et al., 2017) A relationship has been shown between elevated levels of C-reactive protein (CRP)- produced in the liver and increased interleukin-6 levels, which is produced by adipose tissue. (Araiza-Garaygordobil et al., 2024) There are also adipokines with anti-inflammatory properties, such as adiponectin. It shows an inverse association with cardiovascular diseases. In individuals with obesity, adiponectin levels are reduced, which is linked to a higher risk of cardiovascular events. (Landecho et al., 2019) Chronic inflammation, endothelial dysfunction and remodeling of small blood vessels develop in the course of severe obesity. All of which contribute to metabolic disorders and cardiovascular diseases such as hypertension, atherosclerosis, coronary artery disease, arrhythmias, cardiomyopathies, and heart failure. (Welsh et al., 2024; Khanna et al., 2022; Powell-Wiley et al, 2021)

Obesity leads to structural and functional changes in the heart and vascular system, causing disturbances in myocardial and circulatory function. The accumulation of excessive adipose tissue increases blood volume and cardiac output. The rise of blood volume contributes to ventricular overload, which elevates wall tension and subsequently causes ventricular dilation. Obesity also contributes to elevated arterial blood pressure through activation of the renin–angiotensin–aldosterone system (RAAs) and the sympathetic nervous system. (Gallo et al., 2024; Csige et al., 2018) Hypertension increases the afterload of the left ventricle, raising the risk of structural cardiac remodeling. Left ventricular hypertrophy (LVH) and dilation are the most common outcomes, ultimately leading to diastolic dysfunction and later systolic dysfunction. (Alpert et al., 2016; Lavie et al., 2014) Elevated aldosterone levels due to activation of the renin–angiotensin–aldosterone system, along with accumulated adipose tissue in the myocardium, may promote interstitial cardiac fibrosis over time and contribute to the development of left ventricular diastolic dysfunction (LVDD) and heart failure. Comorbidities frequently associated with obesity—such as obstructive sleep apnea and hypoventilation syndrome—can lead to the development of pulmonary hypertension and right-sided heart failure. (Csige et al., 2018) All pathomechanisms described above are presented in Figure 1.

