

INTEGRATING THE USE OF ARTIFICIAL INTELLIGENCE (AI) TO PROMOTE PHYSICAL ACTIVITY: THE EFFECTS ON LIFESTYLE AND ACADEMIC PERFORMANCE OF UNIVERSITY STUDENTS. A LITERATURE REVIEW

INTEGRAZIONE DELL'USO DELL'INTELLIGENZA ARTIFICIALE (AI) PER PROMUOVERE L'ATTIVITÀ FISICA: GLI EFFETTI SULLO STILE DI VITA E SUL RENDIMENTO ACCADEMICO DEGLI STUDENTI UNIVERSITARI. UNA REVISIONE DELLA LETTERATURA



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ABSTRACT

Physical activity (PA) and exercise are essential for a positive and healthy lifestyle. A population exposed to lifestyle changes is university students, who are more prone to experiment anxiety and stress. PA reduces anxiety and depression, increases self-esteem, and improves academic performance (AP). The integration of artificial intelligence (AI) facilitated the promotion of PA using several devices that interpret PA data to customise and guide exercises. This investigation analyze how the integration of AI to promote PA impact on the wellbeing of students and their AP.

L'attività fisica (AF) e l'esercizio sono essenziali per uno stile di vita positivo e sano. Gli universitari sono più esposti a cambiamenti nello stile di vita e sperimentano ansia e stress. L'attività fisica riduce ansia e depressione, aumenta l'autostima e migliora il rendimento. L'uso dell'intelligenza artificiale ha facilitato la promozione della AF utilizzando diversi dispositivi che interpretano i dati sull'AF per personalizzare gli esercizi. Questa indagine analizza l'impatto dell'integrazione dell'IA per promuovere l'AF sul benessere degli studenti e sul loro rendimento.

KEYWORDS

Physical activity, university students, artificial intelligence
Attività fisica, studenti universitari, intelligenza artificiale

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Introduction

According to the World Health Organization (WHO), physical activity and regular exercise are a means of promoting health and maintaining active, positive and healthy lifestyles (Herbert C, 2022). Inactive lifestyles, poor diets, overweight and obesity are issues that affect countries globally (Oh et al., 2021). Constant and regular physical activity has both short- and long-term beneficial effects not only on the organic and functional level. In fact, regular exercise is a means of prevention in reducing chronic non-communicable diseases, mental health issues and promotes cognitive function, as found in the scientific literature (An et al., 2023). Despite the well-documented benefits and protective factors outlined in the literature, incorrect lifestyle habits remain deeply ingrained. The global prevalence of sedentary and inactive lifestyles, ranging from 60% to 85%, underscores the emphasized risk of mortality for those who maintain such habits. This risk is 20% greater compared to individuals who regularly engage in adequate daily movement and physical activity (Chatterjee et al., 2023). The global decrease in physical activity is accompanied by increasingly sedentary daily habits, whether for work, study, or leisure, a substantial portion of the young population leads a lifestyle marked by excessive sitting, even if they engage in physical activity, which contributes to an increased risk of chronic physical and mental conditions (Herbert C, 2022). Indeed, even if some individuals reach the WHO recommendations and guidelines in terms of daily or weekly exercise, increasingly sedentary lifestyles, as in the case of office work or for university students, or with distance learning and increasingly popular smart working, the problem of sedentariness persists. In fact, we are encountering a population defined as 'active couch potatoes', which is the 2013 definition of "an individual who meets or exceeds physical activity guidelines (ie, is sufficiently physically active) but is also highly sedentary" (Fennell, C, et al., 2019). A sedentary lifestyle is linked to issues such as obesity, type II diabetes, high blood pressure, depression, and cardiovascular problems. Although there have been many attempts over the years to raise awareness of the importance of physical activity and health-related behaviors, many people do not lead healthy lifestyles and it is difficult to inspire them to change their habits, even with the now widespread use of therapies, drugs, psychotherapy and digital tools (Oh et al., 2021; Moscatelli et al., 2023). Health is intricately connected to behaviors and lifestyles, emphasizing the importance of reducing sedentary habits through exercise. This endeavor necessitates a dedication not solely to physical activity but primarily to self-motivation and self-control (Chatterjee et al., 2023). University students are a group particularly vulnerable to lifestyle changes (Moscatelli et al., 2023). As future adults facing high cognitive demands, significant psychological

