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SYSTEMATIC REVIEW

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The impact and perceptions of standing desk interventions on movement patterns and physical, mental, and academic outcomes in university students: a scoping review

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Abstract

Background The use of standing desks may reduce sedentary behavior and, in turn, improve other health and academic outcomes. However, the evidence is sparse among university settings. The aim of this scoping review was to identify and map evidence for the effects of standing desk interventions on sedentary behavior and physical, mental, and academic outcomes in university students, as well as instructors and students' perceptions of this type of equipment in the classroom.

Methods A scoping review was conducted in accordance with the Joanna Briggs Institute and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Review guidelines. PubMed, Web of Science, Scopus, PsycINFO, PubPsych and ERIC databases were searched for qualitative and quantitative studies from their inception to 2024. Narrative synthesis and network plots were used to summarize the available evidence.

Results Seventeen studies involving 2886 university students and 163 instructors were included. Fourteen studies were experimental and three were cross-sectional. In seven studies standing desks improved movement patterns (sitting and standing time in the classroom) and in four studies improved mental health outcomes (anxiety, mood, stress, and positive or negative feelings). Four studies analyzed pain and discomfort, one found significant improvements and three found mixed results. Eleven studies analyzed academic and classroom outcomes and seven found significant improvements in the standing desks group and five did not. Additionally, the use of standing desks was accepted and positively perceived by students in ten studies and by instructors in two.

Conclusions The implementation of standing desks at university settings could be a behavioral intervention for improving movement patterns and mental health. However, the extant evidence is sparse; further long-term, high-quality trials are needed to draw robust conclusions.

Keywords Sit-stand desks, University, Sedentary behavior, Physical activity, Classroom behavior, Cardiometabolic risk factors, Pain, Mental health, Cognition, Health

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Background

Physical inactivity and sedentary behavior among young adults are growing health problems worldwide [1]. Sedentary behavior has been defined as sitting, lying down, and expending very little energy (approximately 1.0–1.5 metabolic equivalents) [2]. This behavior has far-reaching consequences for public health, contributing to an increase in cardiovascular diseases, and other related conditions [3, 4]. Sedentary lifestyles are not only associated with physical health risks, but also affect mental well-being, leading to increased stress and depression, reduced overall quality of life and decreased cognitive function [4, 5]. Furthermore, university students are at risk of high levels of sedentary behavior due to the amount of time spent in class, studying or in front of a computer [6]. It has been estimated that university students spend more than 7 h per day sitting, resulting in more sedentary time than the general young adult population does, which has been associated with an increased risk of adverse health outcomes [7]. Therefore, effective interventions to reduce sedentary time during the university stage are needed.

Non-exercise physical activity (NEPA), refers to the physical motion of the body in activities that do not pertain to volitional exercise, including all activities of daily living (fidgeting, maintaining posture and ambulation), whereas non-exercise activity thermogenesis (NEAT) defines the energy expenditure associated with these activities [8]. This term has gained increasing attention as a determinant of metabolic and mental health [9]. In academic settings, standing desks may promote NEPA by encouraging postural transitions and reducing prolonged sedentary time, to increase physical activity levels and the subsequent levels of NEAT [9]. Given that students spend much of their time attending lectures and sitting in classrooms [7], replacing traditional university desks with standing desks can reduce sitting time and provide other benefits [10]. Standing desks, also known as sit-stand desks, involve the use of height-adjustable or standing workstations. Replacing traditional desks in classrooms with standing workstations is expected to reduce sitting time, increase standing and light ambulatory movement, improve postural control and musculoskeletal symptoms and increase energy expenditure in adults and in school contexts [11–13]. Studies in schoolchildren and young adults have suggested that standing desks may also have benefits for academic performance, cognitive function, time spent on tasks, and other important academic and behavioral outcomes [14, 15], although evidence is sparse and inconclusive results have also been reported [15, 16].

A previous systematic review on the effects of standing desks in school classrooms revealed an increase in standing time (ranging from 24-40 min per school day) and a decrease in sitting time (ranging from 59-64 min), whereas some studies reported increased physical activity and energy expenditure and improved classroom behavior in children and adolescents aged 5-18 years [17]. Other studies reported that an increase in energy expenditure was the only consistently reported positive outcome, while mixed results were found for sitting and standing time and step counts [10].

Regarding academic outcomes, previous research has suggested that sedentary time is associated with poor academic and cognitive outcomes in children and adolescents. Therefore, a reduction in sedentarism may have a beneficial effect on these outcomes [5]. Two controlled trials have shown no differences in cognition or academic outcomes in a classroom with standing desks as opposed to a traditional classroom [18, 19]. However, some research has identified indirect benefits, including improvements in better on-task attention and executive function [20], as well as higher self-reported focus and engagement [21]. Notably, from the findings of these studies suggests that implementing standing desks in the classroom is feasible, and does not adversely affect learning outcomes [10, 17].

To our knowledge, no study has comprehensively reviewed the available evidence on the impact of standing desks in university classrooms on health and academic outcomes. Previous reviews primarily focused on school-aged children and adolescents; however, there is a lack of studies involving university students, a crucial period for the establishment of long-term health behaviors in a population characterized by high levels of sedentary behavior [6]. The high cost of standing desk interventions makes it necessary to collect more evidence on its effect before being widely implemented. Furthermore, the inclusion of instructors is key to the implementation of interventions in the classroom. Despite the high cost, wide-scale adoption of standing desks could have long-term economic benefits compared to the healthcare costs associated with high sitting time [22]. In this context, the aim of this scoping review was to identify and map evidence on the effects of standing desk interventions on university classrooms. Specifically, this study aimed to (i) describe standing desk interventions in university classrooms; (ii) explore their impact on physical and mental health and academic outcomes; and (iii) synthesize the perceptions and acceptability of standing desk interventions among students and instructors.

Methods

Protocol and registration

This scoping review followed the guidelines of the Joanna Briggs Methods Manual for Scoping Reviews [23] and the Preferred Reporting Items for Systematic Reviews and

Meta-Analyses extension for Scoping Review (PRISMA-ScR) [24]. The study protocol was registered at the Open Science Framework (https://doi.org/10.17605/OSF.IO/X8BYD).

Eligibility criteria

Participants

Undergraduate or postgraduate university students attending classes in person and their instructors (e.g., lecturers, professors). Studies conducted with primary or secondary school children, administrative and service staff, or work officers were excluded. Studies with university staff who did not attend classes were excluded.

Concept

Studies that investigated the effects and perceptions of standing desks in university classrooms. Any intervention that increased standing time but did not use standing desks (e.g., active learning classrooms, or open/flexible classrooms or spaces) was excluded.

