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SAUNA AS A CATALYST FOR HEALTH: MULTIFACETED BENEFITS OF THERMOTHERAPY IN ENHANCING CARDIOVASCULAR, ENDOCRINE, AND IMMUNE FUNCTIONS

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ABSTRACT

Introduction: A growing body of research suggests that regular sauna use is associated with a range of health benefits. Observational studies indicate positive effects on multiple physiological systems, but the mechanisms underlying these effects require further investigation.
Aim of the Study: This study aims to systematically review and analyze scientific literature on the health effects of regular sauna use. The focus is on its impact on the cardiovascular system (including mortality risk and lipid profiles), mental health (symptoms of depression and anxiety), the immune system (inflammatory markers and immune cell activity), the endocrine system (levels of cortisol, adrenaline, and prolactin), the respiratory system, and skin health.
Methodology: This review synthesizes data from scientific publications on thermotherapy via sauna use. Studies were selected for their relevance and methodological quality. Articles lacking scientific rigor were excluded. The literature search included databases such as PubMed and Google Scholar, prioritizing systematic reviews and longitudinal studies.
Results: The review found a strong association between regular sauna use and reduced cardiovascular mortality. Positive effects were also seen in lipid profiles, reductions in depression and stress symptoms, and modulation of immune responses (e.g., lower inflammatory markers). Potential benefits were noted for respiratory and skin health. Endocrine responses were complex, with thermal stress increasing cortisol and catecholamine levels, and possible changes in growth hormone.
Conclusions: Regular sauna use may serve as a simple, accessible method to support health and prevent disease. Nonetheless, risks like dehydration and overheating must be considered. Further research is essential to clarify mechanisms and optimize therapeutic use.

KEYWORDS

Sauna Bathing, Cardiovascular Benefits, Immune System Modulation, Endocrine Effects, Mental Health Impact, Respiratory System Effects

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Introduction

This article focuses on the analysis of the impact of regular thermotherapy in the form of sauna use on health, particularly on the functioning of the cardiovascular system, based on extensive cohort study results. These studies indicate a strong negative relationship between the frequency and duration of sauna use and the risk of death from cardiovascular causes[1,2]. In light of the global health issue of high mortality rates due to cardiovascular diseases, the identification of relatively simple and accessible preventive methods, such as regular sauna use, becomes particularly significant.

A study conducted in 2015 showed that increased frequency of sauna use (4-7 times a week) was associated with a significantly reduced risk of sudden cardiac death, death from ischemic heart disease, cardiovascular diseases, and decreased mortality from the aforementioned causes[1]. The received literature indicate that the health benefits resulting from thermotherapy, including its impact on the circulatory system, hormonal balance, and the immune system, are significant and need further investigation[4]. This paper aims to analyze the health benefits of regular thermotherapy as a relatively simple, accessible, and effective strategy for the prevention of cardiovascular diseases, which is a key strategy in addressing this widespread health problem

Cardiovascular effect

Regular use of the Finnish sauna shows a beneficial effect on the cardiovascular system, although the exact mechanisms of this phenomenon are not yet fully understood. Research indicates several potential pathways of action. First, heat therapy induces endothelium-dependent vasodilation, leading to increased blood flow and reduced peripheral vascular resistance. Second, sauna use stimulates the autonomic nervous system by modulating sympathetic and parasympathetic activity, which may contribute to the regulation of blood pressure and heart rate. Third, regular sauna use may improve endothelial function by reducing oxidative stress and inflammation in blood vessels. Fourth, the sauna may influence the lipid profile, promoting favorable changes in HDL and LDL cholesterol levels, thus reducing the negative impact of lipid disorders on the incidence of cardiovascular diseases [1,3,8,9].

The effects of the Finnish sauna on the cardiovascular system are complex and can be categorized into both short-term and long-term effects. Short-term effects include an increase in heart rate, which is a physiological response to elevated body temperature [1], and variable changes in blood pressure depend on various factors, including health status, sauna temperature, and duration of stay[1,6,7].

Long-term effects are more straightforward and indicate a significant impact on cardiovascular health. Regular sauna use is associated with a reduced risk of death from cardiovascular diseases, including sudden cardiac death [1,2], as well as a lower risk of developing hypertension [10] and stroke [11]. These long-term benefits are likely the result of cumulative positive short-term effects, such as improved endothelial function, reduced arterial stiffness, and regulation of the autonomic nervous system. Additionally, regular sauna use may positively influence the lipid profile [12], further contributing to the protection of the cardiovascular system e.g. by reducing the frequency of coronary artery disease.

