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## **Obesity as a civilization threat of the XXI century. The Impact of obesity on individual functions of human organ systems**

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## **ABSTRACT**

### **Introduction**

Over time, obesity has become one of the most serious health problems facing contemporary society, posing a significant threat to public health. With the advancement of civilization and changes in people's lifestyles, obesity rates have increased worldwide, presenting us with challenges in terms of health and social well-being. Obesity, far exceeding a mere issue of physical appearance, carries serious health consequences for both individuals and entire societies. This publication aims to delve into the issue of obesity as a key factor affecting public health in the 21st century. The impact of obesity on individual organ systems will be analyzed, with particular emphasis on its adverse effects on the functioning of these systems.

### **Aim of the study**

This review aims to show the effects of obesity on various systems of the human body. The main goal is to illustrate obesity as a threat to numerous diseases and complications.

### **Material and method**

Literature review was primarily based on scientific materials, English and Polish databases. The following English keywords and its Polish equivalents were used to search Google Scholar and PubMed: "obesity, overweight, fat, weight, illness, lifestyle disease"

**Keywords: obesity, overweight, fat, weight, illness, lifestyle disease**

### **Introduction**

In today's world, obesity poses one of the most significant health challenges that modern society must confront. With the advancement of civilization, changes in dietary habits, and increasingly sedentary lifestyles, the issue of obesity is becoming increasingly pressing for public health worldwide. It is no longer just a matter of aesthetics or individual well-being - obesity carries serious health consequences that affect both individuals and entire societies, presenting the healthcare system with further challenges in terms of public health and well-being [1]. The purpose of this publication is to delve into the issue of obesity as a key factor influencing public

health in the 21st century. The impact of obesity on the individual systems of the human body will be analyzed, with particular emphasis on its adverse effects on the functioning of these systems [2]. By understanding the pathophysiological mechanisms associated with obesity and identifying specific interactions with different systems of the body, we can better grasp the scale of the problem and develop more effective prevention and intervention strategies. Analyzing the interdependence of obesity with the functioning of individual body systems will provide a comprehensive picture of how the body operates and will enable a holistic approach to the issue of obesity, highlighting the need for multifaceted actions to counteract this civilizational threat. Through in-depth scientific analysis, this work contributes to understanding the complex issue of obesity and initiates a discussion on the necessity of coordinated efforts to reduce its adverse impact on public health [1,3].

### **Definition, classification, symptoms and risks of obesity**

Obesity is a condition in which the body accumulates excess fat tissue, leading to an increase in body weight above values considered normal for the individual's height and age. It is a state where the body mass index (BMI), calculated as the ratio of body weight (in kilograms) to the square of height (in meters), is 30 or higher. The classification of obesity includes: Obesity Grade I: BMI 30-34.9. Obesity Grade II: BMI 35-39.9. Obesity Grade III (extreme obesity): BMI 40 or higher. The diagnosis of obesity is based on measuring body weight and height and calculating the body mass index (BMI) [1,4]. Additionally, a doctor may conduct additional tests, such as measuring waist circumference or body composition analysis, to assess the degree of obesity and evaluate the risk of health complications [5].

Obesity can lead to many serious health consequences. One of them is an increased risk of cardiovascular diseases, such as atherosclerosis, hypertension, heart attack, and stroke. There is also often a risk of gastrointestinal diseases, such as fatty liver, gallstones, and gastroesophageal reflux disease, as well as an increased risk of type 2 diabetes associated with insulin resistance, worsening of the hormonal system, which can lead to hormonal disorders, such as polycystic ovary syndrome (PCOS) in women, and increased risk of musculoskeletal diseases, such as arthritis, osteoarthritis, and osteoporosis. An important aspect is also the deterioration of respiratory system health, leading to asthma, chronic obstructive pulmonary disease (COPD), and sleep apnea, or worsening mental health, leading to depression, anxiety disorders, and decreased self-esteem [5,6].

Obesity negatively affects the functioning of the body on many levels. Starting from daily problems such as deterioration in quality of life due to physical limitations, psychological discomfort, and loss of well-being, through an increased risk of inflammation in the body, which can lead to various inflammatory diseases, to disturbances in the body's hormonal balance. The latter mainly entail a series of negative consequences such as insulin resistance, hormonal disorders, and other metabolic complications. A very important aspect is also the burden on the cardiovascular system by raising blood pressure, increasing the risk of heart disease, and stroke [7].