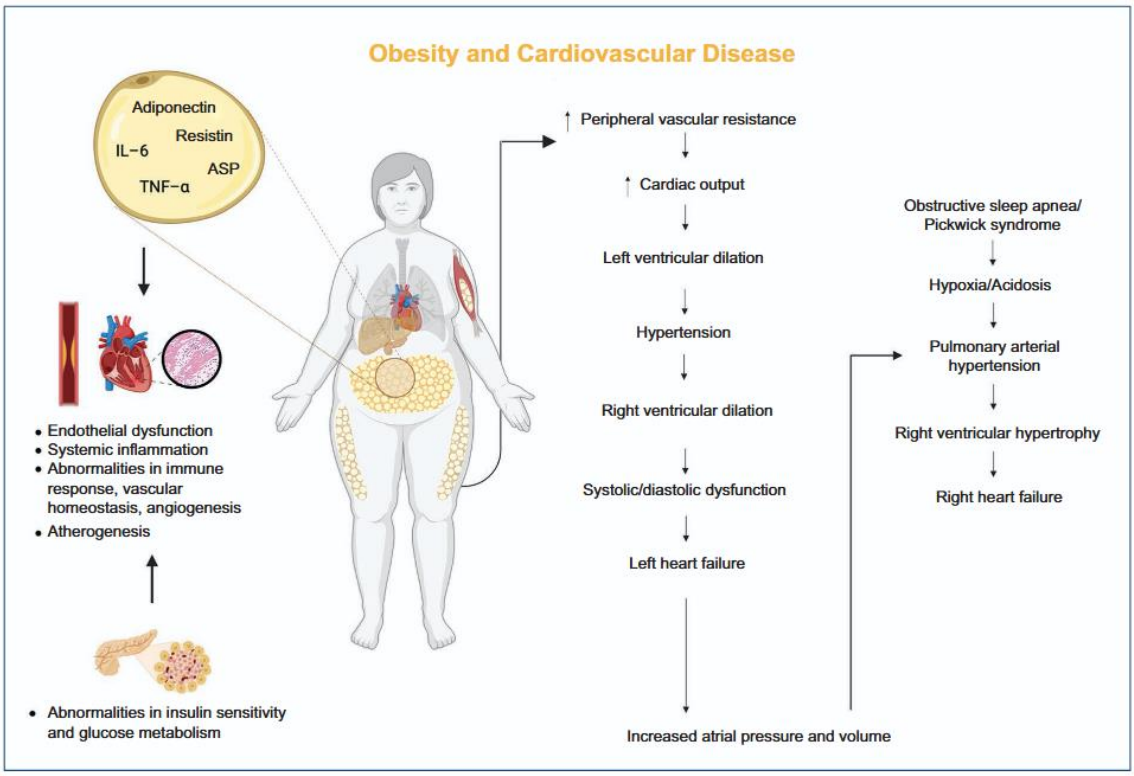

Fig. 1. *Pathophysiological changes in the cardiovascular system caused by obesity.*

Source: Araiza-Garaygordobil D et al. (2024), Obesity and cardiovascular risk: a primer for the clinician, *Arch Cardiol Mex. 95(1)*: 71, https://doi.org/10.24875/acm.24000123

TNF-α- tumor necrosis factor-α; IL-6- interleukin-6; ASP- Acylation-Stimulating Protein

Results

Numerous studies have demonstrated a link between obesity and cardiovascular diseases. Individuals with obesity— even in the absence of other comorbid conditions—have a significantly higher risk of developing type 2 diabetes, atherosclerosis, heart failure, respiratory diseases and overall mortality compared with individuals without obesity. (Araiza-Garaygordobil et al., 2024; Zhou et al., 2021) The following sections of this review discuss the relationship between obesity and specific cardiovascular diseases: heart failure, atrial fibrillation and arterial hypertension.

The relationship between obesity and heart failure

Globally, approximately 65 million new cases of heart failure (HF) have been reported and the 5-year mortality rate following diagnosis still exceeds 50%. (Oguntade et al., 2023) Numerous studies have demonstrated an increased risk of developing heart failure with increasing body weight. Data from the Framingham Heart Study indicate that the risk of developing heart failure increases by 5% in men and 7% in women for every 1-unit rise in BMI after accounting for other factors such as: demographics, myocardial infarction risk factors, hypertension and diabetes. The risk of heart failure increased across the entire spectrum of BMI. (Powell-Wiley et al., 2021) A meta-analysis, conducted by Oguntade A.S. et al. in 2023, evaluated the relationship between body composition measurements and the risk of developing heart failure and its subtypes. The analysis included over 1 million participants. Various measures of body composition were assessed, including BMI, waist circumference (WC) and the waist-to-hip ratio (WHR). The collected data demonstrated an approximately linear relationship between body composition measurements and the risk of heart failure. Above the thresholds of BMI 24 kg/m², 90 cm WC or 0.9 WHR, the risk of heart failure increased in a log-linear manner. Furthermore, the study shows that heart failure with preserved ejection fraction (HFpEF) has a stronger association with obesity than heart failure with reduced ejection fraction (HFrEF). This difference may reflect other pathophysiological mechanisms. (Oguntade et al., 2023) Another study demonstrated a relationship between the duration of obesity and the incidence of heart failure. After 20 years of obesity, the incidence of heart failure increases by 70%, while after 30 years it rises by 90%. (Csige et al., 2018).

