

Progress of Research on Physical Inactivity and Cardiovascular Disease Risk Factors in University Students

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Abstract: *Physical inactivity has emerged as a prevalent issue among college students, contributing significantly to the rising prevalence of cardiovascular disease (CVD) risk factors in this population. The transition to college life frequently coincides with lifestyle changes that diminish physical activity levels, leading to an increase in sedentary behaviors. This review aims to explore the impact of insufficient physical activity on various CVD risk factors, including obesity, hypertension, dyslipidemia, and insulin resistance, thereby highlighting the importance of promoting active lifestyles among young adults. Sedentary lifestyles contribute to obesity by reducing caloric expenditure, leading to excess fat accumulation. Lack of physical activity also impairs blood pressure control and lipid metabolism, resulting in hypertension and unfavorable cholesterol levels (elevated LDL, reduced HDL). Additionally, inactivity disrupts glucose metabolism, increasing insulin resistance and the risk of type 2 diabetes. Together, these factors decrease cardiorespiratory fitness and worsen cardiovascular health. So, physical inactivity significantly raises cardiovascular disease (CVD) risks in college students. This review examines the mechanisms linking inactivity to CVD and suggests interventions, such as exercise programs, education, and campus-wide health initiatives, to promote student health.*

Keywords: physical inactivity, cardiovascular disease risk factors, university students

1. Introduction

The latest global estimates indicate a quarter (27.5 per cent) of adults and more than three quarters (81 per cent) of adolescents are physically inactive (2001). Insufficient physical activity is more prominent among university students, mainly due to factors such as a lack of time or social support during university years, stress and fatigue caused by academic overload, excessive homework and classes, and increased screen time (Gómez-López, Gallegos, & Extremera, 2010; Organization, 2019; Thomas, Beaudry, Gammage, Klentrou, & Josse, 2019). Chinese university students also follow the global trend in the incidence of physical inactivity (PI), with rates of physical inactivity worsening (Chen et al., 2020). A comprehensive global survey revealed that the prevalence of physical inactivity among university students reached 41.4%, a rate significantly higher than the global age-standardized prevalence of physical inactivity. This finding underscores the concerning level of insufficient physical activity within this demographic group when compared to the broader population. Prominent organizations, including the American Heart Association (AHA) and the American College of Sports Medicine (ACSM), have emphasized that physical inactivity (PI) constitutes a key risk factor

for cardiovascular disease (CVD). Prolonged sedentary behavior and inadequate levels of physical activity are strongly associated with an increased occurrence of risk factors for cardiovascular disease, particularly among university students. A high prevalence of abnormal coronary heart disease risk factors has been consistently reported in individuals aged 18 to 24 years, as evidenced by numerous cross-sectional studies, underscoring the urgent need for targeted preventive measures in this population (Collins, Dantico, Shearer, & Mossman, 2004). Conversely, enhancing physical activity levels can help prevent and lower the prevalence of cardiovascular diseases by mitigating associated risk factors.

This study primarily aims to investigate the impact of insufficient physical activity on multiple cardiovascular disease (CVD) risk factors in college students. Specifically, it will explore the association between insufficient physical activity and conditions such as overweight and obesity, elevated blood pressure, abnormal lipid profiles, impaired insulin sensitivity, and reduced cardiorespiratory fitness. This research seeks to offer an in-depth insight into the role of physical inactivity in driving these health challenges among university students. By reviewing the latest research developments, the study reveals the mechanisms through which physical inactivity affects these risk factors and proposes evidence-based interventions, such as structured exercise programs, educational initiatives, and campus health promotion activities. The goal is to develop effective health intervention strategies for college students, lower their risk of cardiovascular diseases and enhance their overall physical well-being.