Impact on Mood and Stress Reduction

Increasing evidence points to the potential benefits of regular sauna use for mental health, including mood improvement and stress reduction. A randomized double-blind clinical trial from 2016 demonstrated a significant reduction in depression symptoms after just one week of regular sauna use, with the effect lasting for six weeks. The study involved heating the body to a core temperature of 38.5°C using infrared rays, while the control group received a simulation of this process. The hyperthermia treatment group showed a significantly greater reduction in depression symptoms compared to the control group over the six weeks after the treatment. This improvement was evident after the first week and persisted throughout the observation period. The results indicate a potential direct impact of hyperthermia on mood. However, the mechanisms behind this effect remain unclear[13]. It is suspected that the stress induced by the high temperature in the sauna may stimulate the release of β-endorphins as a natural mechanism for stress and pain reduction. β-Endorphins have analgesic effects and improve mood [25,29]. Additionally sauna has a relaxing effect, reducing muscle tension and psychological stress, which can positively influence mood [23]. Improved blood circulation in the sauna may also indirectly affect mood by enhancing brain oxygenation and supporting nervous system functioning [23,25].

Furthermore, studies highlight the sauna's influence on reducing the risk of psychotic disorders. One study investigated the relationship between the frequency of sauna use and the risk of psychotic disorders in

men. The results suggest a strong inverse correlation: frequent sauna use is associated with a lower risk of these disorders. The authors proposed that frequent sauna use may reduce stress and anxiety, potentially decreasing the risk of psychotic disorders. However, this relationship is correlational rather than causal. The study did not directly measure the sauna's impact on mood and only suggests a potential mechanism; therefore, the findings should be approached with caution [14].

However, a study from 2005 showed that repeated thermal therapy could be an effective complement to the treatment of mild depression, particularly in patients with reduced appetite and subjective somatic complaints. After four weeks of therapy, the thermal therapy group reported a small but statistically significant improvement in depression symptoms compared to the control group. Patients in the thermal therapy group noted a significant improvement in appetite and a notably higher daily caloric intake compared to the control group. The improvement in appetite may be associated with increased levels of ghrelin in the blood of the thermal therapy group. Patients in this group also reported significant improvements in somatic complaints and feelings of relaxation [15].

Immunomodulatory effects

The impact of sauna use on the immune system is a topic of intensive research but not fully understood yet. Current studies suggest a complex influence, with potential benefits and risks dependent on various factors.

There are several studies indicating a potential positive impact of regular sauna use on the immune system by reducing levels of inflammatory markers in the plasma. Analyses conducted on a large group of men showed that frequent sauna use (4-7 times a week) was correlated with lower levels of inflammatory indicators, such as C-reactive protein (CRP), fibrinogen, and leukocyte count [16,17]. These observations suggest that regular visits to the sauna may contribute to the reduction of chronic inflammation in the body, which could have beneficial effects on patients with autoimmune diseases such as connective tissue inflammatory disorders, potentially serving as a complement to existing therapies as a simple and minimally invasive method [18].

Another potential benefit of regular sauna use is the improvement of the immune response. Some studies suggest that the sauna may stimulate immune system functions, potentially by increasing the number and activity of certain immune cells. In the cited study, an increase in the percentage of neutrophils and a decrease in the percentage of lymphocytes, monocytes, and eosinophils were observed in individuals undergoing regular sauna thermotherapy [19]. We do not have precise information on how this phenomenon affects the functioning of the body as a whole; however, there are scientific reports suggesting that regular sauna use may reduce the frequency of infections, as seen in the cited study below, which examined the impact of regular sauna use on the frequency of colds. Fifty volunteers (25 in the experimental group and 25 in the control group) recorded the frequency, duration, and severity of colds over six months. The sauna-using group reported significantly fewer episodes of colds, especially in the last three months of the study (almost half as many as in the control group). However, the average duration and severity of colds did not differ significantly between the groups [20].

The Impact of Sauna Bathing on the Endocrine System

The impact of the sauna on the endocrine system is complex and not yet fully understood. However there is evidence that sauna sessions trigger significant changes in the levels of various hormones. These responses depend on many factors, such as the sauna's temperature, humidity, duration of the session, individual heat tolerance, as well as the health status and physical activity level of the person using the sauna. Based on available research, two groups of hormones can be identified – those sensitive to thermal stress and those that are insensitive. Previous studies have not shown significant changes in the levels of thyroid hormones, TSH, testosterone, FSH, and LH [3,21]. Therefore main observations regarding the impact of the sauna on the endocrine system will focus on hormones sensitive to thermal stress.

