

Study on the effect of workstation on college students' health and feasibility analysis: a systematic review and meta-analysis

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Abstract: Objective: Analyze the promotion effect and feasibility of active workstations such as 'vertical desks', 'movable desks and chairs', and 'adjustable workstations' on the health of college students, and explore whether they are beneficial to students. Increase physical activity time and improve cognitive ability.

Methods: According to the principle of PICO, a unified literature screening standard was designed to retrieve relevant foreign literatures, and finally 8 research literatures were included. Meta-analysis of some outcome indicators was performed using RevMan5.2 software, and the outcome indicators that could not be quantified were determined to be analyzed by systematic evaluation.

Results: Active workstations have played a relatively positive role in reducing sedentary time and increasing physical activity, and can promote students to improve classroom attention and reduce fatigue. In addition, the feasibility analysis results obtained for the active workstation in this study are generally good, so we believe that the feasibility of the strategy is high.

Conclusion: The introduction of active workstation is an effective measure to promote students' physical activity, reduce sedentary time and improve cognitive ability.

Keywords: active workstation, sedentary behavior, healthy lifestyle, college students, health promotion

1. Introduction

Relevant research in recent years has pointed out that both adolescents, college students, or middle-aged and elderly groups, there are generally poor living habits such as insufficient physical activity and long sitting time [1–3]. And this kind of bad living habits will increase the risk of cardiovascular disease and increase the risk of obesity. For college students, bad living habits also reduce self-esteem and self-confidence, affect mental health. [4]

In order to further understand the current situation and influencing factors of college students' sedentary, Chinese scholars take Jining University as an example to carry out investigation and research, aiming to deeply understand the specific reasons for the sedentary of contemporary college students [5]. Similarly, some scholars have conducted statistical surveys on the daily life and physical characteristics of sedentary college students, aiming to provide guidance for the development of college students' physical and mental health [6,7]. From the results of the study, in recent years, through a large number of investigations and studies, the causes of the lack of physical activity and sedentary phenomenon of college students have a more profound understanding. Moreover, some scholars have put forward specific measures to promote college students' daily exercise, and carried out feasibility analysis or practical exploration. For example, Lynch believes that classroom rest and sports learning can effectively reduce students' sedentary and fatigue, and analyzes the feasibility of this measure by reviewing relevant research results [8]. Through a set of experimental studies, Castro et al. analyzed the feasibility of one-to-one education and SMS reminders to reduce the sedentary behavior of college students [9].

Masini proposed in a recent study that active workstations are a strategy to solve students' sedentary problems and promote physical activity [10]. We summarize the relevant research and find that the active workstation is a kind of table and chair with 'adjustable table and chair' as an example, and includes a desk combined with a bicycle, a desk combined with a Swiss ball, etc. And related research has also pointed out that inactive desks and chairs is a major factor in sedentary phenomenon [11], And standing activities can increase muscle energy consumption, so as to achieve the purpose of exercise [12]. Based on the above problems, this paper decided to retrieve the relevant research on the intervention measures of 'vertical desk', 'movable desk and chair', 'adjustable workstation', etc., to analyze the positive effect of such strategies on college students and the feasibility of promoting physical activity and reducing sedentary time, and to explore whether it is beneficial to students to cultivate a healthy lifestyle.

2. Methods

2.1 Search strategy

We retrieved the papers without considering the date of publication of the article. Using the Boolean logic retrieval strategy, the detailed retrieval information is shown in Table 1.

Table 1 Retrieval process

Search term	
#1	sedentary behavior or reduce sedentary behavior or Decreasing Sedentary Behavior
#2	college student or pupil or student or university student or college and university students
#3	In-Class Cycling* or physical activity* or Activity Workstations* or Activity Workstations* or Physically Active Learning*
#4	#1 AND #2 AND #3

2.2 Inclusion criteria

Each article included in this study strictly abides by the PICO principle, and has corresponding standards for the participants, interventions, control measures, and main outcome indicators included in the literature, as detailed below.

1) This paper only accepts the research literature written in English, and there is no special requirement for the publication date. For the experimental design of the literature, we included randomized controlled trials (RCTs), cross-design experiments, and feasibility studies.