Obesity may coexist with other chronic conditions such as diabetes, hypertension and dyslipidemia, all of which play important roles in the pathogenesis and progression of heart failure. Obesity combined with metabolic disorders can lead to impaired cardiac function and the advancement of heart failure. A meta-analysis conducted by Wang X. et al. in 2022 which included over 8 million participants, examined the impact of obesity and metabolic health on the risk of developing heart failure. Based on the collected data, it was found that obese individuals have approximately a 52% higher risk of heart failure, even if they are metabolically healthy. The analysis also showed that overweight and obese participants with additional metabolic disorders have a 75% and 128% higher risk of heart failure compared to individuals who have normal body weight and are metabolically healthy. (Wang et al., 2022)

The relationship between obesity and atrial fibrillation

Atrial fibrillation (AF) is the most common cardiac arrhythmia, affecting 33.5 million people worldwide. Due to the increasingly aging population, it is estimated that by the year 2060 the prevalence of atrial fibrillation will double. (Jones et al., 2019) Obesity induces structural and functional changes in the myocardium which promote the development of various cardiac arrhythmias. It leads to an increase in epicardial adipose tissue, atrial enlargement, interstitial atrial fibrosis and impaired diastolic function of the heart. Structural remodeling of the atria disrupts atrial electrophysiology and leads to heterogeneous conduction in their area. In consequence may develop cardiac arrhythmias such as atrial fibrillation. (Aune et al., 2017; Sahakyan et al., 2015)

Many studies have shown that obesity is strongly associated with an increased risk of atrial fibrillation. Individuals with obesity have a 1,52 higher risk of developing atrial fibrillation compared to persons with normal body weight. Additionally, it has been demonstrated that each 1-unit increase in BMI raises the incidence of newly developed atrial fibrillation by 4%. (Elagizi et al., 2020; Csige et al., 2018) Another study reported that the risk of atrial fibrillation increases by 3% to 8% for each 1-unit rise in BMI, independently of other cardiovascular risk factors. (Oguntade et al., 2023) A meta-analysis conducted by Aune D. et al. in 2017, evaluated multiple measures of obesity in relation to the risk of atrial fibrillation. This study included over 2 million participants. All analyzed indicators of obesity were associated with an increased risk of atrial fibrillation. The study reported a 28% increase in relative risk for every 5-unit rise in BMI, an 18% increase for every 10-cm increase in waist circumference (WC) and 9% increase for every 0.1-unit rise in waist-to-hip ratio (WHR). The analysis also indicated that being relatively lean—based on BMI, waist circumference and other obesity measures—may be associated with the lowest risk of atrial fibrillation. (Aune et al., 2017) On the other hand, studies have demonstrated that weight reduction can decrease the risk of developing atrial fibrillation. Berkovitch and colleagues, using a multivariable Cox regression analysis, found that each 1-kg/m² decrease in BMI was associated with a significant 7% reduction in the risk of recurrence of a first episode of atrial fibrillation. (Berkovitch et al., 2016) A meta-analysis conducted by Zheng Y. et al. in 2021, evaluated the association between metabolic syndrome and its individual components and the risk of atrial fibrillation. The analysis showed that patients with metabolic syndrome were exposed to a higher risk of atrial fibrillation than individuals without metabolic syndrome. (Zheng et al., 2021)

The relationship between obesity and hypertension

Hypertension is the most common chronic disease in the world, involving approximately one-third of the adult population. (Hall et al., 2015) Obesity is a major cause of hypertension which accounts for 65–75% of the risk of developing primary hypertension. (Welsh et al., 2024; Cunha, 2023) In the course of obesity, a range of cardiovascular, renal and metabolic disorders occurs, promoting the development of arterial hypertension. As previously described, the increase in blood pressure is a consequence of activation of the renin–angiotensin–aldosterone system and stimulation of the sympathetic nervous system. (Gallo et al., 2024; Csige et al., 2018) In addition, excess adipose tissue exerts mechanical pressure on the kidneys, leading to increased intrarenal pressure and impaired natriuresis. Chronic obesity may also cause kidney damage, which in the long term increases the risk of developing chronic kidney disease. (Welsh et al., 2024)

