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## MECHANICAL ENGINEERING | REVIEW ARTICLE

# Effects of active microbreaks on the physical and mental well-being of office workers: A systematic review

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**Abstract:** Risk factors associated with sedentary work and prolonged sitting time can be detrimental to office workers' health and productivity. Recent literature introduced the concept of active microbreaks and their benefits to sedentary workers. The purpose of this study was to better define active microbreaks and to determine the evidence behind utilizing active microbreaks at work, through a qualitative synthesis of the literature in a systematic review. A comprehensive systematic search was conducted using primarily ergonomics, medicine and allied health databases, in addition to grey literature (CINAHL, Google Scholar, PubMed, and ScienceDirect) and respective ergonomics journals. Six interventional controlled trials (232 total participants) met the inclusion criteria and qualified for the inclusion in this review. The quality of the reviewed articles was deemed to be moderate to high according to the utilized assessment scales. The results of this review may support the use of short active microbreaks (2–3 minutes of light intensity exercises every 30 minutes) due to the observed physical and mental health benefits without negative impact on productivity in the workplace.

**Subjects:** Ergonomics; Cognitive Ergonomics; Ergonomics & Human Factors; Musculoskeletal Disorders - Ergonomics; Communications - Ergonomics

**Keywords:** microbreaks; micro-breaks; microbreak; active work breaks; office work; sedentary work; ergonomics



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### PUBLIC INTEREST STATEMENT

This systematic review recommends that employers and employees in sedentary workplaces should consider active microbreaks as a viable, easily implemented solution in combating the deleterious health consequences related to sedentary behavior. Active microbreaks (2–3 minutes of light intensity activity for every 30 minutes of sedentary work) may have the potential to decrease musculoskeletal discomfort, improve cardiometabolic markers, and help provide relief from fatigue and stress experienced throughout the workday. Future research should focus on providing further high-quality evidence regarding the use of active microbreaks in the workplace.

## 1. Introduction

Sedentary behavior has been an ongoing health crisis across the globe (Kar & Hedge, 2021). Over the last several decades, individuals around the world have embodied this term, becoming increasingly sedentary at work, home, and even in their free time. Though we have seen technological advancement progress society to new heights, rising screen time has helped influence a significant regression in physical activity level, leading to the increasingly sedentary lifestyles that are observed throughout the modern world today (Owen et al., 2010).

Recent data suggest that the average individual engages in sedentary behaviors for 8–9 hours per day, with the majority of this sedentary behavior occurring in the workplace (Kar & Hedge, 2021). By sitting more and moving less in the workplace, workers put themselves at a heightened risk for a variety of pathologies that can have lifelong implications on their health. Number of hours spent sitting has been positively correlated with risk for diabetes, obesity, cardiovascular disease, and even premature mortality (Buckley et al., 2015). Sedentary workers are also at risk for developing a variety of musculoskeletal disorders, including disorders of the neck, upper limbs, and lower back. These work-related musculoskeletal disorders represent the most common occupational related disorders in the world, with 20–60% of all office workers reportedly suffering (Hoe et al., 2018). In addition to physical pathology, the effects of sedentary behavior have been linked with negative mental outcomes such as depression, lower cognitive functioning, increased risk of dementia, and overall lower quality of life (Izawa & Oka, 2018).

Though these issues represent a clear problem for sedentary workers, these same difficulties translate into complex issues for employers worldwide. Such high prevalence of musculoskeletal disorders in workers has resulted in significant loss of working days leading to less productivity.

Between 2017 and 2018, musculoskeletal disorders alone accounted for 21–28% of all occupational sick days in the UK, Germany, and the Netherlands. In the United States, musculoskeletal conditions resulted in as high as 74% of total work days lost in 2012 (Hoe et al., 2018; Luger et al., 2019). In addition to lost work time, the management and treatment of these musculoskeletal disorders results in significant financial burden to both employers and employees. In 2011, those suffering from musculoskeletal conditions in the United States averaged healthcare costs of 7,104 USD, with the country total representing an overall 5.73% of the Gross Domestic Product (GDP) in 2012 (Hoe et al., 2018). Similarly, the European Union has estimated the costs of work-related upper limb musculoskeletal disorders to account for 0.5–2% of their respective GDP (Hoe et al., 2018). While musculoskeletal costs make up a significant figure themselves, the total healthcare costs worldwide are even more staggering. In 2013, total healthcare costs associated with sedentary behavior across the globe were estimated to be about 67.5 billion USD (D. Ding et al., 2016).

Due to the significant health consequences, loss of productivity in the workplace, and monetary costs related to sedentary behavior, solutions to this multifaceted problem have been the focus of employees, employers, and researchers alike. Regular breaks from sitting for an extended period have been correlated with heightened benefits in metabolic profiles, suggesting frequent breaks from activities required in a sitting position may have lower health risks (Masala et al., 2017). Additionally, it has been shown that physical activity at work improves psycho-physical performance, social relationships, and work performance while simultaneously reducing sickness, absenteeism, and injuries from work (Masala et al., 2017).