2) The participants or main participants included in the literature must be college students, and there are no special provisions on age, major, gender and degree.

3) For the experimental setting, we must take the active workstation as the intervention measure of the experimental group. For the control measures of the research experiment, this paper only accepts ordinary tables and chairs. If the included literature is non-RCT, this article does not have any special requirements for the control group interventions in the literature.

4) This paper does not set special requirements for the outcome indicators included in the literature. As long as the measurement indicators can effectively reflect the impact of intervention measures on the experimental results, the statistical test used to evaluate the main results is suitable for experimental design.

2.3 Data extraction

We used the pre-defined literature inclusion criteria to screen the relevant literature. We use the PRISMA (Preferred Reporting Items for Meta-Analyses and Systematic Reviews) procedure to retrieve relevant research literature.

In terms of data extraction, we extracted the following information from the included articles: study design, subject / participant information (age, gender, sample size), intervention settings

(intervention measures in the experimental group and the control group, intervention duration, intervention frequency), outcome measures, and main results.

2.4 Studies quality and bias risk assessment

Because not all the studies included in the study were RCT, this paper is more inclined to evaluate the quality and bias risk of the literature included in the study through the quality checklist of Downs and Black [13]. It is divided into five parts: Reporting, External Validity, Internal Validity (Bias), Internal Validity (Confounding), Power, a total of 27 questionnaire questions, a total of 28 points. Because the calculation method of the Power part is more complex and does not apply to the outcome indicators of the literature included in this article, we decided to use the improved calculation method of the Power part such as Sohanpal for evaluation [14].

2.5 Statistical analysis

Systematic review was used as the main analysis method, and meta-analysis was used as the secondary analysis method to extract the results suitable for this research direction for data analysis, such as feasibility analysis, physical activity time, and cognitive ability results. In the analysis of the feasibility results, this paper refers to the feasibility study framework of Bowen et al [15]. The results of physical activity mainly include sedentary and standing time, and the cognitive results mainly include academic level and classroom attention. For statistical analysis, we used the Cochrane Collaboration to provide Review Manager software for data processing (RevMan5.2).

3. Result

3.1 Search results

As mentioned above, we retrieved 2292 related articles from Web of Science, Cochrane library, Embase and PubMed databases. Before screening, we excluded 1745 articles. After further reading the main contents of the literature, we excluded 539 articles such as patients, language, theme, intervention measures that did not meet the standards and imperfect outcome indicators. Finally, 8 articles were included in the study. The complete literature screening process is shown in Figure 1.

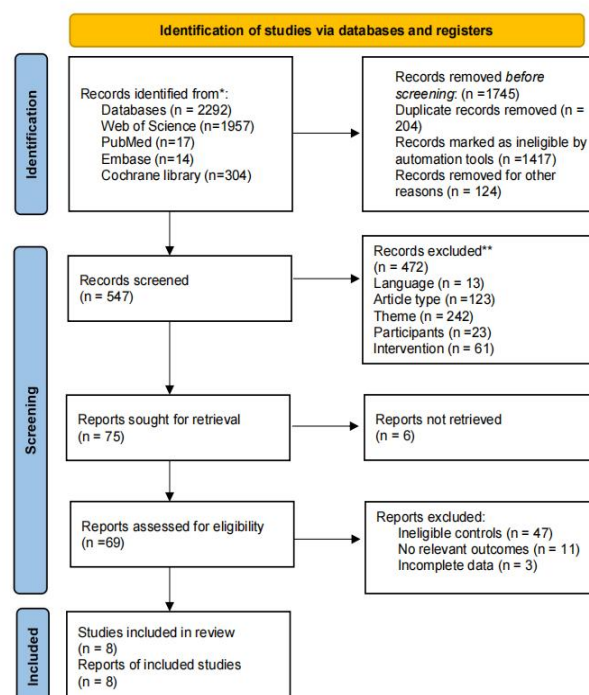


Fig.1 Literature screening exclusion flow chart

3.2 Basic information included in the studies

A total of 8 articles were included in this study, of which 5 were feasibility analysis [16–20], There was 1 cross-intervention experiment [21], There are 2 randomized controlled trial (RCT) [22,23]. Detailed basic information is shown in Table 2.