stress, and substantial weekly sedentary activity, they may become a key target for primary prevention efforts in the future (Herbert C, 2022). University students are estimated to suffer from the so-called 'Freshman15 effect' by gaining 2.3-6.8 kg (15 pounds, hence the term) in their first year of university (Lyzwinski et al.,2018; Morassut et al., 2020) and are more prone to experience anxiety and stress (Herbert C, 2022). The shift from high school to university, especially for those away from home, represents a critical period during which behaviors and lifestyles take shape and solidify. Consequently, if sedentary and unhealthy habits are embraced during this time, they are more likely to persist into adulthood (Peng et al., 2022). The presence of conditions such as stress or anxiety, smartphone and digital device abuse are positively correlated with increased BMI or low participation in physical activities (Moscatelli et al., 2023). In addition, for students living away from home, leaving home and facing social challenges alone such as peer relationships, as well as managing themselves and their finances, the amount of studying and lectures can be particularly arduous and stressful factors (Li, Zhong, 2022). Physical activity and inactive and sedentary lifestyles, as widely repeated, are important in the university population and beyond, due to the health effects but at the same time have a strong impact and correlation with academic achievement (Babaeer L, et al., 2020). Indeed, physical activity acting on factors on stress reduction and improvement of anthropometric parameters can improve concentration, self-perception, motivation, and thus academic success (Babaeer L, et al., 2020; Lyzwinski et al.,2018; Moscatelli et al., 2023; Peng et al., 2022). Despite the known benefits of being physically active and leading a healthy lifestyle and the risks associated with sedentariness and its attendant problems, there are often many reasons that hinder active lifestyle maintenance and adherence to physical activity programs. These include the lack of the opportunity for professionals to have more time and financial resources to be able to provide ongoing support and recommendations (Zaleski et al, 2024) as well as the costs to be incurred by subjects for on-site physical activity. The use of technology and artificial intelligence (AI) to support the physical activity of university students fits positively and successfully into this scenario. AI encompasses the process where non-human devices acquire knowledge and skills, initially programmed but capable of operating autonomously to varying degrees, and performing adaptive tasks based on learned data inputs (Bays et al., 2023). Machine learning, a fundamental aspect of AI, improves machine performance by learning from accumulated data inputs.. Natural language processing enables machines to comprehend, interpret, and respond to human language, including applications like chatbots, virtual assistants, and language translation tools. Machine learning is supported by initial algorithmic programming,

allowing devices to adjust task outputs based on new data inputs (Bays et al., 2023; An et al., 2023;). Interventions with technology such as mobile applications, wearable devices, software, and the use of AI are beginning to take hold among possible alternatives to traditional physical activity. This type of physical activity delivery is part of the broader concept of e-health understood as health and general health-related services delivered via information and communication technologies (ICT) (Peng et al., 2022). AI can provide a new and innovative way to change the approach between health professionals and physical activity programming through devices and applications that can provide real-time communication, feedback and recommendations by analyzing, adapting and personalizing interventions based on the data collected on the subject (An et al., 2023). This paper will focus on the analysis of the use of AI-based chatbots although it will analyze the results of all studies in the literature that have related the use of AI to physical activity. The current literature scenario shows a gap regarding the correlation between the use of artificial intelligence to promote healthy active lifestyles, the reduction of sedentary behaviours and the increase of physical activity levels in the university population. This paper aims to investigate the state of the literature regarding the use of current artificial intelligence in physical activity, analyzing different frameworks of the current evidence focusing on the findings related to the use of physical activity interventions via artificial intelligence, the lifestyles of university students and their psycho-physical well-being and possible correlations between academic performance and physical activity. The research question focused on the possibility of opening new research perspectives on the possible use of artificial intelligence to promote physical activity among the university population for the improvement of their lifestyles, mental and physical well-being and academic success, analyzing the ethical aspects, benefits and disadvantages of such means.