Recent research has revealed promising evidence that the use of scheduled micro-breaks, results in decreased musculoskeletal pain, while demonstrating improvements in work quality, efficiency, and productivity (Buckley et al., 2015; Kar & Hedge, 2021). Furthermore, research regarding the “active microbreak” suggests that a break should offer something more stimulating and dynamic than simply standing up and stretching (Mainsbridge et al., 2020).

The purpose of this systematic review was to define microbreaks and determine the value of their use. Our goal is to provide employers and individuals engaged in sedentary work behaviors with an in-depth analysis of the literature concerning the effectiveness of active microbreaks in reducing physical and psychological stresses of office workers.

## 2. Methods

### 2.1. Eligibility criteria

Eligibility criteria for article inclusion in this systematic review can be seen in [Table 1](#). The PICO model guided in the assessment of study relevance and in the search of studies. Only published Peer reviewed controlled trials (control group or a control condition/crossover design) were included in this search. The manuscripts had to be written and/or published in English language (or English translation readily available) and had to be published in the last 10 years (January of 2011 and till present). Participants of these trials had to be 18 years old or older working in an office environment. The microbreaks studied had to be active (non-sedentary) microbreaks and short in duration (less than 30 minutes). Finally, at least one health related outcome measure, related to physical, metabolic, psychological well-being, and productivity had to be assessed and reported. Examples of accepted outcomes included; musculoskeletal discomfort, fatigue, work productivity, mental stress and others.

### 2.2. Search strategy

Blinded researchers were randomly paired and assigned by the principal investigator (PI) to perform an independent search of databases. Databases searched were ScienceDirect (that includes most relevant ergonomics journals), Google Scholar (that includes most grey literature), PubMed, and CINAHL (both include most medical and allied health published research). The references of the chosen articles were then independently scanned for additional resources relevant to the research question using a snowballing technique.

In each database search, each pair of researchers utilized key words in order to narrow the search results to the most relevant literature. Researchers implemented a combination of the following terms; “microbreaks” OR “micro-breaks,” AND “active work breaks”. If the search yielded greater than 300 articles based on these three keywords, the researchers added the terms “office work” or “sedentary work” to further narrow the results to the most relevant literature.

### 2.3. Screening of articles’ titles and abstracts

Following the completion of the search, 599 articles were initially found (ScienceDirect yielded 168 articles, Google Scholar generated 170 results, PubMed produced 145 results, and CINAHL found 111 articles). These articles were independently screened by examination of their respective titles and abstracts to confirm their relevance to the research question. The decision was made based on reaching a consensus between two researchers, a third researcher (PI) was used to make a final

**Table 1. Illustration of the PICO model for defining the research question of the systematic review**

| P | Population   | Adult office/sedentary workers  |
|---|--------------|---|
| I | Intervention | Active microbreaks of short duration carried out in the workplace     |
| C | Comparison   | No active microbreak, alternative microbreaks                         |
| O | Outcome      | Decrease in MSD discomfort, mental health, fatigue, work productivity |

decision regarding the selection and advancement of the article if consensus was not reached. Duplicate and irrelevant articles ( $n = 590$ ) that did not meet the inclusion criteria (mostly due to absence of a control group/condition or lack of outcome reporting), were excluded from the qualitative synthesis of this review.

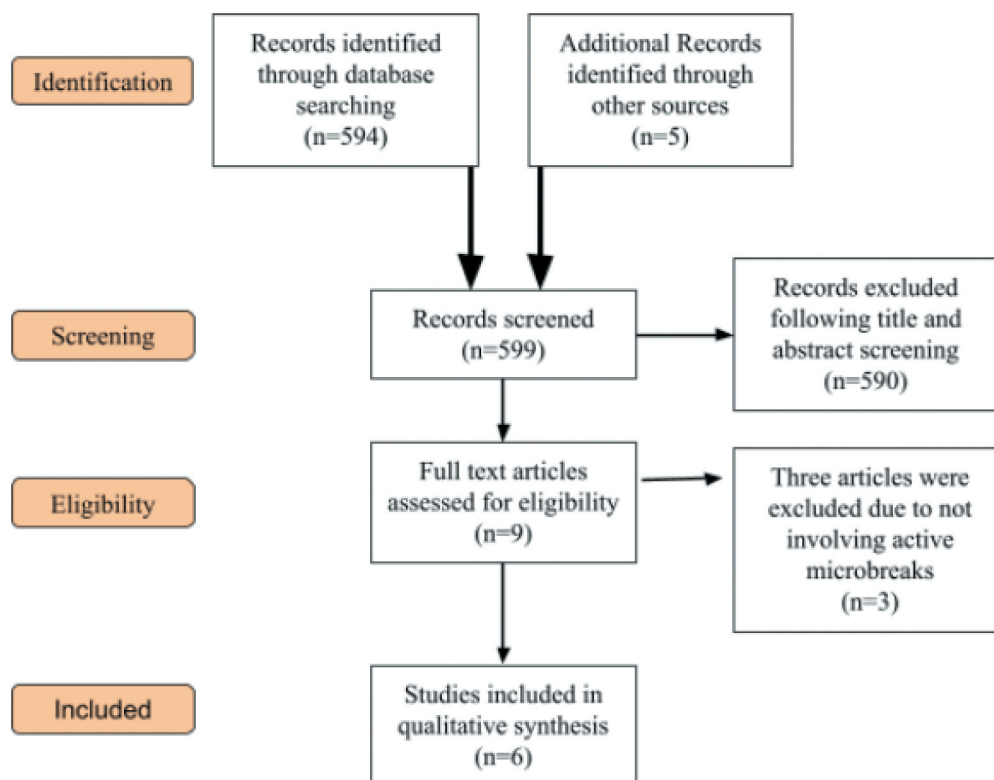
After the initial article screening process was completed, the full-text of the remaining nine articles were further reviewed for relevance and quality assessment by two independent researchers. Three additional articles were excluded, at this stage, as they failed to directly address the research question. A total of six articles qualified for the qualitative synthesis part of this systematic review. Details regarding the search process can be seen in [Figure 1](#).