Studies that analyzed movement behaviors (i.e., physical activity, sedentary time, standing and sitting time), physical health (i.e., body mass index, cardiometabolic risk factors, musculoskeletal pain), mental health (i.e., anxiety, stress, depression, psychological well-being), academic and classroom outcomes (e.g., academic performance, fatigue, attention), or student and instructors' perceptions (e.g., acceptability, perceived barriers and facilitators) of standing desks were of interest for this review.

Context

Studies conducted in university classrooms or laboratories. Non-university classrooms (e.g., vocational training) and out-of-class interventions (e.g., standing desks placed at home or in the library) were excluded. Intervention studies (randomized controlled trials [RCTs], non-RCT, quasi-experimental studies, pre-post studies and interrupted time-series studies) and observational studies (prospective and retrospective cohort studies, case-control studies, case series and individual case studies, and cross-sectional studies) were considered for inclusion. Text and opinion articles, conferences and reviews were excluded.

Search strategy

First, two authors (MEVA and MSL) independently conducted a systematic search of peer-reviewed scientific articles in the PubMed, Web of Science, Scopus, PsycINFO, PubPsych and ERIC databases. A complete search strategy (Supplementary Material Table 1) was developed using the text words contained in the titles and abstracts of relevant articles, and the index terms used to describe the articles. The search strategy, including all identified keywords and index terms, was adapted for each electronic database and information source. Furthermore, the reference lists of all included studies were screened for additional studies. Second, gray literature was searched through Google Scholar to identify other eligible studies. Studies published from inception to 20 January 2024 were included. No language or other restrictions were applied.

Study selection

The search terms were entered into each electronic database and all identified citations were collated and uploaded into EndNote (version 20, Clarivate Analytics). Duplicates were removed, and titles and abstracts were then screened by two independent reviewers (MEVA and MSL) for eligibility against the inclusion/exclusion criteria. These independent reviewers assessed the full texts of the selected articles. The reasons for the exclusion of those studies that did not meet the inclusion criteria were recorded and reported in the scoping review. Disagreements between the reviewers at each stage of the selection process were resolved by discussion, and if disagreements persisted, a third author (VMV) was consulted. The results of the search and study inclusion process are fully reported in the final scoping review and presented in a PRISMA-ScR flowchart [24].

Data extraction

Two independent reviewers (MEVA and MSL) extracted the data from the studies included in the scoping review using an Excel spreadsheet developed by the authors. The extracted data included specific details on study characteristics (e.g., authors, year of publication, country, design, aims), population (i.e., sample size, mean age, % female, recruitment method), standing desk intervention protocols, control groups, and key findings of the studies. The data are provided as tables in the results section. Any disagreement that arose between the reviewers was resolved through discussion, and when disagreement persisted, a third author (VMV) was consulted.

Data analysis and synthesis

A narrative synthesis was conducted to summarize the results. Additionally, we performed a series of network geometry graphs to show the associations between the study designs and outcome groups. These data were used to identify the main topics on the research question. Network geometry plots were generated using STATA SE software (v.18, StataCorp, College Station, TX, USA).

Quality assessment of included studies

Two investigators independently assessed the methodological quality of the included studies using The Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies, the Quality Assessment Tool for Before-After (Pre-Post) Studies with No Control Group, and The Quality Assessment of Controlled Intervention Studies [25]. This tool evaluates 14 items for cross-sectional, longitudinal and intervention studies, and 12 for pre-post studies. Each item was rated as 'Yes', 'No', cannot determine, not applicable, or not reported. Each study was rated as follows: "good" when the study had the least risk of bias, and the results were considered valid; "fair" when the study was susceptible to some bias deemed not sufficient to invalidate its results; and "poor" when the study had a significant risk of bias.

Results

The electronic searches retrieved 675 references. After the removal of duplicate studies, 608 studies were reviewed based on title and abstract. Following this process, the full texts of 32 studies were reviewed and 15 were excluded (Supplementary Material Table 2). Five additional studies were identified after screening the reference lists of eligible articles, three of which were selected. Finally, 17 studies that met the eligibility criteria were included. The selection process is shown in Fig. 1.

Study design and participants

The 17 selected studies were published from 2016 to 2023 and included 2886 university students aged 18.7 to 25.0 years. Two studies also included a sample of instructors (n =163) [26, 27]. Among the 17 studies included in this scoping review, three studies were cross-sectional studies [26, 28, 29]; seven were RCTs [30–36], of which two were counterbalanced trials [31, 36], one was a cross-over trial [32] and four were parallel trials [30, 33–35]; and seven were non-RCTs [20, 30–35], of which three studies used a quasi-experimental design [37, 38, 41] and used a pretest–posttest design [20, 32, 33, 35]. Furthermore, two of these studies used qualitative analyses [29, 39]. The sample sizes ranged from 21 to 993 students for the quantitative studies and from 25 to 210 for the qualitative studies. The main characteristics of the included studies are displayed in Tables 1 and 2.