### **The influence of obesity on the nervous system**

Obesity can have a significant impact on the nervous system, leading to various health consequences. Research has shown that obesity may increase the risk of various neurological disorders, such as stroke caused by sudden ischemia or hemorrhage in the brain. Excess body fat leads to inflammation and dysfunction of blood vessels, which can in turn lead to thrombosis and circulatory disturbances in the brain, increasing the risk of stroke [8]. Obesity may be associated with peripheral neuropathy, which manifests as tingling, numbness, pain, or weakness in the limbs. Damage to peripheral nerves may be caused by inflammation, mechanical stress, or metabolic disorders associated with obesity. There is also growing evidence suggesting a link between obesity and the risk of Alzheimer's disease. Excess body fat can lead to inflammation and oxidative stress, which in turn can accelerate the neurodegenerative processes characteristic of this disease [9]. Obesity may increase the risk of multiple sclerosis, an autoimmune disease that attacks the myelin sheaths in the brain and spinal cord. Inflammatory processes and immune disorders associated with obesity may contribute to the development of this disease [10].

These processes can lead to damage to nerve cells and deterioration of cognitive function. Excess body fat can lead to structural and functional changes in the brain, which can affect the ability to perform daily activities. Excess body fat can affect hormone secretion, which in turn can affect the functioning of the nervous system. For example, obesity can lead to insulin resistance and disturbances in insulin secretion, which can affect cognitive function and mood. Obesity is often also associated with a higher risk of depression and other psychiatric disorders, which can affect the functioning of the nervous system. Psychosocial factors associated with obesity, such as social discrimination and lower self-esteem, may be risk factors for psychiatric problems [10,11].

Obesity is often also associated with sleep disorders, such as sleep apnea. During sleep apnea, there are repeated interruptions in breathing, leading to oxygen deprivation in the brain and other tissues. Oxygen deprivation in the brain can lead to memory disturbances, concentration problems, and other neurological issues. Research suggests that obesity may lead to structural changes in the brain, such as reduced brain volume, changes in white matter, and other abnormalities, which can affect cognitive and emotional functions [11,12].

Overall, obesity can increase the risk of various neurological disorders through various mechanisms, including inflammation, metabolic disorders, structural and functional changes in the brain, and psychosocial factors. Therefore, it is important to monitor neurological health in individuals with overweight and obesity and to take appropriate preventive and therapeutic actions to reduce the risk of these disorders [12,13].

### **The impact of obesity on the digestive system**

Obesity can significantly impact the digestive system, leading to various health consequences. This condition is characterized by the excessive accumulation of adipose tissue in the body. Excess fat may deposit around internal organs, including within the abdominal cavity, which can disrupt the functioning of the digestive organs. An excessive amount of adipose tissue can affect hormonal processes related to the digestive system. Obesity may disrupt the secretion of digestive hormones such as insulin, leptin, and ghrelin, affecting appetite, glucose and fat metabolism, and body weight regulation [14].

Furthermore, obesity is associated with a higher risk of many gastrointestinal diseases, such as gastroesophageal reflux disease, pancreatitis, fatty liver disease, gallstones, and non-alcoholic fatty liver disease. Individuals with overweight and obesity often exhibit improper dietary habits, such as consuming high-calorie, processed foods lacking in nutrients, and excessive intake of fats and sugars. These habits can lead to digestive disorders and nutrient malabsorption, increasing the risk of gastrointestinal diseases. Additionally, obesity can affect gut function through alterations in intestinal motility. Some individuals with obesity may experience constipation or bowel regulation issues, possibly due to the excessive amount of adipose tissue around the intestines and unhealthy dietary habits [15].

Importantly, obesity is linked to a higher risk of certain gastrointestinal cancers, such as colorectal cancer, pancreatic cancer, and esophageal cancer. Obesity can have numerous

negative effects on the health of the digestive system, impacting the functioning of digestive organs, the risk of diseases, and an individual's quality of life. Therefore, weight control and the promotion of healthy dietary habits and physical activity are crucial for preventing and managing obesity and its gastrointestinal complications [16].