Methods

A literature review was conducted in March 2024. PubMed was selected as the database and different search frameworks were searched within it using strings of terms. Keywords were chosen with the use of synonyms as well. Research results that fell within the date range between 2018 and 2024 were included. The terms used for physical activity in the database were 'physical activity' or 'physical exercise' or 'exercise'. For technology-related terms, 'artificial intelligence' or 'AI' were chosen. For the sample chosen, the keywords were 'university students' or 'college students'. Concerning frameworks on academic success, the terms were 'academic performance' or 'academic success' or 'academic achievement'. Furthermore, to limit the search to results unrelated to the covid-19 pandemic, the

exclusive Boolean operator NOT for the term “covid-19” was added to all strings. The combination of keywords used in the search did not produce any results, prompting exploration of alternative sets of terms related to the research frameworks discussed in the following contribution. 99 The final search strings were: “artificial intelligence” OR “AI” AND “physical activity”; “physical activity” OR “physical exercise” OR “exercise” AND “university student” OR “college student” NOT “covid-19; “physical activity” OR “physical exercise” OR “exercise” AND “university student” OR “college student” AND “academic performance” OR “academic success” OR “academic achievement”. 99 Inclusion and exclusion criteria Only studies in English were included in the research. Studies dealing with populations with mental illnesses or disorders, or at least psychiatric ones, were excluded. Studies with any protocol, both qualitative and quantitative, were included. In the first string, either studies that did not have the term artificial intelligence in the title, abstract or keywords were excluded. In the second and third strings, studies that did not sample students aged 19 years and over were excluded. The choice of date range was made from the most recent review for each of the search strings.

Results

The literature search provided many results, which were then selected several times in response to the inclusion and exclusion criteria. The first string correlating artificial intelligence with physical activity initially provided 150 results, which were reduced to 50 with the filters of language and time interval. In turn, the results were selected by excluding those that did not have the word artificial intelligence, that dealt with mental or psychiatric illnesses or disorders, thus arriving at 33 results. The second string correlating physical activity and the university population yielded 75 41 results which, with the filters of language and time interval, the choice of sample age 19 years and older reduced to 8 results. The third string, the correlation between physical activity, academic performance and university students provided a large volume of results, 393. With the filters of language and time interval, 21 results were obtained. With the selection of only studies on the sample aged 19 and over, the final results were 16. In addition, a handsearch was conducted by drawing on bibliographies and searching Scopus and ERIC yielding 24 additional results. By applying filters and exclusion criteria, the results were reduced to 15. The results were registered on Zotero, which then removed 10 duplicates. The final number of data was 72 items included.

String	Results	Inclusion/exclusion criteria	Final result	Total
AI + PA	150	50	33	

PA + US	41	8	8	72
PA + AP + US	393	21	16	
Handsearch	24	15	15	

Key to terms: Artificial Intelligence (AI); Physical Activity (PA); Academic Performance (AP); University Student (US).

Tab. 1 Summary of search results on PubMed

The results of the review led to the identification of a gap in the literature concerning the use of artificial intelligence via chatbots, wearable devices and mobile applications for the promotion of healthy and active lifestyles, the improvement of psychophysical well-being and the reduction of sedentary behavior in correlation also with academic success, in the university population. However, the literature search outlined the clear presence of what could be understood as the research framework from which this study decided to start. There are studies in the literature that correlate the effectiveness of using artificial intelligence, in the form of various devices and software, to promote physical activity, motivation and adherence to healthy lifestyles. There are also studies analyzing the beneficial effects of regular physical activity and healthy lifestyles in the university population. There are also studies that analyze the beneficial effects of regular physical activity and healthy lifestyles in the university population characterized by sedentary habits due to lessons, study hours and distance teaching. Exercise not only improves their levels of physical activity and therefore reduces the risk of exposure to non communicable diseases, such as cardiovascular, diabetes, obesity, but also acts on reducing anxiety, stress and depression. In addition, many studies positively correlate physical activity to academic performance thanks to the lowering of cortisol levels, stress levels, and the increase in perceived self-effectiveness and self-esteem.

