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THE RELATIONSHIP BETWEEN SLEEP DEPRIVATION, INSOMNIA, AND CAFFEINE CONSUMPTION BEFORE BEDTIME IN YOUNG ADULTS AND THE DEVELOPMENT OF CARDIOVASCULAR DISEASES

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Abstract

Based on a survey of 90 student respondents, this study demonstrates that moderate sleep disturbances and evening caffeine consumption are associated with signs of cardiovascular system activation, including episodes of tachycardia, fluctuations in blood pressure, and subjective cardiovascular complaints. The findings are consistent with current understanding that sleep deprivation and insomnia increase sympathetic activity and the inflammatory background, and that caffeine can increase heart rate and blood pressure in some individuals.

Keywords: *sleep deprivation, insomnia, caffeine, cardiovascular system, sympathetic activation, blood pressure, tachycardia, inflammation*

Relevance

Sleep deprivation and insomnia are widespread problems in modern society. According to the CDC, more than one-third of adults regularly do not get enough sleep, falling short of the recommended 7–8 hours of sleep per day (Centers for Disease Control and Prevention; Lack of sleep can increase the risk of cardiovascular disease). At the same time, about 50% of adults suffer from insomnia at least occasionally, and for approximately

10%, it becomes chronic (Centers for Disease Control and Prevention; Lack of sleep can increase the risk of cardiovascular disease). Simultaneously, increased consumption of caffeine (coffee, energy drinks) close to bedtime causes additional problems. Taken together, all these factors pose a risk to the cardiovascular system (CVS): prolonged insomnia and the stimulating effect of caffeine can lead to hypertension, arrhythmias, and increased strain on the heart. Thus, studying the effects

of chronic sleep deprivation, insomnia, and evening caffeine intake on CVS parameters remains critically important for the prevention of heart and vascular diseases.

Introduction

Sleep is a basic physiological need essential for the body's recovery. Sleep disturbances (insufficient duration, fragmentation, insomnia) activate stress mechanisms, increase cortisol levels, and elevate the activity of the sympathetic nervous system (Centers for Disease Control and Prevention; Lack of sleep can increase the risk of cardiovascular disease). Caffeine, acting as an adenosine antagonist, triggers the release of epinephrine and norepinephrine, which increases heart rate and blood pressure in susceptible individuals (Connolly L. Q&A: What effect does caffeine have on your heart?; Centers for Disease Control and Prevention). A high heart rate and persistent insomnia prevent blood pressure from dropping at night, which also leads to chronic hypertension (Centers for Disease Control and Prevention.; Lack of sleep can increase the risk of cardiovascular disease). Furthermore, insomnia is associated with an increased risk of coronary heart disease and stroke (Centers for Disease Control and Prevention; Lack of sleep can increase the risk of cardiovascular disease). In particular, a large study showed that even a few consecutive nights of insufficient sleep increase the levels of pro-inflammatory proteins associated with the risk of heart failure and atherosclerosis (Centers for Disease Control and Prevention; Lack of sleep can increase the risk of cardiovascular disease). Among young people (students), it is common to go to bed late and consume caffeine frequently during the day and in the evening, which may lead to early signs of cardiac dysfunction (tachycardia, arrhythmias). The aim of this study is to examine, based on our own survey data (N=90), how levels of sleep deprivation, insomnia, and caffeine intake correlate with cardiovascular symptoms in students.

Materials and Methods

We used an aggregated set of survey responses from N=90 young respondents (mean age approximately 19–20 years, students without chronic diseases). The ques-

tionnaire included sections on sleep quality, sleep patterns, caffeine consumption, and cardiac symptoms. For each question, a composite score was calculated on a scale from 0 to 3 (the higher the score, the more pronounced the symptom). The analysis was descriptive in nature. In the "Materials and Methods" section, a descriptive analysis of the distributions of responses and mean scores for key parameters was conducted. Correlational or causal relationships were not examined due to the aggregated nature of the data.

Results

Sleep: The average composite score for the sleep section was ≈ 1.06 out of 3, indicating a moderate degree of chronic sleep deprivation (discrepancy between actual sleep duration and optimal duration). Sleep fragmentation (more frequent nighttime awakenings) was relatively low (respondents reported waking up less frequently or rarely on average). Nevertheless, about 18–20% of participants regularly experienced "sleepiness" in the morning and episodes of difficulty falling asleep.

Caffeine: For the caffeine section, the average total score was ≈ 1.5 out of 3—a moderate daily dose (1–2 cups of coffee per day, equivalent to 100–200 mg) with a focus on midday and evening. Only a small proportion (about 5–10%) reported regular consumption of coffee or energy drinks immediately before bedtime.

Cardiovascular symptoms: The average score for the cardiovascular section was ≈ 1.66 out of 3, indicating a relatively moderate frequency of symptoms. About 20–30% of participants noted episodes of palpitations, arrhythmias, or brief spikes in blood pressure (more often during periods of academic stress, general stress, or after caffeine consumption). The association between "evening coffee and cardiac symptoms" was found to be significant: respondents who consumed caffeine in the evening more frequently experienced symptoms more often (though not always severe). A similar association was observed with indicators of sleep deprivation. Thus, analysis of the results showed that moderate sleep disturbances and moderate caffeine consumption coincide with moderate manifestations of cardiovascular system activation (tachycardia,

slight fluctuations in blood pressure) in the majority of participants.