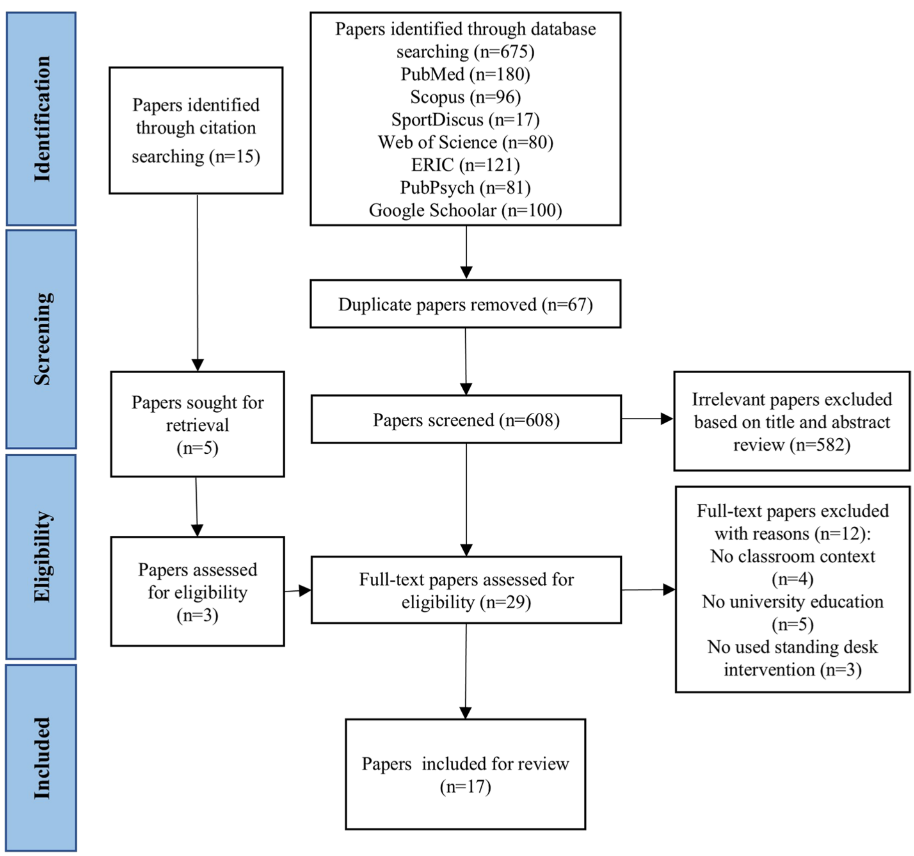

Fig. 1 PRISMA flow chart of the study selection process

Table 1 Characteristics of the included studies

Author (year)	Country	Study design	N (% female)	Age, mean (SD)	Recruitment
Bantoft et al. (2016) [31]	Australia	Counterbalanced RCT	45 students (71.1)	22.7 (6.3)	University, NR
Benzo et al. (2016) [26]	United States	Cross-sectional	993 students (69.7); 149 instructors (57.1)	20.4 (4.1); 43.1 (13.7)	By email, university
Butler et al. (2018) [32]	United States	Cross-over RCT	21 students (38.1)	22.7 (6.4)	Poster advertisement and word-of-mouth
Chim et al. (2021) [35]	The Netherlands	Parallel RCT	96 students (53.0)	19.9 (1.4)	Convenience sample of first year students
Chrisman et al. (2020) [42]	United States	Pre-post trial	22 students (73.0)	25.3 (6.2)	Flyers on campus and word of mouth
Chrisman et al. (2021) [30]	United States	Parallel RCT	48 students (90.0); IG: 21; CG: 27	21.5 (4.9)	Flyers and posters on the campus
Finch et al. (2017) [36]	United States	Counterbalanced RCT	96 students (80.2)	20.9 (3.0)	Convenience sample from psychology university
Frost & Terbizan (2018) [34]	United States	Parallel RCT	23 students (NR); IG: 14; CG: 9	IG: 21.2 (3.5); CG: 23.8 (6.6)	Two classes of a university
Frost & Terbizan (2020) [33]	United States	Parallel RCT	23 students (NR); IG: 14; CG: 9	IG: 23.8 (6.6); CG: 21.2 (3.5)	Two classes of a university
Goodrich et al. (2020) [29]	United States	Cross-sectional and qualitative	210 students (NR)	NR	Purposive sampling at business school
Green et al. (2020) [37]	United States	Quasi-experimental crossover	88 students (54.5)	21.6 (6.6)	Purposive sampling of a classroom
Grosprêtre et al. (2021) [27]	France	Pre-post trial	663 students (37.1); 14 instructors (75.0)	18.7 (1.6); NR	Purposive sample of one classroom
Jerome et al. (2017) [38]	United States	Quasi-experimental crossover	304 students (73.9)	20.1 (1.3)	Purposive sample of two classrooms
Moulin et al. (2022) [39]	Canada	Pre-post trial and qualitative	Study 1: 25 students (95.0) Study 2: 28 students (82.0)	NR	Email and social networks in university
Raulli (2017) [40]	United States	Pre-post trial	50 students (58.0)	21.3 (2.6)	Purposive sample of a university course
Rostami et al. (2022) [41]	Iran	Quasi-experimental crossover	40 students (50.0)	25.0 (1.6)	Random sampling
Sengupta & Kuilan (2023) [28]	United States	Cross-sectional	178 students (33.0)	22.4 (4.7)	Random sampling by email

Abbreviations: *CG* control group, *IG* intervention group, *N* sample size, *NR* not reported, *RCT* randomized controlled trial, *SD* standard deviation

Study aims

Seven studies evaluated movement patterns, such as physical activity, sedentarism, standing and sitting time [26, 30, 34, 35, 38–40]; two studies assessed general physical health [29, 38]; three studies estimated musculoskeletal pain and physical discomfort [27, 33, 40]; one study evaluated cardiometabolic risk [32]; four studies analyzed mental health (i.e., anxiety, depression, or mood) [27, 33, 36, 37]; eight studies measured academic and classroom indicators (i.e., academic performance, fatigue, attention, or engagement) [26, 27, 33, 34, 36–38, 40]; and two studies evaluated cognitive functions [31, 41].

Studies using quantitative and qualitative techniques aimed to explore the following: 10 studies on students' perceptions, such as acceptability and feasibility [26–28, 33, 38, 39], preferences [42], self-perceived usage of the standing desks [34], attitudes [29], and experiences [39] toward standing desk interventions in college classrooms; and two studies on reasons for using/not using standing desks [38, 42] and instructors' perceptions [26, 27].

Interventions

This review includes interventions conducted in a single session [30, 31, 36, 41], in 4 sessions [42] and in 6 sessions [37]. Interventions lasted 2 weeks [40], 3 weeks [32], 4 weeks [39], 9 weeks [35], 12 weeks [38], 13 weeks [33] and 24 weeks [27, 34]. All the 14 studies that included interventions involved replacing traditional desks with standing desks, which were provided with adjustable stools. The specific modalities and characteristics of the intervention and control groups are detailed in Table 2.

Table 2 Aims, intervention, study variables and main results of the included studies