Research framework

Artificial Intelligence and Physical Activity

Research on the utilization of artificial intelligence (AI) spans various sectors, including healthcare, education, and computer science (The studies analyzed for this framework are presented in the following **Tab2**, **Tab 2.1**, and **Tab2.2**). However, the application of AI to promote physical activity is a burgeoning field, with ongoing studies exploring its diverse applications. Over recent years, systematic reviews, scoping studies, and experimental research have shed light on the advantages,

drawbacks, and ethical considerations surrounding AI's integration into the healthcare and medical sectors. Questions regarding the potential of AI to enhance users' engagement with physical activity, reduce service costs, and induce behaviour change have accompanied the evolution of studies on AI in healthcare. In the domain of physical activity interventions, AI has the capacity to transform the methods employed by health professionals when creating and executing programs. By analysing individual data, AI can tailor interventions to specific needs, provide personalized feedback, and create demographic-specific workout plans (An et al., 2023). The introduction of AI represents a radical change in healthcare delivery, encompassing technologies such as machine learning (ML), deep learning (DL), and reinforcement learning (RL), which offer unprecedented opportunities for patient care (An et al., 2023). Conversational agents, a tangible outcome of AI, are emerging as valuable resources in the healthcare sector. Leveraging machine learning and natural language processing, these agents interact naturally with users, overcoming workforce shortages and enhancing the accessibility of healthcare services (Zhang et al., 2020; Milne-Ives et al., 2020). Concurrently, the evolution of lifestyle change programs is propelled by the adoption of digital technologies, including the internet, mobile devices, and data-driven interventions, to reach a broad audience and maximize intervention effectiveness (Baca et al., 2022). Wearable monitoring systems, incorporating various sensors, enable the monitoring of exercise metrics, physiological responses, and sleep patterns, facilitating personalized health management (Baca et al., 2022). The use of technology-based devices and applications, such as chatbots and virtual assistants, is increasingly prevalent in promoting physical activity. These tools offer 24/7 availability, enabling users to engage in exercise remotely and receive personalized feedback and guidance (Oh et al., 2021). Chatbots, driven by AI and natural language processing, engage users in natural language conversations, providing tailored interventions and educational content (Oh et al., 2021). The effectiveness of AI-driven interventions in promoting physical activity, sleep, and healthy dietary habits has been examined, highlighting the importance of personalized interactions and multicomponent interventions (Singh et al., 2023). Moreover, AI technologies hold promise in disease management, facilitating real-time data analysis, personalized recommendations, and educational outreach to patients (Bays et al., 2023). However, the integration of AI into healthcare systems poses several challenges, including accuracy, data privacy, ethical considerations, and human-computer interaction. While AI presents opportunities for improving patient care and promoting healthy

behaviours, careful integration and oversight are essential to mitigate potential risks and guarantee fair access to health systems and services (Bays et al., 2023). Overall, AI has the potential to transform healthcare delivery, enhance patient outcomes, and address complex health challenges, rendering it a valuable asset in advocating physical activity and holistic well-being (El Sherbini et al., 2024).

Authors	Title	Study and AI analysed
Al Ghafri et al	Study protocol: behaviour change intervention to promote healthy diet and physical activity in overweight/obese adults with diabetes attending health care facilities in Muscat: a cluster randomised control trial	Artificial intelligence application to manage diabete
An et al	A scoping review of methodologies for applying artificial intelligence to physical activity interventions	Artificial intelligence applications to physical activity
Baca et al	Ubiquitous Computing in Sports and Physical Activity-Recent Trends and Developments	Micro-electro-mechanical system inertial measurement units (MEMS IMU) and current approaches for data acquisition on human activities and sports.
Bays et al	Artificial intelligence and obesity management: An Obesity Medicine Association (OMA) Clinical Practice Statement (CPS) 2023	Use of chatbots for obesity treatment and develop
Blok et al	The Usefulness of Web-Based Communication Data for Social Network Health Interventions: Agent-Based Modeling Study	Social network interventions and web-based communication in physical activity promotion agent-based model
Brakefield et al	An Urban Population Health Observatory for Disease Causal Pathway Analysis and Decision Support: Underlying Explainable Artificial Intelligence Model	Use of machine learning based system to improve Urban Population Health Observatory (UPHO)
Catellani et al	A theory-based and data-driven approach to promoting physical activity through message-based interventions	Message-based intervention to promote physical activity
Chao et al	An Artificial Intelligence Exercise Coaching Mobile App: Development and Randomized Controlled Trial to Verify its Effectiveness in Posture Correction	Develop of a coaching mobile app to evaluate posture
Chatterjee et al	AI and semantic ontology for personalized activity eCoaching in healthy lifestyle recommendations: a meta-heuristic approach	Study of AI approach develop develop of a E-coach to promote healthy lifestyle
Chatterjee et al	ProHealth eCoach: user-centered design and development of an eCoach app to promote healthy lifestyle with personalized activity recommendations	Design process to develop a prototype of a Ecoach app
Diaz et al	Mining Sensor Data to Assess Changes in Physical Activity Behaviors in Health Interventions: Systematic Review	Systematic review on using sensors to evaluate change in physical activity behaviors
Dindoff et al	Conceptual Structure and Current Trends in Artificial Intelligence, Machine Learning, and Deep Learning Research in Sports: A Bibliometric Review	Use of AI in sports
El Sherbini et al	Artificial intelligence in preventive cardiology	AI as a tool of screening in primary and secondary prevention of CVD
Fabrizio et al	Smart Devices for Health and Wellness Applied to Tele-Exercise: An Overview of New Trends and Technologies Such as IoT and AI	Analysis of IoT and AI devices for tele-exercise