Table 2 Basic characteristics of the included studies

Study, Design	Participants	Baseline Characteristics			Intervention			Outcomes Measure	Mean Results
		Sample size(n)	Gender (male / female / NA)	Age	Intervention	Frequency	Duration		
Bastien Tardif 2018 feasibility study	college student	99	43/51 /5	28.3 ± 9.8	A: a conventional sitting desk B: a portable pedal exercise machine (PPEM) C: a standing desk (SD)	No restriction	12 weeks	Questionnaire survey	The main results of the questionnaire (1-7 points) 1.Are you in favor of active workstation? PPEM:6.5(1.4), SD:6.6(1.0) 2.Do you think it is socially acceptable to use active workstations? PPEM:6.0(1.5), SD:5.7(1.5) 3.Do you have the intention to use active workstations more frequently? PPEM:6.0(1.7), SD:6.4(1.1)
Benzo 2016 feasibility study	College students and teachers	993 (student) 149 (teacher)	students:30 /0 teachers: NA	Students: 20.4 (4.1) Teachers: 43.1 (13.7)	3 types of standing desks A: sit-stand desks B: height-adjustable desks C: stand-biased desks	No restriction	1 term	Questionnaire survey	The main results of the questionnaire (student) 1. Do you think the introduction of desks will not take up class time? 82.9% (Percentage of consenting persons) 2. If you were given this option, would you prefer to sit or stand in class? Sit :34.5% (Percentage of consenting persons) Standing and sitting: 60.8% (Percentage of consenting persons) Stand: 4.6% (Percentage of consenting persons) The main results of the questionnaire (teacher) 1. Would you agree to provide standing desks in the class you teach? YES: 86.6%, NO:13.4%
Clement 2018 feasibility study	University library users, most of	138	NA	NA	3 types of standing desk A: cycling desks B: treadmill desks C: balance-ball	No restriction	20 weeks	Questionnaire survey	The main results of the questionnaire 1. Does it make me feel comfortable YES: 92%, NO: 8% 2. Is it conducive to my learning YES: 91%, NO: 9%

	them stud ents				chairs				
Grospr être 2021 feasibil ity study	colle ge stud ent	663	417/2 16/0	18.7 ± 1.6	4 types of active workstations A: standing desk B: Swiss ball C: cycling-desk s D: pedal- or stepper-boar d	No restric tion	24 wee ks	Questi onnair e survey	The main results of the questionnaire 1. Can active workstation reduce discomfort and pain (Percentage of people who agree) standing desk: 19% Swiss ball: 30% cycling-desks: 37% pedal- or stepper-board:27% 2.Can Active Workstation Reduce Fatigue (Percentage of people who agree) standing desk: 26% Swiss ball: 43% cycling-desks: 40% pedal- or stepper-board: 45%
Jerome 2017 Cross-i nterven tion experi ment	colle ge stud ent	143	37/10 8/0	> 18	2 types of active workstations A: sit-stand desks and stools B: traditional seated desks	NA	12 wee ks	Questi onnair e survey	The main results of the questionnaire (Percentage of consenting persons) 1.Relieve agitation in the classroom :53.0% 2. Reduce class fatigue :42.6% 3. Reduce the boredom in the classroom :45.5% 4. Reducing the use of mobile phones in class: 38.6%
Joubert 2017 random ized controll ed trial	colle ge stud ent	24	7/17/ 0	19-24	2 types of active workstations A: stationary cycle desk B: traditional desk to sit	3 times /week 50min /times	12 wee ks	Avera ge and Final Test Scores	Main Test Results The average of test scores: T:87.88, C:83.08 Final course results : T:89.71, C:85.49
Maeda 2014 feasibil ity study	Univ ersit y libra ry users , most of them stud ents	527	NA	NA	Portable Pedal Machines	No restric tion	11 wee ks	Questi onnair e survey	The main results of the questionnaire (1-5 points) 1. I'm not distracted when someone else is using a bike :3.7 (1.2) 2. I hope the bike can stay in the library all the time :3.6 (0.9) 3. I wish there were more bikes in the library :3.3 (0.8) 4. The bike did not mess up the library :3.8 (0.9)
Pilcher 2017 random ized controll ed trial	colle ge stud ent	T:59 C:58	42/75 /0	18.39 ± 0.94	2 types of active workstations A: FitDesk: a stationary bike with a desktop B: traditional desk	2 hours/ week No restric tion	10 wee ks	Questi onnair e survey	Main test results and sleep test results Sleep quality (1-5 points) T:3.56(0.70), C:3.32(0.69) examination performance: T:85.33(9.57), C:83.77(8.81)

