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Abstract

Psychological stress is a pervasive issue among university students, significantly impacting their academic performance, mental health, and overall well-being. The increasing prevalence of stress-related disorders has highlighted the need for innovative, proactive approaches to stress management. Wearable sensors integrated with AI-based biofeedback mechanisms offer a promising solution by providing real-time, personalized monitoring of stress biomarkers, such as heart rate variability, electrodermal activity, and skin temperature. These technologies enable continuous tracking of physiological stress responses, facilitating early detection and intervention. This chapter explores the potential of wearable sensor technologies and AI-driven biofeedback systems to monitor and manage psychological stress in university students. The integration of these technologies not only enhances individual stress management strategies but also provides universities with valuable insights for creating a more supportive and resilient campus environment. The chapter discusses the key challenges associated with the adoption of wearable systems, including privacy concerns, user engagement, and the integration with existing mental health frameworks. By examining the effectiveness, limitations, and future prospects of wearable stress monitoring systems, this chapter highlights their transformative potential in improving student well-being and academic outcomes.

Keywords: psychological stress, wearable sensors, AI-based biofeedback, heart rate variability, electrodermal activity, student well-being.

Introduction

Psychological stress among university students has become an increasing concern in recent years, reflecting broader societal challenges and academic pressures [1]. The transition from high school to university life introduces a complex set of stressors, including academic workload, social adaptation, and personal identity formation [2]. For many students, the academic environment, marked by deadlines, exams, and high expectations, can trigger significant psychological stress [3]. Social pressures, such as forming new relationships and navigating diverse social dynamics, further exacerbate these challenges [4]. Research has shown that prolonged exposure to stress during these formative years can lead to both short- and long-term consequences, affecting not only academic success but also physical and mental health [5]. Chronic stress in university students

can manifest as anxiety, depression, sleep disorders, and a decline in overall well-being, making it imperative to find effective methods for early detection and intervention [6].

Given the critical role stress plays in academic and personal life, traditional stress management techniques such as counseling, therapy, and relaxation exercises while valuable, often fail to provide real-time, continuous support [7]. These interventions are reactive, often implemented after stress levels have reached a problematic threshold [8]. The need for a proactive, individualized approach to stress management is evident [9]. Technological innovations, particularly wearable sensor devices integrated with artificial intelligence (AI)-based biofeedback systems, offer a promising solution to this issue [10]. Wearables, equipped with sensors that monitor physiological markers like heart rate variability, skin conductance, and respiratory rate, enable real-time stress monitoring [11]. These systems not only provide immediate feedback but can also suggest personalized interventions, helping students manage stress as it occurs [12].

The integration of wearable technologies with AI-based biofeedback mechanisms presents a new paradigm in stress management, particularly within the university setting [13]. Wearable devices offer a non-invasive and user-friendly method for continuously monitoring physiological changes that indicate stress [14]. Unlike traditional methods that rely on self-reporting or periodic check-ins, these systems provide real-time data, allowing for immediate intervention [15]. The AI component of these systems enhances their efficacy by analyzing the collected data to identify patterns in individual stress responses [16]. With this information, the system can deliver tailored biofeedback interventions—such as guided breathing exercises, mindfulness practices, or relaxation techniques—designed to address the specific stressors affecting the individual at that moment [17].