### **The impact of obesity on the cardiovascular system**

Obesity has a significant impact on the cardiovascular system, leading to various health consequences. Excessive accumulation of body fat increases the workload on the heart and blood vessels, resulting in a range of cardiovascular issues. One of the primary concerns is the development of atherosclerosis, a condition characterized by the buildup of plaque in the arteries, narrowing them and restricting blood flow. This can lead to hypertension (high blood pressure), a major risk factor for heart disease, stroke, and other vascular problems [17].

Moreover, obesity is associated with dyslipidemia, an abnormal lipid profile characterized by elevated levels of LDL cholesterol and triglycerides and decreased levels of HDL cholesterol. Dyslipidemia contributes to the development of atherosclerosis and increases the risk of coronary artery disease and myocardial infarction (heart attack) [18].

Obesity also promotes the development of metabolic syndrome, a cluster of conditions including insulin resistance, abdominal obesity, dyslipidemia, and hypertension, all of which significantly increase the risk of cardiovascular disease. Additionally, obesity is linked to inflammation and oxidative stress, which further exacerbate cardiovascular damage [19].

Furthermore, individuals with obesity are more likely to develop heart failure, a condition in which the heart cannot pump blood effectively to meet the body's needs. This can lead to symptoms such as shortness of breath, fatigue, and swelling in the legs and ankles [20].

Overall, obesity negatively impacts the cardiovascular system by increasing the risk of atherosclerosis, hypertension, dyslipidemia, metabolic syndrome, inflammation, oxidative stress, and heart failure. Managing obesity through lifestyle modifications, including healthy eating habits, regular physical activity, and weight loss, is crucial for reducing the burden on the cardiovascular system and lowering the risk of cardiovascular disease [19, 21].

## **The impact of obesity on the respiratory system**

Obesity significantly impacts the human respiratory system. Excessive adipose tissue can lead to various health issues related to breathing. One of them is a decrease in lung capacity. Excess fat tissue around the chest and abdomen can restrict the movement of the diaphragm and chest wall. This results in reduced lung capacity and functional residual capacity, making gas exchange less effective. Consequently, breathing problems may arise [22].

Moreover, individuals with obesity often experience increased burden on the respiratory system, as the additional fat mass makes breathing more difficult. Breathing effort becomes greater, leading to fatigue and breathlessness, especially during physical exertion. Obesity is also frequently associated with a higher risk of developing obstructive sleep apnea. This condition involves periodic cessation of breathing during sleep due to narrowing of the upper airways. It disrupts breathing and disturbs the normal sleep cycle, leading to excessive fatigue and health issues [23].

Obesity can also affect lung ventilation, leading to hypoxia and excessive accumulation of carbon dioxide in the blood. This, in turn, can worsen overall health and increase the risk of respiratory diseases such as asthma or chronic obstructive pulmonary disease (COPD). Additionally, there is an increased risk of respiratory tract infections. Individuals with obesity may be more susceptible to respiratory infections because excess adipose tissue can weaken the immune system. This increases the risk of inflammation in the respiratory tract and exacerbates infection symptoms [24].

Therefore, obesity not only affects the functioning of the respiratory system but also increases the risk of various associated health problems. Hence, weight control and promotion of healthy lifestyle habits, such as a balanced diet and regular physical activity, are crucial for maintaining respiratory health [25].

## **Obesity and the excretory system**

Obesity can have significant effects on the excretory system of the body. The excretory system, primarily composed of the kidneys, ureters, bladder, and urethra, plays a crucial role in removing waste and excess substances from the body, regulating electrolyte balance, and maintaining proper hydration levels [26].

One of the primary impacts of obesity on the excretory system is an increased risk of developing chronic kidney disease (CKD). Obesity is closely associated with conditions such as hypertension and diabetes, which are leading causes of CKD. The excessive accumulation of fat tissue can also lead to inflammation and structural changes in the kidneys, impairing their function over time [27].

Moreover, obesity can contribute to the development of kidney stones. The higher levels of circulating insulin associated with obesity can lead to increased urinary excretion of calcium, oxalate, and uric acid, predisposing individuals to the formation of kidney stones. Additionally, obesity-related conditions such as metabolic syndrome can alter urine composition, promoting stone formation [26].