One of the primary responses of the endocrine system is an increase in cortisol levels. A sauna bath induces thermal stress, leading to the release of cortisol – the stress hormone. Cortisol levels rise in response to elevated body temperature and physical exertion associated with sweating. Scientific reports suggest that chronic heat exposure may affect neurotransmission in the hypothalamus, which could change the endocrine responses to stressors such as thermal stimuli. For instance, prolonged sauna use may modify the action of opioids in the hypothalamus, influencing the release of stress hormones and causing gradual adaptation of the body to stress [22,23].

Increased levels of adrenaline and noradrenaline: Similar to cortisol, adrenaline and noradrenaline - catecholamine hormones, are released in response to thermal stress. These hormones contribute to increased heart

rate, blood pressure, and metabolism, aiding thermoregulation. Regular sauna use may positively affect blood pressure regulation and vascular function, reducing long-term mortality rates from cardiovascular causes [1,3,22].

Some studies suggest that sauna use may elevate growth hormone (GH) levels. GH plays a role in muscle regeneration and growth processes, as well as influencing fat metabolism. This increase could potentially have a significant impact on muscle mass gain rates, such as in athletes, and slow the rate of muscle loss in older individuals [21,22,24].

Research indicates the potential impact of the sauna on other hormones, such as prolactin. Exposure to thermal stress during sauna sessions raises plasma prolactin levels [21]. Studies suggest that short-term overheating of the body may cause temporary disruptions in the ovulatory cycle in women. This effect is attributed to potential disturbances caused by hyperprolactinemia (elevated prolactin levels). Prolactin levels increased after each sauna session, particularly strongly after the first. Excessively high levels of prolactin can affect the regularity of the menstrual cycle [21,25,26].

In men, while the sauna does not affect levels of sex hormones, it may temporarily reduce sperm count and motility, especially in men who use the sauna infrequently. However, it should be emphasized that according to current studies, while sperm production decreases in men using the sauna, this effect is reversible, and regular sauna use does not correlate with decreased fertility [22]. Several hypotheses are associated with the issue of spermatogenesis disorders in men using saunas. This is most likely related to increased scrotal temperature and elevated prolactin levels, which may adversely affect the spermatogenesis process [21,27,28].

Another important fact related to the sauna's impact on the endocrine system is that Finnish sauna treatments may lead to increased levels of beta-endorphins (released by the anterior pituitary gland). That contributes to feelings of well-being and relaxation after a sauna session, and may have long-term analgesic and mood-enhancing effects [22,29].

Respiratory system

In a study by Kunutsor et al. from 2017, researchers analyzed data from a prospective cohort study involving 1,935 Caucasian men aged 42-61 years. The occurrence of respiratory diseases was monitored over a period of 25.6 years. The influence of sauna use frequency (≤1, 2-3, or ≥4 times per week) on the risk of these diseases was analyzed, accounting for factors such as age, smoking, diabetes, heart disease, education level, alcohol consumption, physical activity, and socioeconomic status.

After adjusting for risk factors, the hazard ratios (HR) for respiratory diseases were:

0.73 (95% CI 0.58-0.92) for individuals using the sauna 2-3 times a week.

0.59 (95% CI 0.37-0.94) for individuals using the sauna ≥4 times a week, compared to the group using the sauna ≤1 time a week. Frequent sauna use was also associated with a reduced risk of pneumonia [30].

Potential mechanisms underlying the observed association between frequent sauna use and decreased risk of respiratory diseases have been sugested. One of them is the reduction of oxidative stress. The sauna may reduce oxidative stress, which plays a significant role in the pathogenesis of respiratory diseases, leading, among other things, to damage to lung parenchyma [31]. Another factor is the direct impact on the lungs. The heat from the sauna may have a direct effect on lung tissue, reducing pulmonary edema and increasing tidal volume, vital capacity, ventilation, and forced expiratory volume (FEV1) [30,32].

Other health benefits associated with sauna use

Regular sauna usage is associated with numerous health benefits, ranging from detoxifying the body to improving physical performance and skin health, as well as supporting healthy sleep [3].

Regular use of the Finnish sauna demonstrates a beneficial effect on skin physiology, including the stability of the epidermal barrier, hydration, and blood circulation. The sauna stimulates sweating, leading to improved skin hydration. The heat opens the pores, allowing for deeper hydration. Improved circulation and hydration may also promote increased skin elasticity and reduce visibility of wrinkles. The observed effects suggest a "training" effect on the skin, resulting from adaptation to regular exposure to high temperatures. Increased blood flow delivers more oxygen and nutrients to skin cells, supporting regeneration and healing processes. Reduced sebum levels and a more acidic skin surface pH indicate potential benefits for individuals with skin conditions such as acne or seborrheic dermatitis [4,33]. Some studies suggest that the sauna may alleviate symptoms of inflammatory skin conditions, such as psoriasis, although the mechanism of this action remains unclear [17]. Additionally, intense sweating during sauna sessions may help eliminate toxins from the body through the skin, potentially leading to a healthier complexion [23,33].