Tab. 2 Summary of the studies analysed in this contribution

Forrahi e Clare	Artificial Intelligence and Machine Learning-Powerful Yet Underutilized Tools and Algorithms in Physical Activity and Sedentary Behavior Research	Analysis of the potential and capabilities of AI and ML to reduce sedentary behaviour
Figueroa et al	Conversational Physical Activity Coaches for Spanish and English Speaking Women: A User Design Study	Develop of chatbots for physical activity in 2uggest and 2uggest
Formas et al	Using artificial intelligence to optimize delivery of weight loss treatment: Protocol for an efficacy and cost-effectiveness trial	Study of a reinforcement learning protocol to manage weight loss
Han et al	Feasibility and Acceptability of Chatbots for Nutrition and Physical Activity Health Promotion Among Adolescents: Systematic Scoping Review With Adolescent Consultation	Chatbot for physical activity and nutrition
Kuru	Identifying Behavior Change Techniques in an Artificial Intelligence-Based Fitness App: A Content Analysis	Analysis of an artificial intelligence based app and the effects on behaviour
Li et al	Feasibility and effectiveness of artificial intelligence-driven conversational agents in healthcare interventions: A systematic review of randomized controlled trials	Systematic review of artificial 2uggesting2e conversational agents
Moore et al	Barriers and facilitators to physical activity and further digital exercise intervention among inactive British adolescents in secondary schools: a qualitative study with physical education teachers	Physical education teachers perception of barriers and facilitators of AI among inactive adolescents
Nutanavath et al	Deep Learning for Classifying Physical Activities from Accelerometer Data	Application of two different artificial intelligence-based approach to track and treat user's physical activity
Oh et al	Comparative Effectiveness of Artificial Intelligence-Based Interactive Home Exercise Applications in Adolescents with Obesity	Artificial intelligence game-based applications for adolescents
Oh et al	A systematic review of artificial intelligence chatbots for promoting physical activity, healthy diet, and weight loss	Systematic review of chatbots used to 2uggest physical activity and healthy lifestyles
Sefa-Yeboah et al	Development of a Mobile Application Platform for Self-Management of Obesity Using Artificial Intelligence Techniques	Artificial intelligence-based application to track and predict food intake and energy expenditure for obesity management
Sinab et al	Systematic review and meta-analysis of the effectiveness of chatbots on lifestyle behaviours	Systematic review of the use of chatbots to change lifestyle behaviours
Thomas Craig et al	Systematic review of context-aware digital 2uggestion change interventions to improve health	Systematic review of digital behaviour change intervention devices and context-awareness
Tudorici et al	Toward Systems Models for Obesity Prevention: A Big Role for Big Data	Use of Big Data to prevent and manage childhood obesity
Vandelanotte et al	Increasing physical activity using an just-in-time adaptive digital assistant supported by machine learning: A novel approach for hyper-personalised health interventions	Machine learning-based platform to perform physical activity and receive real time personalisation and adaptations of exercises

