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## The Detrimental Effects of Sedentary Lifestyle on Human Health

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## ABSTRACT

**Introduction:** Sedentary lifestyles have become increasingly prevalent in modern societies, posing significant threats to human health. Technological advancements and the shift towards desk-based occupations have contributed to a substantial decline in physical activity, leading to a rise in various diseases. The detrimental effects of a sedentary lifestyle are far-reaching, impacting physical, mental, and cognitive aspects of well-being.

**Purpose of work:** This review article aims to provide an examination of the ramifications of a sedentary lifestyle, exploring its multifaceted impact on the different domains of well-being.

**State of knowledge:** Research examining the consequences of sedentary behavior has expanded significantly in recent years. Studies have consistently demonstrated the negative impact of sedentary lifestyles on various health outcomes, including increased risk of cardiovascular disease, metabolic disorders, musculoskeletal problems, and cognitive impairment [1][2].

**Material and methods:** The review is based on an in-depth analysis of current scientific literature, including recent publications in leading medical journals and relevant research studies. To identify relevant scientific publications and research studies, the review utilized comprehensive searches on well-known academic databases, including PubMed and Google Scholar.

**Summary:** A sedentary lifestyle poses a significant threat to human health, contributing to a range of physical, mental, and cognitive ailments. Given the widespread prevalence of sedentary behaviors, particularly in modern societies, it is imperative to develop and implement effective strategies that encourage regular physical activity and reduce prolonged periods of inactivity. The review explores the key aspects of the detrimental effects of sedentary lifestyles, including their impact on cardiovascular health, metabolic processes, musculoskeletal well-being, and cognitive function.

Keywords: sedentary behavior; exercise; back pain; cardiovascular diseases

## **INTRODUCTION**

Prolonged sitting, lack of exercise, and reduced physical activity can lead to a host of negative health consequences, including cardiovascular problems, musculoskeletal degeneration, metabolic disorders, cognitive decline, and psychological distress. The increased prevalence of sedentary lifestyles in modern societies is a growing public health concern, as it contributes to the development and progression of various chronic diseases [1]. Technological advancements, such as the widespread use of computers, smartphones, and other electronic devices, have significantly reduced the physical demands of daily activities. In addition, the change towards a sitting lifestyle has resulted in a significant proportion of the population spending the majority of their waking hours in a sedentary state, exacerbating the problem.

This problem is most visible in younger generations, with teenagers and young adults exhibiting alarmingly high levels of sedentary behavior [3][4]. The root cause lies not only in the availability of technology but also in the decreased emphasis on physical education and outdoor activities in modern educational systems [5][6]. Parents do not encourage physical activity as much as in previous generations, further contributing to the issue [7][8]. Those behaviors tend to be carried over into adulthood, leading to long-term negative health consequences. Evaluating data from one research among high-school students in US shows that the sitting lifestyle has increased by over 40% between 1965 and 2009 [3]. Similarly, a study conducted in urban households in India revealed that the majority of teenagers (13-25 years) spend over 6 hours per day in sedentary activities [9].

Extensive research has linked sedentary lifestyles to a range of adverse health outcomes. The negative effects can be categorized into three main domains: physical, mental, and cognitive well-being [1][10][11]. The complex and multidimensional nature of this issue, with its extensive ramifications, necessitates a multilayered approach to effectively address it.

Physical domains include cardiovascular diseases, metabolic disorders, and musculoskeletal problems [12]. Sedentary behavior has been associated with an increased risk of developing conditions such as obesity, and type 2 diabetes [13][14].

Mental domains encompass psychological distress, depression, and anxiety. It has been linked to high incidences of mental health issues, with some studies suggesting a relationship [15].

As for cognitive well-being, sedentary lifestyles have been shown to negatively impact cognitive function, leading to impaired memory, attention, and overall cognitive decline [11][16]. In this last case, the physiological mechanisms underlying the connection between sedentary behavior and cognitive impairment remain an area of active research. All the results in this field are quite new and more research is needed to fully comprehend the relationships.