Studies conducted in various populations worldwide have shown an almost linear relationship between BMI and both systolic and diastolic blood pressure. In the Framingham Heart Study, it was estimated that 78% of cases of primary (essential) hypertension in men and 65% of cases in women could be attributed to excessive weight gain. (Cunha, 2023) Given the aforementioned pathophysiological mechanisms induced by obesity, which have negative consequences, weight loss in obese individuals is important. Research has shown that maintaining a BMI below 25 kg/m² is effective in the primary prevention of hypertension and weight reduction lowers blood pressure in patients with hypertension. (Cunha, 2023)

The role of physical activity in obesity

Physical activity is one of the best ways to improve health quality. It positively affects overall well-being, the condition of the cardiovascular system and enhances cardiorespiratory fitness. (Ozemek et al. 2018) According to the European Guidelines for obese individuals, it is recommended to engage in at least 150 minutes per week of moderate-intensity aerobic exercise (such as brisk walking) and three sessions of resistance training per week. Performing exercises in this combination has a beneficial effect on the long-term maintenance of reduced body weight as well as on reducing anxiety and symptoms of depression. (Yumuk et al. 2015)

Numerous studies have shown that the type of physical training influences the reduction of cardiovascular disease risk in individuals with obesity. In 2024, Lee D.C. et al. conducted a randomized controlled trial to evaluate the effectiveness of different types of physical exercise (resistance, aerobic and combined aerobic-resistance training) on cardiovascular disease risk profiles. The exercise programs had little or no effect on weight loss. The study demonstrated that in adults with overweight or obesity, aerobic exercise alone or a combination of aerobic and resistance training improved cardiovascular risk profiles compared to the control group. This effect was not observed in individuals performing resistance training only. (Lee et al. 2024) A meta-analysis by Al-Mhanna S.B. et al., conducted in 2024, evaluated the impact of combined aerobic and resistance training (CART) on the control of parameters such as: blood glucose levels, blood pressure, cardiorespiratory fitness and quality of life in individuals with overweight or obesity and type 2 diabetes. The study showed that CART positively influences glycemic profile, blood pressure and improves the quality of life of these patients. CART leads to a reduction in diastolic blood pressure (DBP) without changes in systolic blood pressure (SBP) and resting heart rate (RHR). (Al-Mhanna et al. 2024) The benefits of CART on these parameters and the improvement in cardiovascular fitness result from the different effects of both types of training. (Al-Mhanna et al. 2024) Aerobic exercise improves cardiac output, vascular and endothelial function, while resistance training improves blood pressure regulation, arterial stiffness and increases muscle strength. (Lee et al. 2024; Al-Mhanna et al. 2022) These findings have also been confirmed in pediatric populations. Chen T. et al. reported that aerobic and resistance exercises significantly improve physical indicators and most cardiovascular risk factors in school-aged children with obesity or overweight. (Chen et al. 2021)

A randomized controlled trial conducted in 2023 by Ahmad A.M. et al. showed that high-intensity interval training (HIIT) can be considered an alternative option to combined aerobic and resistance training (CART). HIIT involves alternating short bouts of intense exercise with brief periods of rest. Similar to CART, HIIT can effectively reduce blood pressure in overweight or obese individuals with type 2 diabetes. (Ahmad et al. 2023)