#### 2.4. Quality assessment of included articles

The quality of the six reviewed articles was assessed utilizing the Physical Therapy Evidence Database (PEDro) scale (De Morton, 2009) and the modified PEDro Scale for Ergonomics Research (MPSER; Radwan et al., 2021). The PEDro scale is used as a validated measure for assessing the quality of clinical trials. The PEDro scores items from “0 to 10” depending on the methodological quality of each. Articles with a score between “0 and 3” are deemed to have “poor quality,” articles between “4 and 5” are considered “of fair quality,” articles with a score between “6 and 8” are considered “of good quality”, while articles with a rating between “9 and 10” are considered to have “high quality”. The PEDro scale assesses article quality based on the following areas: eligibility criteria specification, randomization, blinding, baseline comparison between groups and appropriate statistics reporting. Refer to [Table 2](#) for a detailed description of the PEDro scale.

The Modified PEDro Scale for Ergonomics Research (MPSER) is an assessment tool created by the principal investigator in order to more accurately assess the quality of research in the field of ergonomics. The PEDro scale in its original form includes various rating criteria that are not

**Figure 1.** PRISMA Chart by Moher et al. (2009), illustrating the article selection process of the systematic review.



**Table 2. PEDro scale for evaluating the methodological quality of the clinical trials**

| <b>PEDro Scale</b>   | <b>Yes</b> | <b>No</b> |
|--|------------|-----------|
| Eligibility criteria were specified  |            |           |
| Subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)   |            |           |
| Allocation was concealed   |            |           |
| The groups were similar at baseline regarding the most important prognostic indicators   |            |           |
| There was blinding of all subjects   |            |           |
| There was blinding of all therapists who administered the therapy  |            |           |
| There was blinding of all assessors who measured at least one key outcome  |            |           |
| Measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups  |            |           |
| All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by “intention to treat” |            |           |
| The results of between-group statistical comparisons are reported for at least one key outcome   |            |           |
| The study provides both point measures and measures of variability for at least one key outcome  |            |           |

relevant to ergonomics-based research. As a result, ergonomic articles which lack a basis for those criteria would score lower on the original PEDro scale, and may be falsely represented as lower quality. It is because of this discordance that the Modified PEDro Scale for Ergonomics Research was created. In place of the traditional 10 points seen with the PEDro, the MPSEr utilizes a seven-point scale that more accurately appraises the quality of ergonomics-based research. According to this scale, articles that score from 4 to 5 are categorized as “moderate quality”, and those that score from 6 to 7 are categorized as “high quality”. Articles that score below four are categorized as “low quality”. Refer to [Table 3](#) for a detailed description of the MPSEr.

In the quality assessment phase, each article was evaluated by two independent researchers (physical therapy doctoral degree candidates with appropriate research, evidence-based and statistics background and academic preparedness) to determine quality assessment scores utilizing both the PEDro scale and MPSEr. The final score of each article was determined by independent raters’ consensus. If there were discrepancies in scoring between the two raters, a third rater (the PI) was utilized to solve the dispute and reach a final consensus on the quality assessment score of the article in question.

**Table 3. Modified PEDro Scale for Ergonomics Research (MPSER)**

| <b>Modified PEDro Scale for Ergonomics Research (MPSER)</b>                                | <b>Yes</b> | <b>No</b> |
|--|------------|-----------|
| Study provides adequate explanation of the parameters and procedures                       |            |           |
| Randomized allocation or randomized sequence of interventions and measurements             |            |           |
| There was blinding of all assessors who measured at least one key outcome                  |            |           |
| Measures of at least one key outcome measure were obtained from more than 85% of subjects  |            |           |
| Intention-to-treat analysis was performed  |            |           |
| Between-group statistical comparisons were reported  |            |           |
| Study provides both point measures and measures of variability on at least one key outcome |            |           |

### 3. Results

#### 3.1. Demographics of participants

The total number of participants within the included studies was 232 with relative representation between both genders (118 men, 114 women; Y. Ding et al., 2020; Kar & Hedge, 2020; Wennberg et al., 2016). The mean age was 27.2 years (Bailey & Locke, 2015; Y. Ding et al., 2020; Kar & Hedge, 2020; Mainsbridge et al., 2020; Osama et al., 2015; Wennberg et al., 2016). These studies included mostly office workers, performing sedentary work (Y. Ding et al., 2020; Mainsbridge et al., Osama et al., 2015; Wennberg et al., 2016).