Obesity-related obstructive sleep apnea (OSA) can also impact the excretory system. OSA, characterized by repeated episodes of partial or complete upper airway obstruction during sleep, can lead to nocturnal polyuria and altered renal function. The recurrent episodes of hypoxia and hypercapnia associated with OSA can activate the sympathetic nervous system and the renin-angiotensin-aldosterone system, leading to increased urine production and decreased renal blood flow [26].

Furthermore, obesity is closely linked to urinary incontinence, particularly stress urinary incontinence (SUI) and overactive bladder (OAB). The excess weight places increased pressure on the pelvic floor muscles and bladder, compromising their function and increasing the risk of involuntary urine leakage [27].

In summary, obesity can adversely affect the excretory system by increasing the risk of chronic kidney disease, kidney stone formation, urinary incontinence, and exacerbating obstructive sleep apnea-related urinary disturbances. Maintaining a healthy weight through lifestyle modifications, including regular physical activity and a balanced diet, is crucial for preserving the proper function of the excretory system and overall health [26,27].

### **The influence of obesity on the hormonal system**

Obesity can significantly impact the hormonal system in the body. Excess adipose tissue, particularly visceral fat, can lead to changes in hormone levels and disrupt the delicate balance of hormonal regulation. One of the key hormones affected by obesity is insulin. In individuals



with obesity, the body may become resistant to insulin, leading to higher blood sugar levels and an increased risk of developing type 2 diabetes [28].

Additionally, obesity is associated with alterations in other hormones involved in appetite regulation and metabolism, such as leptin and ghrelin. Leptin, often referred to as the "satiety hormone," is produced by fat cells and helps regulate energy balance by signaling to the brain when the body has had enough to eat. In obese individuals, high levels of leptin can lead to leptin resistance, where the brain no longer responds to the hormone's signals, contributing to overeating and weight gain [28,29].

On the other hand, ghrelin, known as the "hunger hormone," stimulates appetite and promotes food intake. Obesity is associated with lower levels of ghrelin, which may contribute to increased food intake and further weight gain [29].

Furthermore, obesity can disrupt the normal functioning of hormones involved in reproductive health, such as estrogen and testosterone. In women, excess adipose tissue can lead to elevated levels of estrogen, which may disrupt menstrual cycles and increase the risk of conditions like polycystic ovary syndrome (PCOS). In men, obesity is associated with lower testosterone levels, which can affect libido, fertility, and overall reproductive health [30].

Overall, obesity-induced alterations in hormonal balance can have profound effects on various physiological processes in the body, contributing to the development of metabolic disorders, reproductive health issues, and other complications associated with obesity [28,30].

### **The effects of obesity on the musculoskeletal system**

Obesity is a multifaceted health issue with far-reaching consequences, affecting various systems in the body, including the musculoskeletal system. This system comprises bones, joints, muscles, and connective tissues, all of which play essential roles in supporting the body and facilitating movement. When excess body weight is present, it exerts additional strain and pressure on these structures, leading to a range of health problems and complications [31].

One of the most notable effects of obesity on the musculoskeletal system is joint pain and osteoarthritis. Weight-bearing joints, such as the knees, hips, and lower back, bear the brunt of this excess mechanical stress. Over time, the continuous wear and tear of cartilage in these joints can result in osteoarthritis, a degenerative joint disease characterized by pain, stiffness,

and reduced mobility. The prevalence of osteoarthritis is higher among individuals with obesity, highlighting the significant impact of excess body weight on joint health [32].

Furthermore, obesity increases the risk of fractures, contrary to the belief that higher body weight provides protection against bone-related injuries. While obese individuals may have greater bone density, other factors such as reduced mobility, altered gait patterns, and decreased balance contribute to an increased risk of fractures, particularly in the lower extremities. The combination of excessive weight and compromised bone integrity heightens the vulnerability to fractures, posing challenges to musculoskeletal health [32,33].

In addition to joint pain and fractures, obesity contributes to the development of various musculoskeletal disorders, including tendinitis, bursitis, and plantar fasciitis. These conditions often arise from repetitive stress on tendons, ligaments, and soft tissues due to excessive weight. Moreover, obesity is associated with back pain and spinal disorders, such as herniated discs, spinal stenosis, and degenerative disc disease. The strain on the spine from carrying excess body weight can lead to nerve compression, radiating pain, and decreased spinal mobility [31].