Numerous scientific reports indicate a positive impact of the sauna on sleep quality. The article "Sauna bathing in northern Sweden: results from the MONICA study 2022" highlights a study in which a significant increase in deep sleep was observed after sauna sessions, as well as a reduction in time spent in a wakeful state after sauna use [34]. Other studies indicate that 83.5% of respondents in a global sauna study reported improved sleep quality after using the sauna [23].

The article "Effects of passive body heating on body temperature and sleep regulation in the elderly: a systematic review" reviews studies examining the effects of passive body heating on body temperature and sleep regulation in older adults. The studies showed that passive body heating before sleep could increase slow-wave sleep (deep sleep) in healthy elderly women with insomnia. Older individuals who took warm baths also reported better sleep quality and faster sleep onset. Evening warm baths facilitated nighttime sleep in healthy elderly individuals with insomnia [35].

Some studies suggest that sauna use may lead to an increase in maximal oxygen uptake (VO2 max – the body's ability to absorb oxygen), indicating improved physical performance. The sauna may also raise the lactate threshold, meaning that the body can work longer at a higher intensity without a significant increase in blood lactate levels. Futhermore sauna use may improve running economy, allowing a person to cover the same distance using less energy [36].

Discussion

This article presents a review of studies demonstrating the beneficial effects of sauna use on various aspects of health, including the cardiovascular, immune, and endocrine systems, and describes its impact on mental health. It highlights the potential of saunas as a simple and accessible method for disease prevention. However, to maintain the credibility of this article, it is important to mention the methodological limitations of the cited studies. Most of the referenced studies are observational rather than interventional. Correlations between sauna use and positive health effects do not necessarily imply a direct cause-and-effect relationship. Potential confounding factors, such as lifestyle, diet, or physical activity, may not have been fully accounted for in the analyses, which could have influenced the interpretation of the results. The diversity of sauna types (Finnish, infrared, steam) and the varied methods of measuring parameters also complicate the straightforward interpretation of results.

It is also important to mention the risks associated with sauna use, as there are several limitations that may exclude potential patients from this type of therapy. Intense sweating in the sauna can lead to dehydration, particularly in inadequately hydrated individuals. Sauna use may also lead to circulatory overload, which is especially dangerous for people with heart conditions. Prolonged exposure to the sauna or excessively high temperatures can result in burns or heat stroke. Other possible risks include arrhythmias, hypotension, breathing problems (in individuals with asthma or other lung diseases), and negative effects on fertility in men. [37]

In summary, although there is promising evidence for the potential health benefits of regular sauna use, caution should be exercised in interpreting the results of observational studies. Further well-designed research is necessary to clearly define the impact of saunas on health and optimize their use, taking potential risks into account.

Conclusions

There are increasing scientific evidence indicating numerous health benefits associated with regular sauna use. The effects of the sauna on the body are multidimensional and positively impacting the cardiovascular system, immune system, endocrine system, as well as mental health, respiratory system, skin and sleep quality. Regular sauna use is associated with a reduced risk of death from cardiovascular causes, lower blood pressure, and improved endothelial function. The sauna may also reduce symptoms of depression and stress, as well as potentially decrease the risk of psychotic disorders. Additionally sauna use can lower levels of inflammatory markers and potentially enhance immune functions.

The impact on the endocrine system is complex. However, according to current knowledge, sauna use may influence stress hormone levels and, through adaptive processes, contribute to better stress tolerance by the body, as well as affect other hormones, such as growth hormone, which plays a crucial role in the body's regeneration especially important for individuals who frequently engage in various sports. The sauna may also provide benefits for the respiratory system, skin health, and better sleep quality.

Regular sauna use can serve as a simple, accessible, and effective strategy for disease prevention and improving overall health. However, further research is necessary to fully understand the mechanisms of sauna action and optimize its use for maximum benefits while minimizing potential risks.

Author contributions

Conceptualization: Kacper Rozenberg; methodology, Justna Stryjecka, Karolina Niewola; Software, not applicable;

Check: Mykhailo Shevchuk formal analysis, Kacper Rozenberg, Filip Łątka; investigation, Adam Grzebinoga; resources, not applicable; data curation, Natalia Łątka; writing - rough

Preparation: Dominika Cuprian-Kwiecińska; Writing - review and editing: Klaudia Nowak, Martyna Różańska; Visualization: Justyna Stryjecka; Supervision: Kacper Rozenberg, Karolina Niewola; Project administration: Kacper Rozenberg; Receiving funding, not applicable.

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