Some of the studies had additional inclusion and exclusion criteria of the sample, like excluding participants with prior cardiovascular or metabolic disorders (Bailey & Locke, 2015), including participants without musculoskeletal, neurological, or vascular problems, as well as no strenuous exercise outside of the study (Y. Ding et al., 2020; Kar & Hedge, 2020; Osama et al., 2015).

#### 3.2. Quality of the reviewed articles

Each article included in this systematic review was screened thoroughly to determine the methodological quality of each article utilizing both the original PEDro scale and a Modified PEDro Scale for Ergonomics Research (MPSER). Refer to Tables 4–6 for detailed scoring of each article. Quality scores of the studies and the level of evidence they bring was deemed appropriate for review. Similar results were obtained through utilizing the MPSER scale, that more accurately assess the quality of the selected articles in the field of ergonomics (Radwan et al., 2020). The utilization of both of these quality assessment tools lends to a more accurate determination of the methodological quality of each. The results of articles ratings are summarized in Tables 4–6 as follows.

#### 3.3. Narrative review of included articles

1. “Breaking up prolonged sitting with light-intensity walking improves postprandial glycemia, but breaking up sitting with standing does not,” Bailey and Locke (2015):

Table 4. A summary table for the qualitative synthesis of the reviewed articles

| Article                 | Score PEDro/MPSER     | Design                                      | Participants  | Intervention   | Outcomes  | Authors' conclusion  |
|-------------------------|-----------------------|---|---|--|---|--|
| Bailey and Locke (2015) | PEDro: 6/10MPSER: 6/7 | Randomized repeated measure crossover trial | Number: 10 adults<br>Gender: 7 men, 3 women<br>Age: 24 ( $\pm$ 3 years)<br>Mean BMI of 26.5 ( $\pm$ 4.3) kg/m <sup>2</sup><br>No previous cardiovascular or metabolic diseases  | Three testing conditions (5 hours each), with a washout period of at least 6 days. <b>Conditions were</b> (1) Uninterrupted sitting<br>(2) Sitting interrupted by standing breaks<br>(3). Sitting interrupted by light-intensity walking breaks<br>Authors assessed metabolic measures after each condition. | <b>Metabolic Measures:</b><br>Glucose AUC levels for sitting and light activity when compared to the other experimental conditions<br>Blood pressure, total cholesterol, HDL, triglycerides | Authors found that, with frequent and brief interruption of sitting time paired with dynamic light-intensity activity, there was a beneficial response to postprandial levels that may reduce the risk of cardiometabolic disease.   |
| Y. Ding et al. (2020)   | PEDro: 5/10MPSER: 6/7 | Randomized controlled trial                 | Number: 48 adults<br>Gender: 24 men, 24 women<br>Age: Mean age of 22.8, SD of 1.1<br>No specific inclusion/exclusion criteria stated.<br>All office workers<br>Right-handed<br>Normal or corrected vision<br>No history of musculoskeletal, neurological, or vascular problems<br>Good rest and no strenuous exercise before the experiment | Three different conditions – “six groups.”<br>(1). Passive breaks remaining seated on an armchair for 5 minutes or 10 minutes respectively<br>(2). Active breaks of changing posture and walking for 5 or 10 min<br>(3). Stand and stretch active break for 5 or 10 min.                                     | <b>Physical Measures:</b><br>Muscular fatigue was measured by EMG studies of the trapezius and latissimus dorsi. Perceived discomfort was measured using a self-reported questionnaire.     | Authors found evidence in supporting the effectiveness of breaks on preventing discomfort. The most effective type of break that reduced discomfort was the stand and stretch break (SS5). The 5-minute passive break (PB5) resulted in the highest self-reported discomfort. Although this was not statistically proven, the authors believe that breaks like the active break (AB5, AB10) may be more advantageous in terms of work productivity and energy expenditure. |

(Continued)



Table 4. (Continued)

| Article              | Score PEDro/MPSE     | Design   | Participants   | Intervention  | Outcomes  | Authors' conclusion  |
|----------------------|----------------------|--|--|---|---|--|
| Kar and Hedge (2020) | PEDro: 5/10MPSE: 6/7 | Between participants randomized controlled trial | Number: 80 adults<br>Gender: 40 males and 40 females<br>Age: at least 18 years<br>Had prior experience with computer typing in English<br>No chronic musculoskeletal health complaints<br>Right-handed<br>Non-native English speakers<br>No prior experience of using an SSW at work | Five testing conditions in groups of 16<br>(1). 30 minutes of standing followed by 30 minutes of sitting.<br>(2). 30 minutes of sitting followed by 30 minutes of standing.<br>(3). 1 hour of sitting<br>(4). 1 hour of standing<br>(5). Sit-stand- walk<br>(20 minutes of sitting, 8 minutes of standing, 2 minutes of walking) repeated twice<br>Measurements of variables took place before and after each condition | <b>Physical Measures:</b><br>Musculoskeletal discomfort was measured using a 15 item VAS standardized Nordic Questionnaire. Perceived physical fatigue was measured using a single-item VAS scale.<br><b>Cognitive/Stress Measures:</b><br>Perceived mental fatigue was measured using a single-item VAS scale.<br><b>Productivity Measures:</b><br>Comparison of speed and typing errors | When compared to the baseline, participants in the Sit-Stand-Walk work condition reported a reduction in mean musculoskeletal discomfort. In contrast, participants in the Sit-Stand, Stand-Sit, Sitting, or Standing work conditions reported increases in mean musculoskeletal discomfort compared to the baseline. When compared to the baseline, participants in the Sit-Stand-Walk work condition reported a reduction in mean perceived physical fatigue. In contrast, participants in the other four work conditions reported increases in mean perceived physical fatigue when compared to the baseline. Participants in the Sit-Stand-Walk work condition demonstrated the least documented increase of mental fatigue when compared to the other conditions. |