3.3 Quality evaluation and bias risk assessment

As mentioned above, we used Sohanpal 's improved quality checklist for Downs and Black to assess the quality of the literature included in the study, as well as bias. [13,14]. Although the scores of each part of the scale are inconsistent and the gap is large, the overall score is good. The average score of the total score is 14 points, reaching 50 % of the total value. See Table 3 for details.

Table 3 The literature quality checklist of Sohanpal 's improved Downs and Black

	Reporting	External Validity	Internal Validity (Bias)	Internal Validity (Confounding)	Power	Total
Question Numbers	1–10	11–13	14–20	21–26	27	
Maximum Score	11	3	7	6	1	28
Average mean	6.15	2.5	3.125	2.25	0	14
Bastien Tardif 2018	6	2	3	1	0	12
Benzo 2016	5	3	3	2	0	13
Clement 2018	4	3	3	1	0	11
Grosprêtre 2021	5	3	2	1	0	11
Jerome 2017	8	3	4	4	0	19
Joubert 2017	8	2	3	4	0	17
Maeda 2014	5	2	3	2	0	12
Pilcher 2017	8	2	4	3	0	17

3.4 Analysis results

3.4.1 Physical Activity Results

Among the 8 articles included in the study, the outcome indicators of 3 articles involved the relevant physical activity outcome indicators [18,23,22]. Among them, Grosprêtre made statistics in the study, 34.9 % of the experimental subjects spent more than 1 hour in the classroom, and 16.3 % of the participants spent between 45 minutes and 1 hour in the classroom. This also means that more than half of the students spend more than 45 minutes in classroom activities. In the study, Joubert et al. described the changes in sedentary time (minutes) of participants before and after experimental intervention in the form of mean \pm sd. Among them, the experimental group decreased from 446 ± 126 to 414 ± 129 , and the control group decreased from 404 ± 106 to 388 ± 120 . It can be seen that the decrease of sedentary time in the experimental group is greater than that in the control group.

In addition, Pilcher used Borg 's RPE (Rating of Perceived Exertion Scale) scale to measure physical activity (mean \pm sd)[24], The results were as follows : 2.02 ± 1.07 in the experimental group and 1.10 ± 2.05 in the control group. It is not difficult to see from the results that the RPE score of the experimental group is higher than that of the control group, which means that the experimental group is more effective than the control group in promoting physical activity.

3.4.2 Cognitive ability results

In this paper, the students ' classroom attention and academic performance in the literature are taken as the main indicators of cognitive results. Five articles meet the criteria. [17,18,21,23,22]

About students' attention in class, Benzo conducted a survey on the students who participated in the study through questionnaires. The results showed that 51.0 % of the students thought that their attention had been improved, and only 18.2 % of the students thought that the introduction of 'three standing desks' would affect their attention in class. Similarly, through the same questionnaire survey method, Jerome also obtained similar results with Benzo. 50.5 % of the students thought that their attention was improved, and the proportion of students who thought that their attention was affected was only 7.9 %. In addition, the results of Grosprêtre's research also show that most students believe that the introduction of standing desks will improve classroom attention, and only a small number of students have objections to it.

Regarding academic performance and academic performance, most of the research results show that the introduction of standing desks has little effect on academic performance. For example, Benzo, 37.2 % of the students think their academic performance has improved; Jerome, 15.8 % of the students think that their academic performance has improved. In addition, we analyzed the academic performance of the students in the two RCT studies through analysis software, and drew a forest map (Fig 2). The final results were negative (SMD = -0.26, 95%CI -0.86-0.33), and the heterogeneity was moderate but not statistically significant ($I^2 = 46\%$, $P = 0.39$).