Tab. 2.1 Summary of the studies analysed in this contribution

<i>Vasquez et al</i>	Effects of Healthcare Technologies on the Promotion of Physical Activities in Older Persons: A Systematic Review	Health technologies to promote physical activity in older persons
<i>Xue et al</i>	Evaluation of the Current State of Chatbots for Digital Health: Scoping Review	Scoping review of current chatbots used in digital health
<i>Zaleski et al</i>	Comprehensiveness, Accuracy, and Readability of Exercise Recommendations Provided by an AI-Based Chatbot: Mixed Methods Study	Analysis of chatGPT as a chatbot to promote physical activity and its efficacy and accuracy in suggesting individual exercise
<i>Gezner et al</i>	A Systematic Literature Review of Medical Chatbot Research from a Behavior Change Perspective	Systematic review of medical chatbot to promote change behaviour
<i>Lorahini et al</i>	Wearable Devices to Improve Physical Activity and Reduce Sedentary Behaviour: An Umbrella Review	Use of sensors and wearable devices to improve healthy lifestyle and reduce sedentary behaviours
<i>Lyzwinsky et al</i>	Conversational Agents and Avatars for Cardiometabolic Risk Factors and Lifestyle-Related Behaviors: Scoping Review	Review of conversational agents developed for cardiometabolic risk factors
<i>Maier et al</i>	A Physical Activity and Diet Program Delivered by Artificially Intelligent Virtual Health Coach: Proof-of-Concept Study	Use of a chatbot and wearable device to deliver physical activity, diet program in sedentary persons
<i>Milline-Lyves et al</i>	The Effectiveness of Artificial Intelligence Conversational Agents in Health Care: Systematic Review	Systematic review of the use of conversational agents to promote healthy lifestyle in health
<i>Nah et al</i>	Conversational Agents for Body Weight Management: Systematic Review	Use of conversational agent to manage weight loss
<i>Zhang et al</i>	Artificial Intelligence Chatbot Behavior Change Model for Designing Artificial Intelligence Chatbots to Promote Physical Activity and a Healthy Diet: Viewpoint	Literature review of chatbot use in promoting physical activity and a healthy diet

Tab. 2.2 Summary of the studies analysed in this contribution

Physical Activity, Sedentary Behaviours and Mental Issues in University Students

In parallel, another area of research was identified concerning the correlation between university students and physical activity. The analysis (**Tab.3**) found that university students often lead sedentary and disordered lifestyles, which are associated with mental well-being problems such as stress and low self-esteem. Physical activity can improve both the lifestyle and mental well-being of students. Ge et al. (2021) found a decline in explosiveness, endurance and strength factors among 18- to 22-year-old university students and the risk of the ‘freshman 15’ effect, a weight gain of approximately 3-4 kg (Lyzwinsky et al., 2018). Engaging students in physical activity is complex due to the lack of awareness of the risks of an inactive lifestyle and the pressures of university life. Ge's study conducted in China highlights poor eating and physical activity habits among students, with 80.15% spending more than 5 hours a day sitting in class, and only a minority taking adequate lunch breaks (Ge et al., 2021). Furthermore, the National College Health Assessment finds that 56% of students do not meet physical activity guidelines and 44% sleep less than the recommended hours (Hutchesson et al., 2023). The transition from high school to university carries a significant risk of misbehaviour, as it is at this stage that the habits of adulthood are stabilised (Peng et al., 2022).

Authors	Title	Study and sample
Aljayyousi et al	Addressing context to understand physical activity among Muslim university students: the role of gender, family, and culture	Investigation on how university students' physical activity can be influenced by sociocultural factors,
Deng et al	Sports motivation in Chinese college students: A systematic review	Systematic review of sport motivation in college student
Ge et al	The Motor Function Evaluation of College Students' Physical Activity State From the Perspective of Educational Psychology	Evaluation of Motor Function and how its correlated with physical activity state of university student
Hutchesson et al	Health behavior interventions for university students measuring mental health outcomes: A scoping review	Scoping review of interventions to improve health behaviour
Hutchesson et al	Are health behaviors associated with mental health among tertiary education students? A systematic review of cohort studies	Systematic review to analyze the association between health behaviours and mental health
Peng et al	The Effectiveness of E-Health Interventions Promoting Physical Activity and Reducing Sedentary Behavior in College Students: A Systematic Review and Meta-Analysis of Randomized Controlled Trials	Systematic review of several e-health interventions and their effectiveness in promoting physical activity in university student
Whatnall et al	Are health behaviors associated with academic performance among tertiary education students? A systematic review of cohort studies	Analysis of association between academic performance and healthy behaviour in university student
Wilson et al	A Scoping Review on College Student Physical Activity: How Do Researchers Measure Activity and Examine Inequities?	Scoping review of physical activity in college student
Babaer et al	Physical Activity, Sedentary Behavior and Educational Outcomes in University Students: A Systematic Review	Systematic review of correlation between physical activity, sedentary behaviour and academic performance
Ferreira Silva et al	Barriers to high school and university students' physical activity: A systematic review protocol	Systematic review to evaluate barriers to physical activity in high school and college students
Herbert Cornelia	Enhancing Mental Health, Well-Being and Active Lifestyles of University Students by Means of Physical Activity and Exercise Research Programs	The use of exercise to improve physical activity, mental health in university students
Li and Zhong	Quality of life among college students and its associated factors: a narrative review	Review of the quality of life of college students
Lyzwinsky et al	The Relationship between Stress and Maladaptive Weight-Related Behaviors in College Students: A Review of the Literature	Review of correlation between stress and weight management
Morassut et al	Identifying factors associated with obesity traits in undergraduate students: a scoping review	Review of factors associated with obesity in undergraduate students
Moscatelli et al	Assessment of Lifestyle, Eating Habits and the Effect of Nutritional Education among Undergraduate Students in Southern Italy	Analysis to assess and improve lifestyle, diet habits and lifestyle in undergraduate students with nutritional education