(Continued)



Table 4. (Continued)

| Article                   | Score PEDro/MPSE     | Design                         | Participants   | Intervention   | Outcomes  | Authors' conclusion   |
|---------------------------|----------------------|--------------------------------|--|--|---|---|
| Mainsbridge et al. (2020) | PEDro: 6/10MPSE: 6/7 | Randomized control pilot study | Number: 43 participants<br>Age: $42.52 \pm 10.89$ years<br>Must be working full time at a desk job and classified as a non exerciser.  | Experimental group participated in two conditions (total of 26 weeks):<br>(1). A computer-generated, hourly microbreak of light exercise intensity for 13 weeks.<br>(2). There was a washout period of 13 weeks following the removal of the microbreak program.   | <b>Cognitive Measures:</b><br>Police Stress Questionnaire was used to assess mental stress Profile of Mood States was used to assess feelings of vigor and fatigue. | At 26 weeks, authors found a significant reduction in stress levels for the experimental group compared to the control group. However, there were no significant differences related to other dependent variables (vigor and fatigue). The authors' main findings suggest incorporating movement alongside sedentary work can be beneficial to the mental health of office workers. |
| Osama et al. (2015)       | PEDro: 6/10MPSE: 6/7 | Randomized controlled trial    | Number: 32 adults<br>Age: Unspecified, similar at baseline<br>Must be working on a static workstation with 6 hours of computer usage a day. Participants had to have musculoskeletal symptoms (of unidentified cause) for more than 2 weeks. | Two conditions in a 5 week experiment:<br>(1). The control group had resting micro breaks of 30s every 15 minutes, in addition to two conventional 15 minute breaks throughout the day.<br>(2). The experimental group participated in exercise breaks of 10 minutes twice a day in addition to the two conventional 15-minute breaks during the work day. | <b>Physical Measures:</b><br>Visual Numeric Rating Scale for musculoskeletal pain. Cornell Musculoskeletal Discomfort Questionnaire                                 | Authors found that both groups reported improvement in musculoskeletal discomfort, more so in the exercise break group than the rest break group after between-group comparison. Their findings suggest that exercise breaks are more effective in preventing musculoskeletal symptoms.   |

(Continued)

Table4. (Continued)

| Article                | Score PEDro/MPSER     | Design                                   | Participants  | Intervention  | Outcomes  | Authors' conclusion  |
|------------------------|-----------------------|--|---|---|---|--|
| Wennberg et al. (2016) | PEDro: 7/10MPSER: 6/7 | Randomized two-condition crossover trial | <p>Number: 19 adults<br/> Gender: 10 men, 9 women<br/> Age: 45–75 years<br/> BMI: &gt;25 kg/m<sup>2</sup><br/> Must be seated for 5 hours a day or more.<br/> Must not engage in regular moderate-intensity vigorous physical activity.</p> | <p>Two conditions, performed by all participants randomly, with a washout period of 6 days between the two conditions.<br/> (1). Participants remain seated, barring bathroom breaks, for full 7 hours performing computer work<br/> (2). Participants remain seated up to the 2-hour mark, at which they begin to perform 2 minutes of light-intensity walking which is then performed every 30 minutes for the remaining 5 hours.</p> | <p><b>Physical Measures:</b><br/> Sitting time and moderate-to-vigorous intensity physical activity were assessed using an accelerometer (Actigraph GT3X+)<br/> Fatigue was assessed by the Visual Analog Scale for Fatigue (VASF).<br/> <b>Cognitive/Stress Measures:</b><br/> Testing assessed by battery of cognitive testing<br/> <b>Metabolic Measures:</b><br/> Glucose levels, HR and BP monitoring.</p> | <p>Authors found that intermittent walking microbreaks resulted in significant decrease in reported fatigue levels of sedentary workers.<br/> No statistical differences were detected in any measured cognitive variables, except for episodic memory testing, which improved slightly with activity.</p> |