Also, to define what constitutes a "sedentary lifestyle", we can take back to a definition provided by the "Sedentary Behaviour Research Network": "Any waking behavior characterized by an energy expenditure  $\leq$ 1.5 metabolic equivalents, while in a sitting, reclining or lying posture." [17]. A metabolic equivalent is a unit called MET, which expresses the energy cost of physical activities as a multiple of the resting metabolic rate.

In the article, I will describe the most common detrimental effects of a sedentary lifestyle on human health.

# IMPACT OF A SEDENTARY LIFESTYLE ON HEALTH

#### **Cardiovascular Complications**

Sedentary behavior is a well-established risk factor for the development of cardiovascular diseases. The lack of physical activity and prolonged sitting lead to metabolic changes, such as increased levels of LDL and decreased levels of HDL cholesterol, which are known to contribute to the progression of atherosclerosis and the risk of heart attack and stroke [18].

LDL, or low-density lipoprotein, cholesterol is a type of cholesterol that is considered "bad" because it can contribute to the buildup of plaque in the arteries, a condition known as atherosclerosis. When LDL cholesterol levels are too high, it increases the risk of developing cardiovascular diseases, such as heart attacks and strokes [19]. This is because plaque buildup can narrow and harden the arteries, reducing the flow of blood and oxygen to the heart and other vital organs. Maintaining healthy LDL cholesterol levels, through a combination of diet, exercise, and sometimes medication is crucial for reducing the risk of these serious and potentially life-threatening cardiovascular complications.

At the same time, higher levels of HDL cholesterol, often referred to as the "good" cholesterol, have been shown to decrease the risk of cardiovascular mortality. HDL cholesterol plays a crucial role in the reverse cholesterol transport process, where it helps remove excess cholesterol from the body and the walls of blood vessels, reducing the buildup of plaque and the risk of heart disease [20]. Numerous studies have consistently demonstrated

an inverse relationship between HDL cholesterol levels and the incidence of cardiovascular events, such as heart attacks and strokes. Maintaining a healthy HDL cholesterol level is an important factor in promoting cardiovascular health and reducing mortality associated with heart disease. In one of the researches *Jim K. et al.* state that even a 1% decrease in HDL cholesterol level increases the risk of coronary heart disease by 2-3% [20].

A review of the literature [21] presented compelling data on the relationship between sitting time, physical activity, and lipid profiles. The study categorized participants based on their reported sitting and activity levels. Individuals who spent more than 4 hours per day sitting had an average HDL cholesterol level of  $60.4 \pm 0.75 \text{ mg/dL}$ , while those who were more physically active had higher HDL levels of  $63.6 \pm 1.2 \text{ mg/dL}$  [21]. Similarly, participants with the highest sitting time had elevated triglyceride levels of  $121.4 \pm 3.9 \text{ mg/dL}$ , compared to  $102.8 \pm 6.5 \text{ mg/dL}$  for those who sat less [21]. Regarding the impact of physical activity on lipid profiles, the research found that individuals exercising 0.5-1 hour per day had HDL levels of  $64.5 \pm 1.2 \text{ mg/dL}$ , higher than the  $60.8 \pm 0.52 \text{ mg/dL}$  seen in those who exercised less [21]. Furthermore, triglyceride levels decreased linearly with increasing physical activity, underscoring the importance of exercise in maintaining healthy lipid levels. These findings clearly illustrate the detrimental effects of sedentary behavior on cardiovascular health, with higher sitting times leading to unfavorable lipid profiles and increased risk.