Tab. 3 Summary of the studies analysed in this contribution

Peng's systematic review on the use of e-health interventions to increase physical activity and reduce sedentariness among university students highlighted lack of motivation as a major limitation (Peng et al., 2022). However, university students, familiar with digital technology, can benefit from e-health interventions, which require personalisation and appropriate change behaviour techniques. Moving away from families, dealing with academic pressures and new life routines cause anxiety and stress, often exacerbated by a lack of physical activity and sleep (Hutchesson et al., 2023). Physical activity is therefore also a protective factor for mental well-being. Moderate-intensity exercises practised three times a week can reduce depressive symptoms and stress in students, while low-intensity exercises such as yoga can have positive effects on general well-being (Herbert, 2022). Moscatelli's (2023) study of out-of-school students in Southern Italy highlighted the importance of lifestyle training, with results showing a reduction in blood pressure, increased physical activity and greater attention to diet. These interventions can improve students' habits, confirming the need to promote healthy choices during the university period.

Physical Activity, University Students and Academic Performance

A final aspect that has emerged from the literature (Tab. 4) is the improvement of academic performance and achievement in correlation with physical activity. Higher aerobic capacity (VO₂max) improves problem-solving skills, cognitive flexibility and attention in young adults with high academic performance (Bayramlar et al., 2022). Intense physical activity interventions have a positive effect on attention, processing speed and inhibition (Haverkamp et al., 2020). Furthermore, metaanalysis physical activity interventions have a positive effect on processing speed, attention, cognitive flexibility, working memory and language, with the greatest effect found on working memory (Haverkamp et al., 2020). Physical activity is considered a key factor that can significantly influence academic performance. Previous studies have shown improvements in various cognitive abilities, such as execution, decision-making, perception, concentration and memory, which may benefit from regular exercise (Redondo - Florèz et al., 2022). Furthermore, stress has been identified as a factor that can impair academic performance, causing concentration difficulties and reduced mnemonic capacity. Anxiety is also correlated with academic success, with higher levels of anxiety associated with poorer academic performance (Redondo-Florèz et al., 2022). In the Redondo-Florèz study, the results partially confirmed the initial hypothesis: students with higher academic performance had a higher VO₂ max and lower diastolic blood pressure, whereas the group with lower academic performance showed higher diastolic blood pressure values. Insomnia caused by breathing problems was more common in the lower academic performance group. Low sleep quality and insomnia can negatively influence academic performance. Physical activity is crucial for improving academic performance as it stimulates neurotrophic brain factors and promotes general health. Student programmes that promote exercise and sleep habits can improve academic performance.