The consequences of obesity on the musculoskeletal system extend beyond physical discomfort to encompass decreased mobility and functional impairment. Obesity-related limitations in mobility hinder individuals from engaging in physical activities and performing daily tasks effectively. As a result, musculoskeletal issues may worsen over time, further compromising quality of life and independence [32,33].

Furthermore, chronic obesity can lead to muscle weakness and imbalance, exacerbating existing musculoskeletal problems. Weakened muscles may struggle to adequately support the body's weight, leading to postural abnormalities and increased susceptibility to falls and injuries. The interplay between excess body weight, weakened muscles, and compromised joint integrity underscores the complex nature of obesity's impact on the musculoskeletal system [32].

In conclusion, obesity exerts profound effects on the musculoskeletal system, predisposing individuals to joint pain, osteoarthritis, fractures, and various musculoskeletal disorders. Understanding these implications is essential for healthcare professionals in developing comprehensive treatment and prevention strategies. By promoting weight management, encouraging physical activity, and addressing musculoskeletal issues proactively, the adverse effects of obesity on the musculoskeletal system can be mitigated, improving overall health and well-being [33].

## **Obesity and the lymphatic system**

Obesity, characterized by excessive accumulation of body fat, represents a significant public health challenge worldwide. Beyond its well-documented association with cardiovascular diseases, diabetes, and metabolic syndrome, obesity profoundly affects various physiological systems, including the lymphatic system—a critical component of the body's immune and fluid balance mechanisms [34].

The lymphatic system comprises a complex network of vessels, nodes, and organs responsible for maintaining tissue fluid homeostasis, immune surveillance, and the transport of fats and immune cells throughout the body. In obesity, however, the excessive accumulation of adipose tissue can disrupt the normal functioning of this intricate system [35].

One of the primary consequences of obesity on the lymphatic system is impaired lymphatic drainage. As adipose tissue expands, it can compress nearby lymphatic vessels, hindering the proper flow of lymphatic fluid. This impairment leads to lymphedema, a condition characterized by localized swelling due to fluid retention, which can exacerbate inflammation and compromise immune function [35,36].

Moreover, obesity-induced inflammation plays a pivotal role in lymphatic dysfunction. Adipose tissue secretes pro-inflammatory cytokines and adipokines, contributing to a state of chronic low-grade inflammation. This inflammatory milieu can damage lymphatic vessels, impair lymphocyte trafficking, and disrupt immune responses mounted by lymphoid organs like lymph nodes and the spleen [34,36].

The consequences of impaired lymphatic function in obesity extend beyond local tissue swelling and inflammation. Individuals with obesity may experience increased susceptibility to infections due to compromised immune surveillance and impaired pathogen clearance. Furthermore, obesity-related lymphatic disorders, such as lymphedema and lymphatic dysfunction, can exacerbate fluid retention, inflammation, and tissue damage, perpetuating a cycle of dysfunction and increasing the risk of secondary complications [35].

Understanding the intricate interplay between obesity and the lymphatic system is crucial for developing effective therapeutic strategies. Lifestyle modifications, including dietary interventions and regular physical activity, are essential for managing obesity and mitigating its adverse effects on lymphatic health. Additionally, targeted therapies aimed at reducing

adipose tissue inflammation and improving lymphatic function may hold promise for alleviating obesity-related lymphatic complications [36].

In conclusion, obesity exerts profound effects on the lymphatic system, impairing lymphatic drainage, promoting inflammation, compromising immune function, and increasing the risk of lymphatic-related disorders. By elucidating these mechanisms and developing targeted interventions, we can address the multifaceted impact of obesity on lymphatic health and improve overall well-being [34,36].

### **The effects of obesity on the functioning of the reproductive system**

Obesity, a prevalent health concern globally, exerts profound effects on the functioning of the reproductive system. The intricate balance of hormones and physiological processes within the reproductive system can be significantly disrupted by excessive adiposity, leading to various complications affecting fertility and reproductive health [37].

One of the primary consequences of obesity on the reproductive system is hormonal imbalance. Adipose tissue, particularly visceral fat, acts as an active endocrine organ, secreting hormones and adipokines that can interfere with the production and regulation of reproductive hormones. In obese individuals, there is often an increase in circulating levels of estrogen due to aromatization of androgens in adipose tissue, disrupting the delicate hormonal milieu necessary for normal reproductive function [38].