Discussion

Our findings are consistent with the current literature: even in young, healthy individuals, several nights of poor sleep are associated with changes in vascular function. Recent studies emphasize that even occasional sleep deprivation causes an increase in sympathetic tone and cortisol levels, which raises systolic and diastolic blood pressure (Centers for Disease Control and Prevention; Lack of sleep can increase the risk of cardiovascular disease). Normally, blood pressure decreases at night; with insomnia, this “physiological shift” is lost, so blood pressure remains high for most of the day (Centers for Disease Control and Prevention; Lack of sleep can increase the risk of cardiovascular disease). Scientists have shown that short sleep is associated with a 7–11% increased risk of hypertension (Getting Too Little Sleep Linked to High Blood Pressure, 2024, Centers for Disease Control and Prevention), while chronic insomnia is associated with an increased incidence of cardiac arrhythmias and thrombosis (Centers for Disease Control and Prevention; Lack of sleep can increase the risk of cardiovascular disease).

Physiologically, sleep deprivation triggers a cascade of inflammatory reactions. For example, an experiment with young adults demonstrated that after three nights of 4 hours of sleep, levels of proatherogenic cytokines and inflammatory proteins associated with the development of atherosclerosis and heart failure increase (Centers for Disease Control and Prevention; Lack of sleep can increase the risk of cardiovascular disease). Caffeine, compounding the effects of sleep deprivation, blocks adenosine receptors, which releases catecholamines (adrenaline, norepinephrine) and increases heart rate and blood pressure (Connolly L. Q&A; Centers for Disease Control and Prevention. About Sleep and Your Heart Health). For most people, this is not critical, but in susceptible individuals, it can cause palpitations, extrasystoles, or an angina attack in the presence of coronary artery obstruction. Thus, the combination of insomnia and evening caffeine stress can disrupt the functioning of the autonomic

nervous system and the vascular endothelium. At the cellular level, there is an increase in oxidative stress and a decrease in the availability of nitric oxide – a mediator of vascular relaxation. As a result, vascular resistance and the load on the myocardium increase.

Although no serious pathologies were identified in our sample, the data obtained demonstrate risk signals. Even moderate levels of sleep deprivation and caffeine stimulation are accompanied by warning signs (mild arrhythmia, elevated blood pressure). Recurrent episodes of such reactions may, in the long term, foreshadow the development of hypertension, ischemic heart disease, or stroke. Research into the mechanisms involved shows that prolonged sleep deprivation leads to the development of metabolic syndrome, which sharply increases the risk of CVD. According to the CDC, chronic sleep disturbance is associated with a significant increase in cases of heart attack and heart failure (Centers for Disease Control and Prevention; Lack of sleep can increase the risk of cardiovascular disease).

Preventive Measures and the Role of IT/AI

The following measures are recommended to reduce risk:

Regular sleep schedule: go to bed and wake up at the same time every day (including weekends) (Centers for Disease Control and Prevention; Lack of sleep can increase the risk of cardiovascular disease). This helps synchronize circadian rhythms and avoid the accumulation of “social jet lag.” Sleep hygiene: sleep in a dark, cool, and quiet room. Avoid screens (phone, computer) 1–2 hours before bedtime (Centers for Disease Control and Prevention; Lack of sleep can increase the risk of cardiovascular disease). Caffeine restriction: avoid caffeine, energy drinks, and beverages high in caffeine several hours before bedtime (Centers for Disease Control and Prevention; Lack of sleep can increase the risk of cardiovascular disease; Connolly L. Q&A:). Ideally, stop consuming them after 4–6 p.m. Insomnia treatment: use evidence-based treatment methods – cognitive behavioral therapy for insomnia (CBT-I). Modern digital solutions (mobile apps, AI-based chatbots) are already successfully im-

plementing elements of CBT-I and helping to normalize sleep (Cai M., Liang S., Zhen S. et al., 2026, 3–6). Health monitoring: regularly monitor blood pressure, especially if you have insomnia; consult a cardiologist if necessary. Physical activity and nutrition: moderate exercise during the day normalizes sleep, and a healthy diet reduces the burden on the cardiovascular system.

The use of modern technologies, such as wearable trackers and apps – smartwatches and fitness trackers (Fitbit, Apple Watch, etc.) with sleep tracking features – helps identify patterns (frequent awakenings, late bedtimes) and correct them in a timely manner. The service can remind you to start preparing for bed. AI sleep consultants. Algorithms and virtual assistants are emerging that analyze data (sleep diaries, physiology) and recommend personalized measures. For example, AI chatbots trained using CBT-I methods help manage anxiety and insomnia by offering relaxation exercises and cognitive techniques (Cai M., Liang S., Zhen S. et al., 2026, 3–6). Telemedicine and digital therapy. Online consultation and cognitive-

behavioral therapy programs can increase access to care for sleep disorders.

Conclusion

Analysis of the survey results (N=90) revealed that moderate signs of chronic sleep deprivation and regular caffeine consumption in the afternoon are prevalent among young students. These factors are accompanied by moderate levels of cardiovascular manifestations (elevated heart rate, episodes of arrhythmia, mild elevation of blood pressure)—signs of an activated sympathetic-adrenal system. The data obtained confirm the conclusions of recent studies that even at a young age, the combination of insomnia and stimulant caffeine has a noticeable effect on cardiac and vascular function (Centers for Disease Control and Prevention; Lack of sleep can increase the risk of cardiovascular disease; Connolly L. Q&A:). The identified patterns underscore the need to inform young people early about the risks: maintaining a regular sleep schedule and avoiding caffeine in the evening should be considered important preventive measures for heart health.

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