2. Prevalence of Cardiovascular Disease and Cardiovascular Risk Factors in Adolescents

Cardiovascular disease, encompassing conditions such as peripheral arterial disease, ischemic heart disease, heart failure, stroke, and a wide range of other disorders affecting the heart and blood vessels, stands as the foremost cause of mortality and diminished quality of life on a global scale. Its widespread prevalence and significant impact on health outcomes highlight its pivotal significance as a key global public health issue. The incidence and prevalence of cardiovascular disease (CVD) have been steadily rising globally over the past few decades, with an increasing trend among younger populations. The high prevalence of moderate cardiovascular risk factors in children, adolescents and young adults is a major contributing factor. This increase is due to the high incidence of potentially modifiable cardiovascular risk of children, adolescents, and young adults. Risk factors for cardiovascular disease can be broadly categorized into two distinct groups: those that are beyond individual control and those that can be actively managed or modified. Uncontrollable factors include an individual's age, gender, race, and family history of CVD (genetic factors that cannot be changed), among other factors. Controllable factors refer to those that can be reduced or managed through behavioral changes. The main controllable risk factors for cardiovascular disease include insufficient physical activity, unhealthy diet, smoking (including passive smoker and inactive), excessive alcohol intake, abnormal cholesterol levels, hypertension, increased blood glucose, unhealthy body weight or obesity, and poor cardiorespiratory fitness (Malone et al., 2009; Roth et al., 2020).

Lack of physical activity is a significant cardiovascular disease risk factor. The rising proportion of people with insufficient physical activity globally, including among university students, has led to an increase in the prevalence of chronic diseases, including cardiovascular diseases. Engaging in regular physical activity is widely recognized as a vital component for preserving cardiovascular health and preventing related diseases. For individuals failing to achieve the recommended physical activity guidelines, the proportion of cardiovascular disease-related deaths attributable to inactivity is estimated at 9.5%. The proportion of physical

inactivity is rapidly rising among young adults aged 18 to 24 pursuing higher education. Studies carried out in multiple countries, such as Australia, the United States, and the United Kingdom, consistently reveals that more than 50% of university students fall short of meeting these recommended activity levels, highlighting a significant public health concern within this demographic (Haase, Steptoe, Sallis, & Wardle, 2004; Health, 2012). As a result, students on college campuses may be at greater risk for poor health.

3. Physical Inactivity and Cardiovascular Disease Risk Factors

3.1 Physical Inactivity and Overweight and Obesity

Physical activity is universally acknowledged as a crucial factor in addressing the challenges of overweight and obesity. Physical activity can cause an increase in energy expenditure, the more physical activity is engaged in, the more energy is expended, whereas prolonged sedentary behaviour or physical inactivity is accompanied by lower energy expenditure, and sedentary behaviour is also often accompanied by poor dietary habits, which can affect the body's energy balance. A wealth of studies and systematic reviews has consistently highlighted the beneficial impacts of physical activity on both physical and psychological health. However, despite its importance, the global prevalence of physical inactivity among adolescents remains alarmingly high (Strain et al., 2024).

In addition, physical inactivity is equally prevalent among college students, with the ACHA-NCHA survey revealing that only 42.1 percent of students meet the standard of two moderate-to-vigorous activities per week (Roth et al., 2020).

Poor lifestyle habits such as insufficient physical activity can lead to overweight and obesity. Evidence from research indicates that the incidence of overweight and obesity tends to rise steadily during the college years, frequently starting with substantial weight gain during the initial year of college, followed by a gradual but persistent increase gradually. The rates of overweight and obesity are notably high among university students in developing nations (Gopalakrishnan, Ganeshkumar, Prakash, Christopher, & Amalraj, 2012). In a study conducted by Karl Peltzer and colleagues involving 15,746 university students across many countries, findings revealed that 22% of the participants were classified as obese or overweight, emphasizing the need for targeted interventions in this population group (Taylor et al., 2006). The main factors contributing to significant weight gain among young adults during college are, on one hand, the decline in physical activity levels, likely due to increased sedentary time during study and exam periods. On the other hand, living on campus leads students to rely primarily on school cafeterias, takeout, and pre-prepared meals, which can result in unhealthy eating behaviors and excessive calorie intake, ultimately causing weight gain and obesity among college students.