**Table 5. Detailed PEDro scores for reviewed articles**

| <b>PEDro Scale</b>                      | <b>Bailey and Locke (2015)</b> | <b>Y. Ding et al. (2020)</b> | <b>Kar and Hedge (2020)</b> | <b>Mains bridge et al. (2020)</b> | <b>Osama et al. (2015)</b> | <b>Wennberg et al. (2016)</b> |
|---|--------------------------------|------------------------------|-----------------------------|-----------------------------------|----------------------------|-------------------------------|
| Random allocation to groups             | Y                              | Y                            | Y                           | Y                                 | Y                          | Y                             |
| Concealed allocation                    | N                              | N                            | N                           | N                                 | Y                          | Y                             |
| Baseline similarity                     | Y                              | N                            | N                           | Y                                 | Y                          | N                             |
| Blinding of subjects                    | N                              | N                            | N                           | N                                 | N                          | N                             |
| Blinding of therapists                  | N                              | N                            | N                           | N                                 | N                          | N                             |
| Blinding of assessors                   | N                              | N                            | N                           | N                                 | N                          | N                             |
| one key outcome measure                 | Y                              | Y                            | Y                           | Y                                 | Y                          | Y                             |
| Intention-to-treat analysis             | Y                              | Y                            | Y                           | Y                                 | Y                          | Y                             |
| Reported statistical comparisons        | Y                              | Y                            | Y                           | Y                                 | Y                          | Y                             |
| Reported point and variability measures | Y                              | Y                            | Y                           | Y                                 | Y                          | Y                             |

- This purpose of this study was to determine the effect of breaking up sedentary behavior with light intensity walking or standing on a variety of cardiometabolic risk markers. To do this, 10 healthy participants (7 men, 3 women, mean age of  $24.0 \pm 3.0$  years) were recruited via convenience sampling for participation in a randomized, repeated measures crossover trial. Participants were healthy, free of any cardiovascular or metabolic disease, and had no contraindications to physical activity. Participants then completed each of the three conditions in three separate visits, in a random order, with each session lasting a total of 5 hours. The conditions were (1) uninterrupted sitting for 5 hours, (2) sitting interrupted by 2-minute standing breaks every 20 minutes, and (3) sitting interrupted by 2-minute, light intensity (Borg 6–9) walking breaks every 20 minutes. Blood samples for analysis were taken every hour, and blood pressure was also measured hourly. Using the blood samples, glucose was tracked hourly, and total cholesterol, triglycerides, and HDL were measured at baseline, and upon completion of the experiment. The results of the experiment showed that there was a significant effect of condition with large effect size for Glucose AUC for the sitting+light activity group when compared to the other groups (sitting and sitting+standing). In summary, the light activity group demonstrated. There was no significant effect shown for either systolic or diastolic blood pressure between the groups, though there was a small and medium effect size respectively. There was no significant main effect seen for changes on total cholesterol or triglycerides, though there was a medium-large effect size for triglycerides.

2. “It is time to have rest: how do break types affect muscular activity and perceived discomfort during prolonged sitting work,” Y. Ding et al. (2020)

**Table 6. Detailed MPSEr for reviewed articles**

| <b>Modified PEDro Scale for Ergonomics Research (MPSEr)</b>                    | <b>Bailey and Locke (2015)</b> | <b>Y. Ding et al. (2020)</b> | <b>Kar and Hedge (2020)</b> | <b>Mains bridge et al. (2020)</b> | <b>Osama et al. (2015)</b> | <b>Wennberg et al. (2016)</b> |
|--|--------------------------------|------------------------------|-----------------------------|-----------------------------------|----------------------------|-------------------------------|
| Adequate explanation of procedures   | Y                              | Y                            | Y                           | Y                                 | Y                          | Y                             |
| Randomized allocation or randomized sequence of interventions and measurements | Y                              | Y                            | Y                           | Y                                 | Y                          | Y                             |
| Blinding of assessors  | N                              | N                            | N                           | N                                 | N                          | N                             |
| one key outcome measure  | Y                              | Y                            | Y                           | Y                                 | Y                          | Y                             |
| Intention-to-treat analysis  | Y                              | Y                            | Y                           | Y                                 | Y                          | Y                             |
| Reported statistical comparisons   | Y                              | Y                            | Y                           | Y                                 | Y                          | Y                             |
| Reported point and variability measures  | Y                              | Y                            | Y                           | Y                                 | Y                          | Y                             |

- The purpose of this study was to examine the effects of various break types on muscular activity and fatigue of trapezius and latissimus dorsi as measured by EMG, and on subjective perceived discomfort. For the experiment, a convenience sample was recruited to participate, comprised of 48 individuals, half male, half female. These participants were all healthy individuals, without a history of neurological, musculoskeletal or vascular issues that would prevent sitting for a period of up to 2 hours. The participants were then randomly divided into six different break groups for the experiment, with 2 groups participating in passive breaks, and 4 groups participating in “active breaks”. The passive break groups were 5-minute passive break (PB5) and 10-minute passive break (PB10), which both involved remaining seated in their armchairs for their allotted break time. For the active break groups, there was 5-minute active break (AB5) and 10-minute active break (AB10), which involved walking for either 5 or 10 minutes, and the final two groups were stand and stretch for 5 minutes (SS5), and stand and stretch for 10 minutes (SS10). Each group participated in seated, sedentary work for a total of 2 hours, with each respective break type given at the 40-minute mark. EMG signals on the trapezius and latissimus dorsi were measured throughout the experiment, and subjective muscle discomfort was measured every 10 minutes using Borg’s CR-10 scale. The results of this study showed that all conditions caused an acute decrease in discomfort at the 40-minute time mark (time of the break). When measuring perceived discomfort, the worst break was the PB5, which showed the highest discomfort at the measured time frames. Following the break, the SS5 break group showed a statistically significant difference from the reference group at the T8 (80 min) time point in subjective discomfort. No other groups showed statistical significance when compared to the reference group. When measuring

muscle fatigue via EMG, AB5 was found to be the most effective in keeping the muscles at a non-fatigue level for about 30–45 mins, followed by the SS10 group.