Reference	Aims	Intervention and comparator; duration if applicable	Variables (instrument)	Key findings
Bantoft et al. (2016) [31]	To investigate cognitive consequences of sitting, using standing desks and using standing desks while walking on a treadmill	Sitting on the traditional desk Static standing: using adjustable standing desks Walking: low intensity walking in a treadmill while working at standing desks 1 session	Cognition: verbal short-term memory (Digit Span forward), verbal working memory (Digit Span backward), visuomotor speed and learning (Digit Symbol Coding), verbal working memory and attention (Letter Number Sequencing), verbal selective attention (Stroop Colour Word Test,), visual information processing speed (Choice Reaction Time), sustained attention (Paced Auditory Serial Addition Task)	No significant change in cognition. Cognitive performance was not deteriorated with the use of standing workstations
Benzo et al. (2016) [26]	To explore the acceptability and feasibility of standing desks in traditional college classrooms	NA	Students: Percentage of class time spent sitting, percentage of class they would stand if standing desks were available, perceived positive health and academic changes (survey) Instructors: Experience with standing desks, attitude toward standing desks, ideal location of standing desks, health and academic outcomes would change for students with standing desks (survey)	Instructors and students were in favor of introducing standing desks. Most students, 83%, spent sitting the entire classes, 77% would be standing if available. Half of students reported that their physical health, attention and restlessness would improve with standing desks
Butler et al. (2018) [32]	To assess the effectiveness of a standing desks classroom for attenuating cardiometabolic risk	IG: standing desks, standing during at least two different class periods/week, this totaled to a minimum of 5 h/week of standing; 3 weeks CG: sitting; 3 weeks *Both trials were separated by 1 week of washout (sitting)	Blood pressure (sphygmomanometer) Fasting lipids and blood glucose (Cholestech LDX System) METs of sitting and standing (Parvo Medics TrueOne 2400 Metabolic Measurement System)	Standing desk intervention improved all cardiometabolic risk factors; METs were significantly higher in standing desk condition than during sitting
Chim et al. (2021) [35]	To investigate the effects of a standing desk intervention on physical activity behavior	IG: standing desks CG: traditional sitting desk 9 weeks	Physical activity behavior, sedentary behavior, light physical activity, moderate-to-vigorous physical activity and lying (activPAL3™)	The stand group showed less sedentary time and more light, moderate-to vigorous physical activity compared to the sit group. Additionally, broke up prolonged sedentarism more frequently

Table 2 (continued)

Reference	Aims	Intervention and comparator; duration if applicable	Variables (instrument)	Key findings
Chrisman et al. (2020) [42]	To assess college students' preferences of standing desks and reasons for or against standing desks	IG1: stand-alone desks (GD Marketing, USA), adjustable from 67 to 113 cm, with stools IG2: portable table-top desks (Desk Riser 28X, Colorado, USA), adjustable from 8 to 36 cm off a desk, with three height settings, with stools *Study protocol for both conditions were sitting 5 min, standing 5 min, sitting 10 min and standing 10 min Four sessions	Student preferences, acceptability, and reasons (survey)	More than half of students preferred the table-top desk, most found the seat and stool acceptable; and 14/22 reported willingness to use standing desks in the classroom, only one reported they would not use them. The reasons to use standing desks were to improve health, prefer standing to sitting, being more attentive, alert and awake and battling boredom. Reasons for not using standing desks were being tired, prefer sitting, feeling hurt, sick or dizzy
Chrisman et al. (2021) [30]	To determine sitting and standing time in students when given access to standing desks and being provided with visual and oral prompts to promote standing and to examine facilitators and barriers to using standing desks	IG: standing desks (Desk Riser 28X, Longmont, CO, USA) with a stool, and told they could sit or stand, whichever they were comfortable with + instructor-provided visual and oral prompts to stand CG: standing desks without prompts 1 session	Sitting and standing time, sit-to-stand transitions and METs (ActivPAL) Use of standing desks, reasons for standing or not, barriers to standing, optimal amount of time to stand in class, opinion about prompts (questionnaire)	CG spent more time sitting, less standing time and less METs, whereas standing desks group had more standing time, less sitting time and more METs, no differences in transitions were reported. Facilitators for standing included breaking up sitting, reduce back pain, and increasing attention and focus; main barriers were not wanting to distract others or being the only one standing. Most of students found the prompts adequate
Finch et al. (2017) [36]	To test for differences in reading comprehension and creativity in standing desks versus sitting desk	Standing desk workstation electronically adjustable (Jarvis, Xinchang, China) Stand condition Sit condition with an office chair with back support 1 session	Reading and comprehension (Graduate Record Examination General Test) Creativity (Wallach and Kogan Creativity Test) Perceived task difficulty and effort (questionnaire) Mood (Positive and Negative Affect Schedule) Performance expectation (questionnaire)	No differences in reading comprehension or creativity, in perceived task difficulty and effort, or the time to complete the tasks were found. Participants reported more positive emotions in standing condition, however reported more comfort sitting
Frost & Terbizan (2018) [34]	To determine the pattern of standing desks usage, the relationship to movement outside of class, and if the participants liked using the standing desks	IG: standing desks, participants were instructed to use the standing desks in standing position as much as they want and to shift position CG: traditional sitting desk 6 months	Sit and stand time at the classroom (video camara) Sitting, standing, and movement duration for 7 days (Actigraph GT3X +) Perception and attitude toward standing desks (questionnaire)	Some participants stood and had more standing time. High variability between individuals and semester periods were reported. Perceptions toward standing desks were positive and perceived that standing desks improved their ability to work in class. No differences in outside physical activity were reported

Table 2 (continued)

Reference	Aims	Intervention and comparator; duration if applicable	Variables (instrument)	Key findings
Frost & Terbizan (2020) [33]	To determine the effect of using standing desks on attention, stress, anxiety, musculoskeletal discomfort, and academic performance	IG: 15 Standing desks (LearnFit model, Ergotron Inc., St. Paul, Minnesota) with a highchair. The participants were instructed to use desks in the standing position as much as they want and to shift from one position to the other CG: traditional sitting desk 13 weeks	Subjective attention, stress, anxiety, musculoskeletal discomfort (Visual Analogue Scale) Direct observation of attention and on-task behavior (video record)	The IG reported more subjective attention, less stress and low musculoskeletal discomfort; on-task behavior and direct observation of attention were not different between groups
Goodrich et al. (2020) [29]	To examine the impact of standing desks on students' health and wellness orientations on the perceived importance of health benefits and to explore users' attitude toward standing desks	NA	Attitude toward the standing desks, health motivation, wellness orientations, ones' perceived ability to influence others, value consciousness, students perceived importance of calorie reduction, discomfort, cognitive attention, intention to use the standing desks at school (online survey)	Students thought that university should provide standing desks, and they would use them if they had the choice. The perceived benefits were weight loss, enhanced productivity and reduced back pain. Calorie reduction and potential cognitive benefits affected attitude towards standing desks, which positively impacted intentions to use
Green et al. (2020) [37]	To examine student responses to sitting versus standing and to compare sitting versus standing on student mood and interest in standing options in classrooms	IG: standing desks CG: traditional sitting desk 6 sessions	Mood (ad hoc scale) Attention and concentration, alertness and energy during the class, class participation, interest in standing desks, choice of standing desks or traditional desk (survey)	Mood increased in standing desks. Most participants preferred standing desks, and perceived that standing desks improve their ability to focus, pay attention, concentrate, alertness, energy and participation; most of them showed interest in standing desks, 91% reported that they would elect to use the standing desks
Grosprêtre et al. (2021) [27]	To test the feasibility and acceptability active workstations (including standing desks), and its impact on subjective markers of fatigue, attention and concentration and the lecturers' point of view	4 active workstations: 6 standing desks (Skarsta, Ikea, Plaisir, France) with chairs; 6 Swiss balls; 6 cycling desks; 6 stepper-boards; 6 months *Students were free to use or not the active workstations and standing desks or not, traditional workstations were still present	Students: Feelings about the use of standing desks on physical aspects (activity, pain, fatigue, comfort), psycho-cognitive aspects (attention, stress, anxiety, participation, distraction) and academic aspects, intention to reuse standing desks in future (survey) Instructors: Observations about the students' behavior on psycho-cognitive and academic aspects, willingness to reuse standing desks in future (survey)	Standing desks were the second chosen workstation; 19% perceived a decrease in discomfort and pain and a 26% decrease in fatigue in standing desks compared with traditional workstations. Conversely, 36% of students perceived an increase in discomfort and pain in standing desks. Most lecturers were willing to use standing desks