Author	Title	Study
Bayramlar et al	The relationship between aerobic capacity and cognitive/academic performance in medical students	Analysis of correlation between VO2max and cognitive and academic performance
Daniels et al	Variables affecting first-year student commitment during the transition to college in Ireland	Analysis of well-being as a predictor factor of commitment in students that pass from high school to college
Diaz-Serrano and Stoyanova	The relationship between overweight and education revisited: a test of the selection hypothesis based on adolescents' educational aspirations	Study of process that links overweight/obesity with the educational aspirations of adolescents.
Frazier and Doyle Foase	Nurturing positive mental health and wellbeing in educational settings - the PRICES model	Implementation of social and emotional learning programs as a means of health promotion in educational settings
Hargens et al	Markers of poor sleep quality increase sedentary behavior in college students as derived from accelerometry.	Analysis of correlation of poor sleep and sedentary behaviour on physical activity
Haverkamp et al	Effects of physical activity interventions on cognitive outcomes and academic performance in adolescents and young adults: A meta-analysis	Meta-analysis of the correlation of physical activity and cognitive outcomes
Hill et al	The relationship between obesity and tertiary education outcomes: a systematic review	Analysis of an association between obesity and <u>academic</u> achievement
Langford et al	Links between obesity, weight stigma and learning in adolescence: a qualitative study	Analysis to explain the possible association of having a not healthy weight and a low academic performance
Nightingale et al	Bi-directional relationships between physical activity and stress in college aged students: a brief report	Analysis of bidirectional relationships between physical activity and stress in college students
Ong et al	Is There an Association between Health Risk Behaviours and Academic Achievement among University Students?	Association between individual and multiple health risk behaviours and academic achievement
Redondo-Floréz et al	Relationship between Physical Fitness and Academic Performance in University Students	Analysis of several factors affecting academic performance with focus on physical activity
Seilo et al	Associations between e-health questionnaire responses, health checks and graduation: Finnish register-based study of 2011-2012 university entrants	Questionnaires to evaluate the affection of several health factors
Warnick et al	Perceptions of Health Behaviors and Mobile Health Applications in an Academically Elite College Population to Inform a Targeted Health Promotion Program	Investigation on the possible use of health promotion on mobile devices among college students
Wernack et al	Prospective associations of different contexts of physical activity with psychological distress and well-being among middle-aged adults: An analysis of the 1970 British Cohort Study	Investigation of various forms and social settings of leisure-time physical activity to analyse <u>which</u> are linked to psychological distress and well-being
Wold et al	University Student Health and Wellbeing Study: A test-retest reliability study of a web-based survey investigating undergraduate student health and wellbeing	Web survey on health and wellbeing among college students
Yuen and Honda	Predicting Physician Assistant Program Matriculation Among Diverse Applicants: The Influences of Underrepresented Minority Status, Age, and Gender	Analysis of how physician assistant (PA) applicants' demographic characteristics and prior academic history affected likelihood of PA program matriculation

Tab. 4 Summary of the studies analysed in this contribution

Conclusions

The final discussion of this study focuses on the importance of using artificial intelligence (AI) to improve university students' lifestyles, increase physical activity, and reduce sedentariness, with a focus on its correlation with academic performance. AI offers enormous potential in transforming physical activity promotion initiatives among university students. Mobile apps, wearable devices, and AI-based software provide real-time, personalised feedback, revolutionising traditional approaches to physical activity promotion. However, despite the growing interest, there is still a gap in the literature regarding the specific use of AI to promote physical activity among university students and its impact on their academic health and performance. This study sought to fill this gap by examining current evidence on AI-guided physical activity interventions among university students. The results showed that physical activity is crucial not only for improving health but also for positively influencing academic performance by reducing stress and enhancing concentration and motivation. Furthermore, the data analysis revealed that university students often lead sedentary lifestyles associated with mental well-being problems such as stress and anxiety. However, physical activity can improve both the lifestyle and mental well-being of students. AI-based

interventions can provide personalised and ongoing support, helping to overcome the challenges associated with promoting physical activity among university students.

In conclusion, integrating AI into initiatives that promote physical activity among university students presents new opportunities to enhance their physical and mental well-being, as well as their academic success. However, further research is essential to fully understand the potential of AI in this context and to ensure that these initiatives are ethical, effective, and accessible to all students. Specifically, future research should address the ethical issues that emerged from this study that we can resume in 4 main focuses:

- 1) The risk of isolation caused by using chatbots, virtual coaches, tele and home exercise;**
- 2) The unfamiliarity with technology;**
- 3) AI's lack of emotional intelligence and ability to empathize with users;**
- 4) Concerns about privacy and the use of data recorded by AI-based devices.**

This study serves as a foundation for future investigations into leveraging AI to encourage physical activity and improve the lives of university students.

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