3. “Effects of a sit-stand-walk intervention on musculoskeletal discomfort, productivity, and perceived physical and mental fatigue, for computer-based work,” Kar and Hedge (2020)

- The purpose of this study was to evaluate the effect of different conditions at work on musculoskeletal discomfort, perceived mental and physical fatigue, and task productivity, using two short duration computer tasks of 30 minutes each. To do this, a convenience sample was taken of 80 young adults (40 males and 40 females) with an inclusion criterion of 18 years of age, prior experience of computer work, and no chronic musculoskeletal complaints. Participants were randomly assigned in groups of 16 to one of five conditions: (1) sitting for two consecutive sessions, (2) standing for two consecutive sessions, (3) sit-stand where the participant will sit for 30 minutes and then stand for 30 minutes, (4) stand-sit where the participant will stand for 30 minutes and then sit for 30 minutes, and (5) sit-stand-walk where each session was comprised of 20 minutes of sitting, eight minutes of standing, and a two minute walk. The assessments used to analyze discomfort and fatigue are the visual analog scale (VAS), with a 15 item VAS for musculoskeletal discomfort, and a single item visual analog fatigue scale. These assessments were given to participants prior to the beginning of the experiment, and again after the completion of the experiment. In total, this experiment took approximately 100 minutes to be completed. The results of this experiment showed that when compared to the baseline, participants in the Sit-Stand-Walk work condition reported a reduction in mean musculoskeletal discomfort. Other participants in the Sit-Stand, Stand-Sit, Sitting, or Standing work conditions reported increases in mean musculoskeletal discomfort compared to the baseline. When compared to the baseline, participants in the Sit-Stand-Walk work condition reported a reduction in mean perceived physical fatigue. In contrast, participants in the other four work conditions reported increases in mean perceived physical fatigue when compared to the baseline. When compared to baseline scores, participants in the Sit-Stand-Walk reported a mean increase in perceived mental fatigue, however participants in the other four work conditions reported increases of a larger magnitude in compared to the baseline scores.

4. “Taking a stand for office-based workers’ mental health: the return of the microbreak,” Mainsbridge et al. (2020)

- The purpose of this randomized controlled trial to see if microbreaks can change desk workers’ moods, levels of fatigue and vigor, and perception of job-related stress. The authors included 43 participants (age  $42.52 \pm 10.89$ ; 32 females, 11 males) to participate in the study. As a pre-test, the researchers gave the participants both the Police Stress Questionnaire as well as the Profile of Mood States. The participants in the experimental group were prompted by a computer program to perform an activity of their choosing every hour during their seated work. Each participant was able to choose what exercise they performed from 65 choices, each of which had video coaching. The participants did this for 13 weeks and took post-intervention baseline measures. After this phase, there was a 13-week washout period in which the participants did not have the program on their computers. The individual would be in charge of when they would perform the microbreaks. Baseline measures were taken at the end of the washout period. The results showed that there was a significant between-group difference at the washout, but not at the baseline and post-test. ANOVA results for perceived stress identified a significant interaction for group and time. There was a significant difference between groups during the washout test ( $p = .03$ ) and a medium effect size (Cohen’s  $d = .77$ ). There were no significant interactions for univariate analyses for mood profile changes for fatigue or vigor.

5. “A randomized control trial comparing the effects of rest breaks and exercise breaks in reducing musculoskeletal discomfort in static workstation office workers,” Osama et al. (2015)

- The purpose of this randomized controlled trial was to compare rest breaks and exercise breaks’ effectiveness in relation to musculoskeletal discomfort at work using a static workstation. There were 32 participants (26 males and 6 females) that worked at a static workstation with at least 6 hours of computer work a day, and reported musculoskeletal discomfort or pain for more than 2 weeks. The rest break group had microbreaks (resting) of 30 s every 15 minutes, as well as two 15-minute breaks. The exercise group had two microbreaks (active) for 10 minutes as well as the two 15-minute breaks. The researchers recorded a Visual Numeric Rating scale for musculoskeletal pain and the Cornell Musculoskeletal Discomfort Questionnaire for a baseline as well as at the end. The results showed that there were significant differences for pre and post scores of both groups on both the VNRS and CMDQ. Independent t-tests were performed to compare the two groups. This showed that the exercise break group to be significantly better compared to the rest breaks group.