Overweight and obesity, including central obesity characterized by the excessive accumulation of abdominal fat, are well-established risk factors for hypertension, diabetes mellitus, cardiovascular disease (CVD), and a range of other metabolic disorders. The elevated risk of CVD associated with obesity can be attributed to its ability to independently induce alterations in cardiac structure and function, as well as its strong associations with other significant CVD risk factors, including hypertension, atherosclerosis, metabolic syndrome (MetS), diabetes mellitus (DM), dyslipidemia, reduced cardiorespiratory fitness, psychological disorders, and sleep apnea (Taylor et al., 2006). The rising prevalence of overweight and obesity in the population, driven by physical inactivity, contributes to a heightened risk of cardiovascular diseases and associated mortality (Lee et al., 2012). Conversely, increasing physical activity

levels has been demonstrated to assist in lowering BMI in individuals with obesity for students. Numerous studies have introduced interventions aimed at mitigating health risks linked to lack of physical activity, such as excessive body fat, overweight, and obesity, abnormal blood lipid profiles, and elevated blood pressure, by encouraging consistent physical activity. These risk factors collectively help to the development of cardiovascular disease and are associated with increased morbidity rates. Considering the widespread occurrence of physical inactivity among university students, the implementation of targeted interventions to mitigate these risk factors is both necessary and urgent.

3.2 Physical Inactivity and Cardiorespiratory Fitness (CRF)

Cardiorespiratory fitness (CRF) is an essential indicator of health and is usually assessed by measuring maximal oxygen excretion at volitional exhaustion during an incremental exercise test. Cardiorespiratory fitness CRF is linked not only to elevated levels of PA, but is also negatively correlated with all-cause mortality and key cardiovascular disease risk factors such as high blood pressure, hyperlipidemia, obesity, metabolic syndrome, and type 2 diabetes (T2D) (Sui, et al., 2017). CRF is widely recognized as a critical risk factor and a robust predictor of both cardiovascular disease (CVD) and all-cause mortality. Evidence from a comprehensive meta-analysis, which synthesized findings from 33 cohort studies, emphasizes the significant relationship between CRF levels and health outcomes, including overall mortality and cardiovascular conditions such as coronary heart disease (CHD). These results highlight the critical importance of CRF in predicting health outcomes and its potential as a focus for preventive and treatment strategies.

102,980 subjects with 6,910 all-cause deaths were reported; 84,323 subjects had 4,485 cases of coronary heart disease (CHD)/cardiovascular disease (CVD) (Kodama et al., 2009). Although CRF has not yet been widely used in clinical measurements, multiple studies have shown that it can effectively predict adverse outcomes. For example, each 1 MET increase is in connection with an 11% decrease in CVD risks, a 19% reduction in heart failure risk, a 14% increase in sudden cardiac death risk, and a 15%-30% reduction in all-cause mortality. CRF has been recognized as a robust predictor of health outcomes, irrespective of age, sex, ethnicity, or health condition (Ozemek et al., 2018).

3.3 Physical Inactivity and Hypertension

Several studies have shown that the prevalence of hypertension has increased in high-, middle- and low-income countries. The prevalence of prehypertension and hypertension remains high among university students, with rates of 42.9% in Malaysia and 33.5% in Vietnam, while in Portugal, the prevalence ranges from 6.9% to 24.9% (Hong-Khoi Vo et al., 2023). As prehypertension and hypertension are important risk factors for cardiovascular disease, it is particularly important to monitor blood pressure in the student population, especially at a young age.

The development of hypertension is closely linked to an inactive lifestyle, and physical activity and/or exercise has been shown to slow the progression of hypertension. One study suggests that 44.1% of cardiovascular disease in Chinese adults can be prevented by maintaining blood pressure at ideal levels (<120/80 mmHg). Therefore, it is significant to take active measures to prevent and control elevated blood pressure. Maintaining adequate physical activity helps to reduce the risk of cardiovascular disease, and hypertension, a significant risk factor for cardiovascular disease, requires early monitoring and intervention at the university level to reduce the incidence of cardiovascular complications. Regular exercise is an effective non-pharmacological therapy to control hypertension.