## **Metabolic Disorders**

Beyond the cardiovascular consequences, a sedentary lifestyle has also been linked to the development of metabolic disorders, such as obesity and type 2 diabetes. The lack of physical activity and prolonged sitting can lead to an imbalance in energy expenditure, resulting in weight gain and the accumulation of body fat. Numerous studies have demonstrated that increased sedentary time is associated with a higher prevalence of obesity, with one study reporting that an additional hour of sedentary activity increases the risk of being overweight and developing high abdominal fat [22]. Moreover, sedentary behavior has been shown to contribute to the development of insulin resistance and impaired glucose metabolism, which are precursors to type 2 diabetes [23][24]. As indicated in previous research findings, even a brief 14-day period of reduced physical activity and heightened sedentary behavior can result in a decrease in insulin sensitivity across multiple organs, including a decrease in the muscle insulin sensitivity index [25]. Additionally, this short-term shift in activity levels has been associated with increases in central and liver fat deposition, as well as elevated LDL-cholesterol levels [25]. Although the precise mechanism is not yet fully elucidated, existing evidence suggests that a sedentary lifestyle can diminish insulin sensitivity by decreasing energy expenditure and disrupting lipid metabolism.



Figure 1: Insulin action in sedentary or physically active subjects [26]

The above figure clearly shows a relationship between insulin sensitivity and physical activity levels. HOMA-IR is a measure of insulin resistance, where higher values indicate lower insulin sensitivity. Whereas ADIPO-IR is a measure of adipose tissue insulin resistance, which is increased in sedentary individuals, leading to disrupted lipid metabolism. The research by *Daniel P. Andersson et al.* presents concerning findings, indicating that the differences in insulin sensitivity and adipose tissue insulin resistance between sedentary and physically active individuals are not trivial, but rather substantial in magnitude [26].

## **Musculoskeletal Degeneration**

Prolonged sitting has many effects on musculoskeletal health. Including, but not limited to a reduction in muscle mass, detrimental effects on bone health, and the development of back pain.

A study executed over 2 years on children found that an additional hour of sedentary behavior was associated with a 0.006 g/cm2 reduction in femoral neck Bone Mineral Density among 11-14-year-old boys [27]. In contrast, each extra hour of Moderate-to-Vigorous Physical activity was linked to a 0.02 g/cm2 increase in femoral neck BMD [27]. Meaning, increasing MVPA had over 3 times greater impact on femoral neck BMD compared to decreasing sedentary time.

Extensive research has consistently linked sedentary behaviors to an elevated risk of developing lower back pain [28]. This association between prolonged sitting and increased susceptibility to lower back pain is well-documented in the literature. Desk-based employees represent a prime target population for interventions aimed at reducing sedentary behaviors, as they are prone to extended periods of sitting and frequently experience lower back pain, with a documented 1-year prevalence ranging from 30% to 50% [29][30].

In one of the researches, sedentary behavior was linked to the risk of knee osteoarthritis, a degenerative joint disease characterized by the breakdown of cartilage [31][32].

Another study found that physical activity can alleviate the outcome of osteoarthritis. It was found that among participants without any functional limitations, around 20% had them developed on the 5XSST and 20-meter walk test after 4 years. Groups were created as follows [33]:

- "Active-Low Sedentary (≥1x 10-minute bout/week of MVPA, lowest tertile for standardized sedentary time)"
- "Active-High Sedentary (≥1x 10-minute bout/week of MVPA, top two tertiles for standardized sedentary time)"
- "Inactive-Low Sedentary (zero 10-minute bout/week of MVPA, lowest tertile for standardized sedentary time)"
- "Inactive-High Sedentary (zero 10-minute bout/week of MVPA, top two tertiles for standardized sedentary time)"

The Active-High Sedentary group did not have an increased risk, while the Inactive-Low Sedentary and Inactive-High Sedentary groups had higher risks of developing functional limitations compared to the Active-Low Sedentary group [33]. The Inactive-High Sedentary and Inactive-Low Sedentary group had a 72% and 52% greater risk of developing functional limitations on the 5XSST and 20-meter walk test, respectively, compared to the Active-Low Sedentary group [33]. Clearly, being physically active can help mitigate the detrimental

effects of high levels of sedentary behavior. However, while physical activity offers protective benefits, high sedentary time counteracts these benefits.