Discussion

Based on the data collected in this article, a strong relationship has been demonstrated between obesity and cardiovascular diseases. Numerous studies have assessed the impact of obesity on cardiovascular risk, obtaining relatively consistent results. As body composition indicators (BMI, waist circumference, waist-to-hip ratio) increase, the risk of heart failure also rises. (Oguntade et al. 2023; Powell-Wiley et al. 2021) The potential mechanisms linking obesity with an increased risk of heart failure are associated with structural and hemodynamic changes in the myocardium. Adipose tissue may lead to increased cardiac output and stroke volume, causing left ventricular hypertrophy and overload, which promote the development of heart failure and arterial hypertension. (Wilner et al. 2017; Alpert et al. 2014) It has also been shown that obesity is more strongly associated with heart failure with preserved ejection fraction (HFpEF) than with heart failure with reduced ejection fraction (HFrEF). This may be caused by different pathophysiological mechanisms. (Oguntade et al. 2023) Additional metabolic disorders in individuals with obesity further increase the risk of developing heart failure and atrial fibrillation. (Wang et al. 2022; Zheng et al. 2021) Many studies demonstrated that obesity, through structural remodeling of the atria and heterogeneous conduction in their area, promotes the development of arrhythmias. Numerous studies and meta-analyses have shown that as BMI increases, the incidence of newly developed atrial fibrillation rises. (Oguntade et al. 2023; Elagizi et al. 2020; Csige et al. 2018) Similar findings have been reported regarding the relationship between obesity and arterial hypertension. As BMI increases, both systolic and diastolic blood pressure rise. (Hall et al. 2015) One study showed that 78% of hypertension cases in men and 65% in women may be attributable to excessive weight gain. (Hall et al. 2015) On the other hand, several studies have shown that weight loss can lower the risk of developing hypertension and atrial fibrillation, as well as improve the functional status of patients with heart failure. (Berkovitch et al. 2016; Hall et al. 2015)

Given the strong association between obesity and cardiovascular diseases, physical activity plays an important role in reducing cardiovascular risk among individuals with obesity. Numerous studies have demonstrated that a combination of aerobic and resistance exercises provides the greatest benefits for obese individuals. (Al-Mhanna et al. 2024; Lee et al. 2024; Chen et al. 2021; Yumuk et al. 2015) Performing exercises in this combination leads to a reduction in visceral fat, an increase in muscle and bone mass, a decrease in blood pressure and improvements in glucose tolerance and lipid profile. (Yumuk et al. 2015; You et al. 2013) It may also reduce symptoms of anxiety and depression. (Yumuk et al. 2015) High-intensity interval training (HIIT) can be an alternative option to combined aerobic and resistance training (CART). (Ahmad et al. 2023)

However, the studies presented in this article have certain limitations. The first is heterogeneity: each study included different patient groups in terms of age, socioeconomic status and lifestyle. It is also necessary to consider the presence of comorbidities and other cardiovascular risk factors in these patients, which may have influenced the final results. Another factor was the various definitions of metabolic syndrome. (Wang et al. 2022; Zheng et al. 2021) In many studies presented, the degree of overweight and obesity was expressed using the Body Mass Index (BMI) which does not reflect fat distribution. Only two of the included studies used additional obesity indicators—waist circumference and waist-to-hip ratio. (Oguntade AS et al. 2023; Aune et al. 2017)

Conclusions

Obesity and metabolic disorders increase the risk of many cardiovascular diseases and other cardiovascular risk factors. Lifestyle changes, including increased physical activity and weight reduction, can help lower this risk. Therefore, regular examinations are important for early detection and treatment because of the rising prevalence of overweight and obesity among adults. Further research is needed to better understand the pathomechanisms occurring in obesity that affect the cardiovascular system. This would allow for the development of more effective methods for the diagnosis and treatment of obesity.

Disclosure

Author Contributions

Conceptualization: Ewa Wieczorkiewicz

Methodology: Anastasiia Holoborodko, Patrycja Stępińska, Eliza Garbacz

Software: Dariusz Nędza, Bartosz Lautenbach

Formal analysis: Wiktoria Błaszczyk, Agnieszka Pocheć

Investigation: Klaudia Wojciech, Anhelina Loputs

Resources: Wiktoria Błaszczyk, Dariusz Nędza, Bartosz Lautenbach

Data curation/ Check: Anastasiia Holoborodko, Agnieszka Pocheć

Writing- original draft preparation: Ewa Wieczorkiewicz, Anastasiia Holoborodko, Eliza Garbacz

Writing- review and editing: Patrycja Stępińska, Agnieszka Pocheć, Bartosz Lautenbach, Dariusz Nędza, Klaudia Wojciech, Wiktoria Błaszczyk, Anhelina Loputs

Supervision: Ewa Wieczorkiewicz

Visualization: Klaudia Wojciech, Anhelina Loputs

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