

SYSTEMATIC 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

Background

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/

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 pre-test–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.

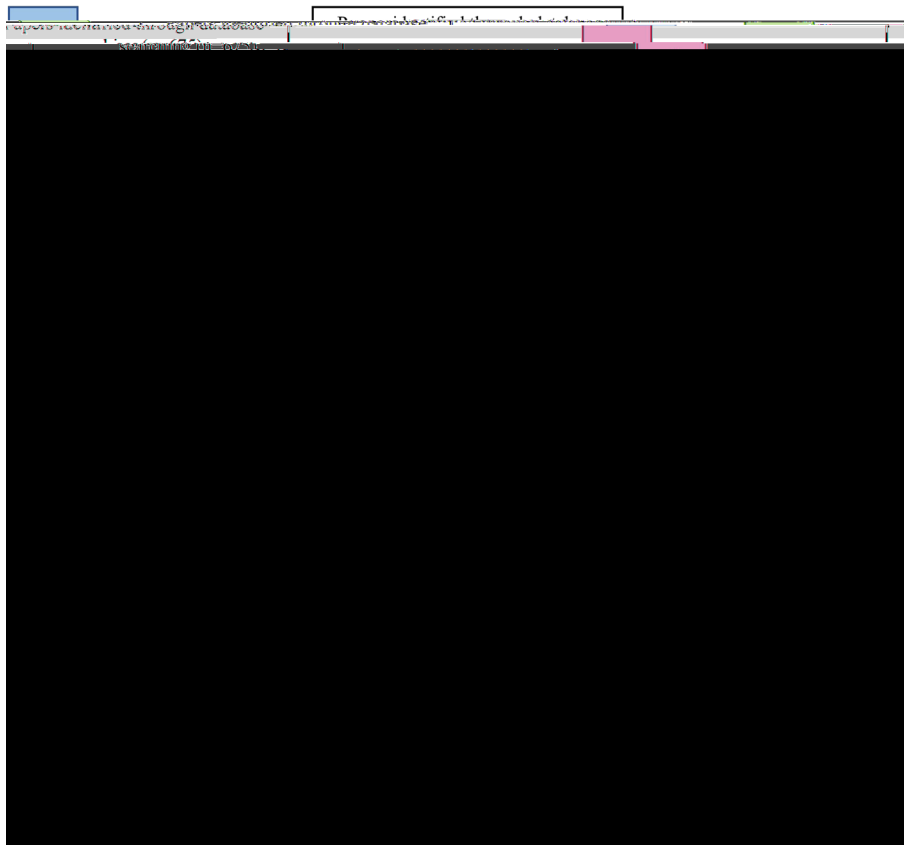


Fig. 1 PRISMA flow chart of the study selection process

Table 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), visuo-motor 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 on 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 camera) 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 in sitting and standing time. Mean sitting and standing time were 11.1 min and 6.1 min, respectively. Mean perceived task difficulty was 3.5 and perceived effort was 3.5.

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 stepperboards; 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 traditional seated desks; 6 each standing desks; 7ac5 Td (a)TJ 0 using/not using stand-CG:behastanding timeevior 19633 - 1.1	CG: traditional seated desks; 6 traditional seated desks; 6 each standing desks; 7ac5 Td (a)TJ 0 using/not using stand-CG:behastanding timeevior 19633 - 1.1	CG: traditional seated desks; 6 traditional seated desks; 6 each standing desks; 7ac5 Td (a)TJ 0 using/not using stand-CG:behastanding timeevior 19633 - 1.1

Table 2 (continued)

Reference	Aims	Intervention and comparator; duration if applicable	Variables (instrument)	Key findings
Sengupta & Kullian (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, MEIs 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

Table 3 Summary of the effects of standing desk interventions in university students^a

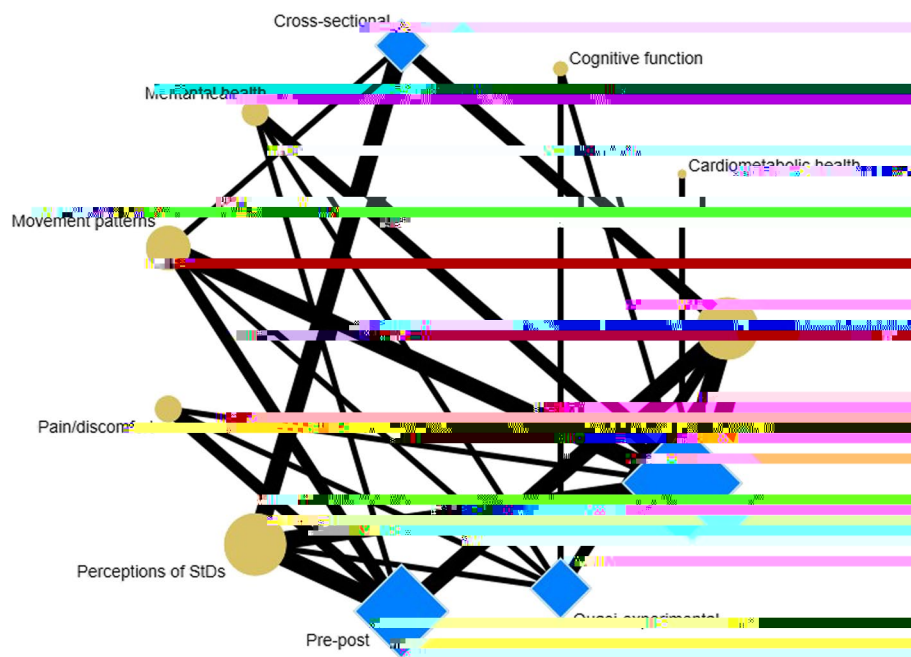


Fig. 2 Network geometry plots of the associations between the study designs and outcome groups. Note: The size of the diamond nodes (study designs) was relative to the number of available data on outcome groups analyzing these components. The size of the circular nodes (outcome groups) was related to 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

Abbreviations

PRISMA-ScR