#### **Cognitive Decline**

Beyond the physical health consequences, emerging evidence indicates that a sedentary lifestyle may also contribute to cognitive decline and impaired brain function.

Studies have shown a link between increased sedentary time and a higher risk of developing dementia later in life [34]. The researchers controlled for various demographic variables, such as gender and age, but their findings suggest that a sedentary lifestyle is independently linked to an elevated risk of developing dementia.

The same results were diagnosed from the study, which had data analyzed from over 49,000 individuals having at least 60 years in the UK Biobank [35], confirming the link between sedentary behavior and increased risk of dementia. The mean sedentary time was determined through a machine-learning analysis of data collected from accelerometers over 1 week. The researchers conducted follow-ups, monitoring participants' accelerometer-measured sedentary time over several years and linking it to their subsequent medical records to draw conclusions about the relationship between sedentary behavior and dementia risk [35].

#### **Sleep disorders**

Another deleterious effect of a sedentary lifestyle is its impact on sleep quality. Sedentary behavior has been associated with disrupted sleep patterns, including difficulties falling asleep, maintaining sleep, and excessive daytime sleepiness [36].

Circadian Rhythm is the 24-hour cycle in the biochemical, physiological, and behavioral processes of living beings [37][38]. The human body's natural sleep-wake cycle is regulated by light exposure and physical activity levels. Prolonged sedentary behavior and diminished daylight exposure can disrupt Circadian Rhythm, leading to difficulties with sleep initiation and reduced feelings of rejuvenation upon waking [39]. Moreover, increased sedentary time is often accompanied by excessive screen time use, which has been independently linked to poor sleep quality [39].

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Research has demonstrated a positive association between the duration of sedentary behavior and the likelihood of experiencing sleep disturbances [40]. In this study with 21,414 adults, people were divided into four groups by daily sedentary time [40]:

- Q1: 0-3 hours/day reference group
- Q2: 3-5 hours/day
- Q3: 5-8 hours/day
- Q4: 8-20 hours/day

With increasing sedentary time, the risk of reporting sleep disturbances increased by 18%, 35%, and 45% for the Q2, Q3, and Q4 groups, respectively, compared to the Q1 group [40]. These findings underscore the importance of limiting prolonged sedentary time to maintain healthy sleep patterns.

# CONCLUSIONS

Excessive sedentary behavior can have far-reaching detrimental consequences for human health. It is associated with increased risks of cardiovascular diseases, metabolic disorders, musculoskeletal issues, cognitive decline, and sleep disturbances. To mitigate these negative effects, individuals should aim to limit prolonged periods of sitting and incorporate regular physical activity into their daily routines. Interventions that promote active lifestyles and disrupt sedentary behavior patterns can yield significant improvements in overall health and well-being.

Adopting a more active lifestyle, with a balance of physical activity and reduced sedentary time, can lead to substantial benefits for physical, mental, and cognitive health. Regular exercise and movement can help strengthen the cardiovascular system, maintain healthy body weight, support musculoskeletal function, and promote better sleep quality. Furthermore, an active lifestyle has been shown to have a protective effect against cognitive decline and the development of dementia later in life. By making conscious efforts to reduce prolonged sitting and incorporate more physical activity into daily life, individuals can make meaningful strides toward improved life functioning.

# DISCLOSURE

# **Authors contribution**:

Conceptualization: Alicja Grzelak Methodology: Alicja Grzelak Software: Alicja Grzelak Check: Alicja Grzelak Formal Analysis: Alicja Grzelak Investigation: Alicja Grzelak Resources: Alicja Grzelak Data Curation: Alicja Grzelak Writing-Rough Preparation: Alicja Grzelak Writing-Review and Editing: Alicja Grzelak Visualization: Alicja Grzelak Supervision: Alicja Grzelak Project Administration: Alicja Grzelak The author has read and agreed with the published version of the manuscript.

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