Table 2 (continued)

Reference	Aims	Intervention and comparator; duration if applicable	Variables (instrument)	Key findings
Jerome et al. (2017) [38]	To test the effect of installing standing desks on a traditional seated university classroom on standing time, sitting time, and sit-stand transitions; and to examine student's perceived impact on health, engagement, acceptability of standing desks, and reasons for using/not using standing desks	IG: 25 height adjustable standing desks (BALT Up-Rite Student Table, MooreCo Inc.) and stools, no specific goals related to sitting or standing were provided but a motivation prompt was placed on top of each standing desks; 6 weeks CG: traditional seated desks; 6 weeks	Sitting and standing behavior in classroom (observation) Students' support for introducing standing desks, perceived impact of using standing desks on engagement and affective outcomes; reasons for standing or not (online survey)	Standing desks classroom stood significantly more min/h and for greater part of class time; sitting time decreased. More than a third of students reported that attention, participation, focus, and engagement improved, and boredom, fatigue and restlessness decreased; 71% of students supported adding standing desks to classrooms
Moulin et al. (2022) [39]	To determine the feasibility of a mobile standing desk intervention and its impact on sedentary time; and to gain understanding of students' experiences with standing desks	Mobile standing desks Study 1: 1 week Study 2: 1 month	Objective sedentary time (ActivPAL4™) Subjective sedentary time (NIGHTLY-WEEK-U questionnaire) Experience with the standing desks, facilitators/barriers, use and attitude toward standing desks (semi-structured interview in study 1 and online survey in study 2)	Mobile standing desks reduced sedentary time. Facilitators for the use of standing desks were desire to have the option to stand, previous knowledge of dangers of sitting, and increase productivity. Participants reported that standing while classmates were sitting was socially uncomfortable and that using the standing desk in the classroom was problematic because they had to use a desk at the back of the classroom to not block the view to others
Raulli (2017) [40]	To determine the effect of instructor-leading breaks on student standing time, student sitting time, and number of sit-to-stand transitions, physical discomfort and alertness during standing desks classroom	Condition 1: adjustable standing desks with stools Condition 2: standing desks + instructor-led activity breaks every 30 min 2 weeks	Standing time, sitting time and stand-to-sit transitions, steps, METs (ActivPal) Physical discomfort (General Comfort Scale) Alertness (Standard Sleepiness Scale) Engagement during class (survey)	Both conditions standing desks had similar percentage of class sitting, standing and transitions, no differences in perceived discomfort or alertness were found. Students valued the contribution of the instructor as close to neutral
Rostami et al. (2022) [41]	To assess cognitive and skill performance of students in standing desks compared with sitting workstations	Condition 1: standing desks; 1 session Condition 2: sitting desk; 1 session *Both trials were separated by a rest period	Working memory (N-back test), selective attention and cognitive flexibility (Stroop Test), reaction time (Advanced reaction time test), bimanual coordination (Two arm coordination test), finger motor skills and gross hand skills (Purdue pegboard test) Comfort (Visual Analogue Scale)	No statistically significant difference between the sitting and standing positions in n-back, Stroop, advanced reaction time, two arm coordination, and Purdue pegboard. Participants were more comfortable in sitting positions and more easily distracted in standing positions

Table 2 (continued)

Reference	Aims	Intervention and comparator; duration if applicable	Variables (instrument)	Key findings
Sengupta & Kuilan (2023) [28]	To explore students'opinions on the acceptability and opportunities of standing desks in the classroom	NA	Opinion about standing desks in the classroom, preference to sit or stand, students' prediction of changes in academic and health with standing desks (survey)	Students perceived standing desks acceptable, over 70% students favored the opportunity of having a standing desk in classrooms and most of the students predicted either no change or positive change academic (focus, restlessness, attention, boredom) and health (fatigue, back pain) domains

Abbreviations: *CG* control group, *IG* intervention group, *METs* metabolic equivalents, *NA* not applicable

Quality assessment

Of the seven controlled studies included all were rated as good quality [30–36]. The items on which most studies failed were the treatment allocation concealed, the blinding of research who assessed the outcomes, not reporting sample size calculations or lack of subgroup analyses. Of the cross-sectional studies one was rated as good [29] and two fair quality [26, 28]. The items on which most studies failed were that the exposure(s) of interest was not measured prior to the outcome, the timeframe was not sufficient to expect to see an association between exposure and outcome, and the assessors were not blinded. Of the seven quasi-experimental and pre-post studies, six were rated as good [37–42] and one as fair [27] quality. The items on which most studies failed were that the people assessing the outcomes were not blinded to the participants' intervention, and the outcome was not measured multiple times. See Supplementary Table 4.

Summary of key findings

Tables 2 and 3 present the descriptions and key findings by movement patterns, pain/discomfort, cardiometabolic health, mental health, academic and classroom behavior, cognition function, and participant perceptions. The associations between the study designs and outcome groups are displayed in Fig. 2.

Movement patterns

Among the studies ($n = 7$) assessing sitting and standing time in the classroom [26, 30, 34, 35, 38–40], five (two RCTs [30, 35, 38], two pre-post [39, 40]) reported significant improvements for the standing desks group compared with the control group; one pre-post study showed that both standing desks conditions had similar percentages of class sitting, standing and transitions [40]; one RCT did not find a clear pattern [34]; and one cross-sectional study reported that students were seated for a mean of 83% class time and that 77% of participants would stand for at least 25% class time if standing desks were applied [26].