3.4 Physical Inactivity and Dyslipidaemia

Dyslipidemia poses a significant health threat primarily due to its strong association with an elevated risk of cardiovascular disease (CVD). Among the primary contributors to the development of dyslipidemia and related cardiovascular conditions are lifestyle factors, including insufficient physical activity and the adoption of unhealthy dietary patterns. Recent studies have suggested that the trend towards higher lipid levels in the college population may increase the risk of CVD. For example, Martínez et al found that about 19% of university students in Chile had high LDL cholesterol and 40% had high blood pressure. The high prevalence of dyslipidaemia in adolescents also poses a serious problem for world public health.

Lipids are essential for cardiovascular health, contributing significantly to vascular plaque development and blood pressure regulation. The direct causation of low-density lipoproteins (LDL) in the pathogenesis of ASCVD is well established. The most common clinical consequence of dyslipidaemia is an increased risk of atherosclerotic cardiovascular disease (ASCVD). Changes in lifestyle, particularly a decline in physical activity levels and the adoption of poor dietary habits, are pivotal contributors to the escalation of risk factors associated with dyslipidemia and other CVDs.

3.5 Physical Inactivity and Glucose Metabolism

Impaired glucose metabolism is recognized as a significant risk factor for the development of diabetes and cardiovascular disease (Lee et al., 2012). This metabolic abnormality is closely linked to several other health conditions, including obesity, physical inactivity (PI), dyslipidemia, defined by high triglyceride levels and/or low HDL cholesterol, along with hypertension, plays a direct causal role. These interrelated factors collectively contribute to an increased risk of disease progression.

Insulin resistance (IR) is closely related to metabolic syndrome (MetS) and is associated with unhealthy lifestyles such as physical inactivity, high-calorie food consumption and excessive stress (Sui et al., 2017). Abnormal glucose metabolism should be considered a risk factor for progression to diabetes and cardiovascular disease (CVD). It is associated with obesity, physical inactivity (PI), dyslipidaemia with high triglycerides and/or low HDL cholesterol, and hypertension. Insulin resistance leads to decreased sensitivity of skeletal muscle, cardiac muscle, adipose tissue, and the liver to insulin, resulting in hyperglycemia and hyperinsulinemia, which disrupt glucose metabolism. It also causes impaired adipose tissue function, low-grade inflammation, and dyslipidemia, thereby increasing the risk of cardiovascular disease (Kodama et al., 2009).

Research has demonstrated a strong link between low physical activity levels and the onset of insulin resistance and elevated insulin concentrations, both of which are key metabolic abnormalities. These disturbances serve as foundational contributors to hypertension, obesity, and dyslipidemia, particularly in young individuals. This evidence highlights the critical role of physical inactivity in exacerbating these interconnected health risks, underscoring the importance of promoting active lifestyles to mitigate metabolic dysfunction and improve overall health outcomes in youth. Moderate aerobic exercise enhances insulin sensitivity and blood glucose regulation, reduces HbA1c levels, and lowers the likelihood of cardiovascular events and microvascular complications. As a result, exercise helps to maintain good health.

4. Summary and Outlook

The benefits of physical activity and the harmful effects of sedentary behavior on cardiovascular health among college students are widely recognized. However, further research is needed to develop effective interventions to enhance physical activity levels for better cardiovascular health. Scientifically sound health education plays a crucial role in promoting the well-being of college students. Implementing engaging and effective exercise methods in physical education courses is essential for fostering good exercise habits and improving cardiovascular health to prevent related risk factors. In the future, further attention and research should focus on effective interventions to reduce and prevent cardiovascular disease risk factors among university students, promoting long-term adherence to recommended PA levels to enhance their cardiovascular health.

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