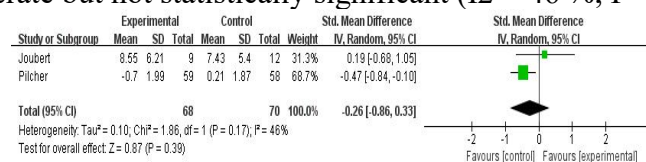


Fig 2. forest pot of academic achievement

3.4.3 Feasibility analysis results

As mentioned above, this paper refers to the feasibility study framework of Bowen for feasibility analysis. Bowen's feasibility study framework includes eight main aspects. According to the research needs and the characteristics of the included literature, this study chooses to conduct feasibility analysis through four aspects: Demand, Acceptability, Practicality and Integration. The detailed analysis results are shown in Table 3. As shown in the figure, most of the evaluation results included in the literature are positive, and only a few of the evaluation results are not ideal. This means that the active workstation can produce more positive results in most cases, and can make the subjects satisfied. In addition, most of the active workstations are set up in university classrooms or libraries, and the requirements for hardware facilities are not high. Combined with the actual situation of domestic universities, we believe that it is feasible to use active workstations such as 'adjustable desks'.

Table 4 The feasibility analysis results under the Bowen framework

Study	Acceptability	Practicality	Demand	Integration
Bastien Tardif	↑	↑	↑	NA
Benzo	↔	↔	↓	NA
Clement	↑	↑	NA	↓
Grosprêtre	↔	↑	↓	NA
Jerome	↑	↔	NA	NA
Joubert	NA	↑	NA	NA
Maeda	↑	↑	NA	NA

Pilcher	↑	↔	NA	NA
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4. Discussion

This study is devoted to exploring the effect of active workstations on students' health. We use the comprehensive results of students' physical activity time and cognitive ability as the evaluation criteria of students' health level. From the results, the choice of active workstation is effective in reducing students' sedentary time and increasing their standing time. The experimental results of Grosprêtre, Joubert and Pilcher all show that active workstations have a positive effect on students' increasing physical activity time. In view of the cognitive ability, from the analysis results, the active workstation has a positive effect on enhancing students' classroom attention and reducing distraction, and can improve students' classroom learning efficiency. However, it has no obvious effect on the improvement of academic performance. The data analysis results for academic performance show that the active workstation does not have an impact on academic performance.

According to the results of feasibility analysis, we carefully analyzed three literatures with unsatisfactory results. Among them, the reason why Benzo and Grosprêtre's evaluation of Demand is not ideal is that different types of standing desks (bicycle desks, Swiss ball desks, etc.) are set up. Participants choose different types of standing desks due to their own preferences, so they have preferences for the use of experimental measures, which in turn affects the evaluation results. The reason why Clement has problems in the Integration part is that it is proposed to add electrical sockets in the active workstation area. Therefore, we believe that the above two problems are not universal, and are caused by the characteristics of the intervention experiment setting, so they will not affect the overall feasibility results.

Although this article strictly abides by the literature screening requirements into the literature, but the overall literature included in the number is small, and because of the experimental characteristics, the literature outcome indicators included in the study are difficult to unify, so it is not possible to fully analyze the positive role and feasibility of active workstations for college students through data analysis, and the results may be subjective. In addition, we conducted a meta-analysis of the outcome indicators related to academic performance in two RCT articles, and found that the results were negative, heterogeneous and not statistically significant. After referring to the results of similar feasibility studies, we believe that the reason why the results are not statistically significant is that most students believe that active workstations have no special impact on their academic performance; the reason for the negative results and heterogeneity is the small number of RCTs included in the study.

5. Conclusion

The establishment of an active workstation with an 'adjustable desk' as an example has a positive impact on students' physical health, mental health, learning and life, and the strategy has low requirements for venues and equipment, and does not interfere with students' daily life. Strong, with high feasibility. Therefore, we believe that this strategy is an effective measure to promote students' physical activity, reduce sedentary time and promote students' health.

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