Pain and discomfort outcomes

Among the studies ($n = 4$) that analyzed pain and discomfort [27, 33, 40, 41], one reported significant improvements in the standing desks group compared with the control group [33], one quasi-experimental crossover study indicated higher discomfort in standing positions [41], one pre-post study reported no differences in discomfort in 2 standing interventions with no sitting control group [40], and one pre-post showed mixed results [27].

Cardiometabolic outcomes

The only study [32] that analyzed the effects of the use of standing desks on cardiometabolic health reported improvements in cardiometabolic risk factors (i.e., blood glucose, blood pressure, high-density lipoprotein cholesterol, and triglycerides) and increased caloric expenditure in the intervention group.

Mental health outcomes

Among the studies (n = 4) that analyzed mental health [27, 33, 36, 37], three reported significant improvements in the standing desks group compared with the control group [27, 33, 36, 37], and one reported significant pre-post benefits in the standing desk intervention [27].

Academic and classroom outcomes

Among the studies (n = 11) that analyzed academic and classroom outcomes (e.g., academic performance, fatigue, attention, restlessness, or boredom during lectures) [26–28, 33, 33, 36–41], two studies reported significant improvements in the standing desk group compared with the control group [34, 37, 38], two studies reported significant pre-post benefits in the standing desk interventions [27, 38–40], three studies indicated no significant differences between standing and control conditions [29, 31, 34, 36], one study reported no significant pre-post differences in alertness in 2 standing interventions [40], and two studies suggested positive expectations to improve academic outcomes [26, 28].

Cognitive function

The two studies [31, 41] assessing cognitive function did not report differences between the sitting and standing groups in working memory, selective attention and cognitive flexibility, reaction time, bimanual coordination and finger motor skills or gross hand skills [41] or in verbal short-term memory, verbal working memory, visuomotor speed and learning, verbal working memory and attention, verbal selective attention, visual information processing speed, or sustained attention [31]. One cross-sectional study [29] reported that students' perceptions of cognitive enhancements were among the most important influences on the use of standing desks.

Students' perceptions

Perceptions, acceptability, feasibility, preferences, reasons for use barriers and facilitators, and experiences were assessed in 10 studies [26–30, 33, 34, 38, 39, 42]. Overall, Grosprêtre et al. [27] reported that the majority of students were in favor of using active workstations and

Table 3 Summary of the effects of standing desk interventions in university students[a] [27, 29–41]

Reference	Study design	Movement patterns	Pain/discomfort	Cardio metabolic	Mental health	Academic / classroom	Cognitive function
Bantoft et al. (2016)	RCT	-	-	-	-	-	◀▶
Butler et al. (2018)	RCT	-	-	▲	-	-	-
Chim et al. (2021)	RCT	▲	-	-	-	-	-
Chrisman et al. (2021)	RCT	▲	-	-	-	-	-
Finch et al. (2017)	RCT	-	-	-	▲	◀▶	-
Frost & Terbizan (2018)	RCT	◀▶	-	-	-	▲	-
Frost & Terbizan (2020)	RCT	-	▲	-	▲	◀▶	-
Goodrich et al. (2020)	Cross-sectional	-	-	-	-	◀▶	▲
Green et al. (2020)	Quasi-experimental	-	-	-	▲	▲	-
Grosprêtre et al. (2021)	Pre-post trial	-	◀▶	-	▲	▲	-
Jerome et al. (2017)	Quasi-experimental	▲	-	-	-	▲	-
Moulin et al. (2021)	Pre-post trial	▲	-	-	-	▲	-
Raulli (2017)	Pre-post trial	▲	◀▶	-	-	◀▶	-
Rostami et al. (2020)	Quasi-experimental	-	▼	-	-	-	◀▶
Total		**5▲ 1◀▶**	**1▲ 2◀▶ 1▼**	**1▲**	**4▲**	**5▲ 4◀▶**	**1▲ 2◀▶**

Upward arrows ▲ = positive effects of standing desk interventions
sideways arrows ◀▶ = no differences or mixed results;
downward arrows ▼ = negative effects.

Abbreviations: *RCT* randomized controlled trial

[a] Prevalence data and results on students' and instructors' perceptions are not reported in this table

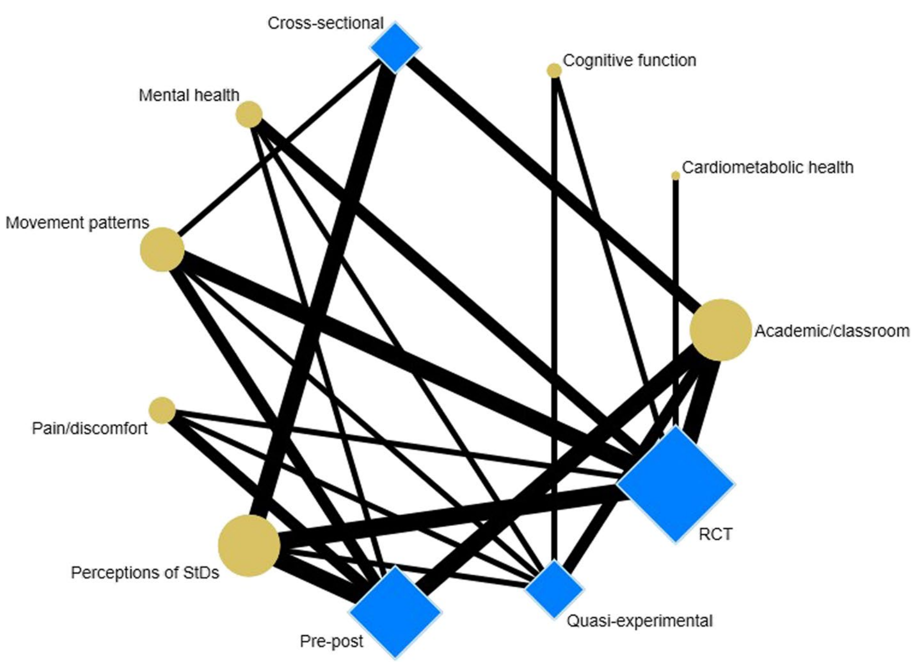

Fig. 2 Network geometry plots of the associations between the study designs and outcome groups. *Note:* The size of the diamond nodes (study designs) was relative to the number of available data on outcome groups analyzing these components. The size of the circular nodes (outcome groups) was related to the number of studies analyzing these components. The width of the solid line connecting the nodes was relative to the number of studies analyzing the outcome groups (circular nodes) according to study design (diamond nodes). Abbreviations: RCT, randomized controlled trial

Frost and Terbizan [34] reported positive perceptions of standing desks and were acceptable to students [42]. Similarly, Green et al. [37] found that most students were interested in having standing desks in their classrooms and that they would use the standing desks if available. In two studies, students indicated a preference to alternate between sitting and standing during class [26, 28] and that they would use standing desks if they were available [28]. Moreover, these studies reported that students held positive expectations regarding the benefits of standing desks, anticipating improvements in physical health and reductions in joint pain [29] as well as back pain [27].