In women, obesity is associated with menstrual irregularities, including oligomenorrhea (infrequent menstrual periods) or amenorrhea (absence of menstrual periods). These irregularities often stem from disturbances in the hypothalamic-pituitary-ovarian axis, where excess adipose tissue disrupts the normal secretion of gonadotropin-releasing hormone (GnRH), follicle-stimulating hormone (FSH), and luteinizing hormone (LH), leading to ovulatory dysfunction and anovulation [37,38].

Furthermore, obesity significantly impacts fertility in women. The disrupted hormonal environment and irregular menstrual cycles can impair the process of ovulation, reducing the chances of conception. Even in cases where ovulation occurs, obesity is associated with decreased fertility rates, increased time to conception, and higher rates of pregnancy complications, such as miscarriage, gestational diabetes, and preeclampsia [38,39].

In men, obesity is linked to subfertility and impaired reproductive function. Excess adiposity disrupts testicular function and spermatogenesis through several mechanisms, including elevated scrotal temperatures due to increased fat deposition around the testes, hormonal imbalances, and oxidative stress. These factors can lead to reduced sperm quality, including decreased sperm motility and morphology, ultimately affecting male fertility and reproductive outcomes [37,39].

Moreover, obesity has implications for assisted reproductive technologies (ART), such as in vitro fertilization (IVF). Obese individuals undergoing ART often have lower success rates, higher rates of cycle cancellation, and increased risks of pregnancy complications compared to their non-obese counterparts, highlighting the challenges faced by obese individuals seeking fertility treatment [39].

In conclusion, obesity exerts multifaceted effects on the functioning of the reproductive system, disrupting hormonal balance, menstrual regularity, ovulatory function, and fertility in both men and women. Addressing obesity through lifestyle modifications, including diet, exercise, and weight loss interventions, is crucial not only for overall health but also for optimizing reproductive health and fertility outcomes [40].

## **Conclusions**

In conclusion, the above publication sheds light on the critical implications of obesity as a civilization threat in the 21st century and its significant impact on various functions of human organ systems. Through a comprehensive analysis of the literature, the multifaceted implications of obesity on various organ systems have been clarified, highlighting its pervasive impact on human health and well-being.

First, obesity is becoming a pressing public health problem, exacerbated by the modernization of society and changes in lifestyle patterns around the world. In addition to its aesthetic implications, obesity poses a serious health threat at both the individual and societal levels, requiring urgent attention and concerted efforts at prevention and intervention strategies.

Moreover, analysis of the impact of obesity on specific organ systems reveals a complex interaction between obesity and physiological functions. From cardiovascular complications to metabolic disorders, respiratory impairment and hormonal imbalances, obesity has a far-reaching impact on human health, contributing to a spectrum of chronic diseases and debilitating conditions.

Moreover, the above publication reveals the complex interaction between obesity and physiological functions. From cardiovascular complications to metabolic disorders, respiratory impairment and hormonal imbalances, obesity has a far-reaching impact on human health, contributing to a spectrum of chronic diseases and debilitating conditions.

In conclusion, the findings presented herein underscore the urgent need for collaborative efforts across disciplines to address the multifaceted challenges posed by obesity in the 21st century. By advancing our understanding of the impact of obesity on individual organ systems, we can inform evidence-based strategies to mitigate its detrimental effects, promote health equity, and improve the quality of life for individuals affected by obesity.

### **Author's contribution**

For full transparency, all submitted manuscripts must include an Author Contribution Statement stating the work of each author. For research articles with multiple authors, a short paragraph must be provided stating their individual contributions.

Conceptualization: Martyna Warno, methodology: Martyna Warno, check:, formal analysis: Anna Brzozowska, investigation: Jeremiasz Dubiel and Marta Zarzycka, resources: Adrian Maj, Wiktor Kozik, data curation: Ines Plewniok; writing- rough preparation: Adrian Maj and Monika Maj-Dziedzic, writing-review and editing: Martyna Warno, supervision: Anna Brzozowska and Monika Maj-Dziedzic, project administration: Greta Śmietana, Marcelina Sikora; All authors have read and agreed with the published version of the manuscript.

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## **Institutional Review Board Statement**

Ethical review and approval were waived for this study, due to characteristics of the study – review.

## **Informed Consent Statement**

Not applicable

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