Three studies reported reasons for using or not using standing desks. Chrisman et al. [42] showed that students using standing desks stay more alert and prefer standing over sitting. The reasons for not using standing desks included fatigue, a preference for sitting, or feeling unwell. In a same group study [30], the students reported breaking sitting time, reducing back pain, and improving as reasons to stand, whereas concerns about blocking others'views, distracting others, and tiredness were reasons against standing. Another study [38] reported that students used standing desks to relieve restlessness and that seeing others use standing desks increased their willingness to stand. Goodrich et al. [29] found that health motivation, wellness orientation, weight loss and cognitive enhancements influenced a positive attitude toward standing desks.

Moulin et al. [39] identified three main facilitators for using standing desks: the desire to stand more, reduce sitting, and increase awareness of the health risks of prolonged sitting. Barriers included the social norm of sitting, desk size, classroom design, and loss of interest. Most participants appreciated the option to stand and expressed interest in using standing desks in the future.

Instructors' perceptions

Two studies also analyzed instructors' perceptions of standing desks; those studies included a variety of teaching positions from teaching assistants to full-time instructors. One study reported that 85% supported the introduction of standing desks, considering the intervention feasible and beneficial for physical health, attention, and engagement [26]. Another study indicated that instructors noticed that students were less tired, bored, and distracted, with no negative impact on lesson quality. Most were willing to use standing desks in their classrooms [27].

Discussion

To our knowledge, this is the first scoping review to map the existing evidence on the use of standing desks in the classroom with university students. Overall, the results of this study suggest that the use of standing desks in classrooms could have beneficial effects on movement patterns (i.e., sitting and standing during class time, and sedentary behavior) and mental health outcomes (i.e., anxiety, mood, stress, and specific positive or negative feelings). Conversely, mixed results have been reported for pain and discomfort, academic and classroom outcomes (e.g., academic performance, fatigue, attention, restlessness, boredom during lectures), and cognitive function. Standing desk interventions were generally accepted and positively perceived by students and instructors, indicating a preference for the possibility of alternating sitting and standing periods during lessons. This evidence is far from consistent; thus, long-term, high-quality intervention studies are needed to confirm these preliminary findings.

The effects of standing desks on movement patterns in university classrooms show promising potential for reducing sedentary time, with most studies reporting a decrease in sitting and an increase in standing [35, 38–40, 42] suggesting that standing desks may be an effective tool for reducing sitting time. In this way, standing desks could be particularly relevant in sedentary academic environments, as they could contribute to the improvement of cardiometabolic health by reducing sedentary lifestyles and increasing NEPA and NEAT. This finding is consistent with previous studies in pre-university samples, which also reported reductions in sitting time [17], although mixed evidence has been reported in schoolchildren [10]. These inconsistencies may be due to differences in the outcome measurement methods such as sitting and standing by accelerometers, observation or self-report questionnaires. Variability was also found in how standing desks were integrated into classrooms because some studies allowed students to use standing desks freely, whereas others encouraged their use or implementation of specific protocols. Furthermore, differences in teaching methodologies could also play a role; for example, in more interactive or active classes, the reduction in sedentary time might be less noticeable than in theoretical lectures, where students are more likely to sit for longer periods. Finally, low statistical power is a characteristic of most studies [17]. Consequently, future research should focus on standardized protocols for the use of standing desks, monitor students'actual usage, and use consistent, objective methods to measure sitting and standing time to better understand their true impact.

Regarding pain and discomfort, the results of the studies included were mixed. Although previous studies have shown that standing desks reduce discomfort and musculoskeletal pain [43, 44], the lack of habits and muscle tone, the detrimental effects of prolonged standing on musculoskeletal symptoms [45], and the existence of some individuals who are intolerant to standing [46] may explain why discomfort increases in some participants.

In terms of cardiometabolic benefits, only one study reported an increase in energy expenditure and improvements in cardiometabolic risk [32], which is consistent with a previous study in school samples [10], and may be due to the well-established relationship between sedentary behavior and cardiometabolic risk indicators [47].

The evidence regarding the positive impact on mental health was limited but consistent. Four studies [27, 33, 37] confirmed that standing desks reduced anxiety and stress, and improved mood, which is consistent with the findings of a previous study in which spending much of one's time sitting was associated with more symptoms of depression and anxiety [48]. Research suggests that working while standing can improve concentration and productivity [49]. Feeling more productive and performing better at work can reduce the frustration and stress associated with work. Additionally, standing desks promote regular changes in posture and movement, which facilitates the release of endorphins that improve mood and reduce stress and anxiety, which may explain the positive effects observed in the studies reviewed.

Overall, most studies highlight that standing desks improve attention, engagement, commitment and concentration, while reducing restlessness and fatigue. However, some studies have not reported a positive effect on reading and comprehension [37] or attention [31, 34]. These contradictory results may be due to differences in the methods of behavior measurement because while observations of classroom behavior were used in some studies, self-report questionnaires or qualitative interviews were used in others; differences in the ages of the participants may explain, at least in part, these differences. Notably, neither our review nor previous studies reported negative effects on academic engagement, reinforcing the overall positive influence of standing desks on classroom behavior [10, 15, 16, 34]. To fully understand the effects of standing desks on academic outcomes, future research should use longitudinal and experimental designs that include validated cognitive measures and objectively assessed academic achievement.

Sedentarism has been associated with brain health structure and function and cognition throughout the lifespan [50]. The mechanisms that might explain the association between sedentary behavior and brain health are changes on molecular and cellular levels (e.g., brain-derived neurotrophic factor), functional and structural brain changes (i.e. grey matter volume), and psychological changes (e.g., stress, sleep) [50]. Recent evidence from a systematic review and meta-analysis by Šömen et al. [51] examined the impact of standing versus sitting on Stroop task performance among healthy young adults and found no significant differences in selective attention and cognitive control between postures. This aligns with our findings, in which only two studies [31, 41] included cognitive tests and found no statistically significant differences between standing and sitting conditions. It is important to note that standing did not impair cognitive performance indicating that standing desk interventions do not negatively affect cognitive performance in university settings. Furthermore, evidence suggests that sedentarism is not a unitary concept and different types of sedentary behavior (e.g., cognitively active sedentary behavior versus cognitively passive sedentary behavior) that might influence brain health differentially [52]. Thus, as sedentary classroom behaviors were cognitively demanding, their reduction may not have the expected impact on cognition. All these findings suggest that standing desks did not adversely affect cognitive tasks, but the lack of significant differences also raises questions about their cognitive benefits. To fully understand the effects of standing desks on academic and cognitive outcomes, future research should use longitudinal and experimental designs that include validated cognitive measures and objectively assessed academic achievement and brain function measures such as EEG and neuroimaging studies.

Studies of the acceptability of standing desks in university classrooms have shown that most students find it a suitable intervention, which is consistent with findings in school and vocational education contexts [53, 54]. Students generally prefer the option to alternate between sitting and standing during class [26, 28], and both students and instructors report perceived physical and mental benefits from the use of standing desks. However, barriers such as the social norm of sitting, increased fatigue and lack of habits have been identified. To address these issues, studies have suggested interventions that actively encourage standing [54] and provide guidance on the correct use of standing desks [19, 23]. Notably, few studies have explored instructors'perceptions, although initial findings suggest that instructors' view of standing desks was positive without any negative impact on teaching. Further research is necessary to explore the experiences of both students and instructors regarding standing desks in academic settings.

While standing desks show promise as an intervention to reduce sedentary behavior and improve health among students, their successful implementation in real-world educational settings requires consideration of several practical factors. Institutional support is critical, including administrative buy-in and alignment with pedagogical goals. Classroom design must also accommodate ensuring that standing desks do not interfere with visibility, movement, or instructional flow and sometimes is not feasible. Cost remains a significant barrier, particularly in resource-limited institutions. Previous studies about the cost of standing desks show that it can be effective and feasible [55] and the cost benefit positive [22, 56]. While there is a significant initial expense, the widespread adoption of standing desks has the potential to generate long-term economic advantages, especially when considering the healthcare costs associated with extended periods of sedentary behavior [22]. However, there is a lack of research in university settings, cost–benefit studies are needed. Finally, sustained student adherence over time is essential; initial novelty may wane, making it necessary to integrate behavioral support or curricular reinforcement. Addressing these factors is essential for the scalability and sustainability of standing desk interventions in educational contexts.

Strengths and limitations

This scoping review is strengthened by its focused examination of university students, the use of network plots to map thematic relationships, the inclusion of both student and instructors' perspectives, and a systematic literature review following PRISMA for Scoping Reviews criteria. These elements contribute to a comprehensive and visually structured synthesis of literature. Some limitations of this review must be acknowledged, most of which are inherent to the nature of scoping reviews. First, the heterogeneity of the included studies, i.e., the wide range of study designs, intervention protocols and control conditions, and outcome measures. Second, methodological limitations were found in many of the included studies, such as a lack of control groups (e.g., Moulin et al. [39], and Grospetrere et al., [27]), failures in the treatment allocation concealed (e.g., Bantoft et al., [31]; Butler et al., [32]; Chim et al., [35]), or problems with the representativity of the sample, as being volunteers (e.g., Jerome et al., [38] and Raulli et al., [40]). Third, a scoping review methodology, such as that used in this study, is limited in its capacity to make recommendations about the effectiveness of interventions and causal inferences. These suggestions should be addressed in future systematic reviews and meta-analyses of empirical studies. Another limitation relates to the population included, only studies with the perceptions of students and instructors were analyzed, and other interested stakeholders (e.g., academic administration staff and management staff with decision-making power in classroom furniture decisions) were not included.

Recommendations for future studies

The findings and limitations of this scoping review provide arguments for recommendations for future studies. First, it is necessary to measure accurately whether standing desks reduce sedentary behavior by using valid instruments. Second, it is recommended that future studies utilize direct tests to establish a correlation between increases in standing time and favorable changes in other outcomes, such as energy expenditure, health markers, or classroom behavior. The utilization of validated tools is imperative to enhance the internal and external validity of conclusions derived from these studies. Third, most studies evaluated the effect of reducing sedentary time in the classroom; however, to assess whether the use of standing desks decreases total sedentary time, it is necessary to account for the potential compensatory behaviors throughout the day. Fourth, further studies are required on the implementation of the intervention, as this could influence students'use of standing desks and therefore the effectiveness of the intervention. In addition, it is necessary to measure indicators of the use of standing desks during the intervention. Drawing from the findings of our review, we suggest that efficacious interventions demand the incorporation of meticulous instructions and an educational component, imparting knowledge on the utilization of standing desks to engender favorable outcomes in both health and academic domains. Fourth, the interventions encompassed in the present review were of a limited duration; thus, we suggest that long-term, well-designed studies be conducted, with a duration ranging from one academic semester to one academic year. Finally, cost remains a significant barrier, particularly in resource-limited institutions. Previous studies on the cost of standing desks have shown that they can be effective and feasible [55], with a positive cost benefit [22, 56]. While there is a significant initial expense, the widespread adoption of standing desks has the potential to generate long-term economic advantages, especially when considering the healthcare costs associated with extended periods of sedentary behavior [22]. However, there is a lack of research in university settings, cost–benefit studies are needed.

Conclusions

This is the first scoping review to summarize the available evidence on standing desks in university students. The results of this review suggest that the use of standing desks in university classrooms may have benefits in reducing sitting time and increasing standing behavior during lessons, as well as improving mental health outcomes. Additionally, students expressed a willingness to employ standing desks, perceiving them to have the potential to confer both health and academic benefits. However, the evidence was limited, and several methodological weaknesses were identified. Consequently, the execution of well-designed, long-term trials is imperative to evaluate the impact of standing desks on reducing sedentary behavior and enhancing standing time, as well as its correlation with health and academic outcomes.

Abbreviations

PRISMA-ScR	Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Review
RCT	Randomized controlled trial

Supplementary Information

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Supplementary Material 1.

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Authors' contributions
MEVA: Conceptualization, Methodology, Data curation, Investigation, Formal Analysis, Visualization, Writing - Original Draft Preparation; MSL: Conceptualization, Methodology, Data curation, Investigation, Visualization, Writing - Original Draft Preparation; BBP: Methodology, Data curation, Formal Analysis, Visualization, Writing - Review & Editing; VDG: Data curation, Visualization, Writing - Review & Editing; SC: Visualization, Writing - Review & Editing; IS: Visualization, Writing - Review & Editing; VMV: Conceptualization, Methodology, Visualization, Writing - Review & Editing, Supervision. All authors reviewed and approved the manuscript.

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Data availability
This scoping review does not include original data. Data are extracted from the literature and are publicly available. The datasets used and analyzed during this review are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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