6. “Acute effects of breaking up prolonged sitting on fatigue and cognition: a pilot study,” Wennberg et al. (2016)

- The purpose of this randomized two-condition crossover trial was to assess the effect that intermittent exercise breaks have on fatigue and various cognitive elements during prolonged seated work. Nineteen adults participated in the study, 10 men and 9 women, all of whom were between 45 and 75 years old with a BMI greater than 25 kg/m<sup>2</sup> and regularly sat for 5 hours a day or more without engaging in regular physical activity. the participants performed one of two conditions followed by a 6-day washout period, after which they performed the other condition. The first condition saw participants remaining seated, barring bathroom breaks, for a full 7 hours while performing computer work. The second condition saw participants remaining seated up to the 2-hour mark, at which they began to perform 2 minutes of light-intensity walking. Walking was then performed every 30 minutes for the remaining 5 hours. Throughout the study, participants were outfitted with an Actigraph GT3X+, which was constantly recording sitting time and levels of MVPA (Moderate-vigorous intensity physical activity). The accelerometer continued to record data throughout the washout period as well. Outcome measures included sitting time and physical activity using an accelerometer, VAS-F (Fatigue), a battery of cognitive testing, glucose concentration, and blood plasma levels. The results of this study reported a decrease in the self-reported fatigue score in the active group versus the sedentary group which correlated with a decrease in HR and plasma level of DOPA and an increase in plasma level of DHPG in the sedentary condition. Levels of MVPA during the washout period showed no significant differences between groups, keeping things consistent. No statistical differences were seen in any measured cognitive variables except for episodic memory testing, which improved slightly in the active group. Their findings suggest that “light-intensity walking breaks may counteract increased fatigue.”

#### 4. Discussion

After conducting the qualitative synthesis for this systematic review, the researchers identified the following discussion themes.

##### 4.1. Parameters of an active micro-break

Interrupting prolonged sitting in the workplace with active microbreaks can help provide a degree of protection against the poor health consequences associated with sedentary behavior. Other literature has previously defined active microbreaks as office appropriate, self-determined, and short in duration, while possessing a variety of benefits (Mainsbridge et al., 2020). Furthermore, active microbreaks are described as lasting anywhere between 1 and 3 minutes in length and can be taken as often as every 20–30 minutes throughout the typical 8-hour work day (Buckley et al., 2015). Taking approximately two active microbreaks per hour throughout the workday can have

a positive impact on both mind and body. The effects of these microbreaks are comparable to prolonged breaks, and do not jeopardize workplace productivity.

Most of the articles incorporated into this systematic review used light intensity walking as the intervention of choice for the active microbreak (Bailey & Locke, 2015; Y. Ding et al., 2020; Kar & Hedge, 2020; Wennberg et al., 2016). Primarily, these walking breaks lasted for 2 minutes in duration while the study performed by Ding et al. had a duration of walking to be either 5 or 10 minutes (Y. Ding et al., 2020). The study written by Osama et al. incorporated a 10-minute exercise break with a specific protocol which contained a total of 12 exercises where the subjects participated in shoulder shrugs, neck tilts, upper body stretching, and lower body stretching as their active microbreak (Osama et al., 2015). Although these exercises are quite different from the other studies included in the systematic review, results were similar in that the experimental group had superior outcomes compared to the control group. Other acceptable exercises for active microbreaks may include standing calf raises, chair squats, and stair climbing, especially if office space is limited and walking may not be a viable option for some employees (Mainsbridge et al., 2020).

#### **4.2. Beneficial effects of microbreaks**

##### **(1) Beneficial physical effects**

Breaking up the monotony of sitting and static posture, of office workers, with active microbreaks has shown promise in reducing many of the physical symptoms that accompany this dangerous practice. Outside of the office, other occupations have experienced similar physical symptoms and discomfort associated with static posturing over prolonged periods of time, specifically in the medical field of surgery. Breaking up the static positioning of operating surgeons with active microbreaks has been shown to be effective in reducing musculoskeletal discomfort and fatigue, while improving subjective ratings of physical performance (Coleman Wood et al., 2018; Hallbeck et al., 2017). Due to the comparable nature of musculoskeletal complaints, sedentary office workers who experience concerns associated with static posturing and lack of movement may experience similar benefits from active microbreaks.

The focus of recent research, and one of the goals of this systematic review, has been to explore various break types and protocols to combat the physical symptoms experienced by sedentary office workers. Ding et al. concluded that breaks of any type are effective in reducing muscular fatigue, specifically in the latissimus dorsi and trapezius muscles. Though all breaks reduced muscular fatigue, the break types varied in efficacy regarding their ability to reduce musculoskeletal discomfort. Passive breaks resulted in the highest reported discomfort, while a more active break, in the stand and stretch group, reported the greatest reduction in discomfort (Y. Ding et al., 2020). When following the “20-8-2” protocol, involving 20 minutes of sitting, eight minutes of standing, and two minutes of sitting, participants were shown to have the greatest reductions in musculoskeletal discomfort and physical fatigue when compared to groups who participated in combinations of sitting and standing without active movement (Kar & Hedge, 2020). Similarly, light-intensity walking outside of the specific “20-8-2” protocol was demonstrated to be effective in other research. Participants who spent two minutes walking for every 30 minutes seated demonstrated less physical fatigue when compared to a sedentary group who sat for the duration of time (Wennberg et al., 2016). Osama et al. further demonstrated the benefits of active microbreaks over more sedentary, resting microbreaks, showing that small bouts of exercise during work breaks resulted in less musculoskeletal discomfort when compared to a group who simply rested during their breaks (Osama et al., 2015).

Though the literature included in this review points to many physical benefits of active microbreaks over other break types, there has been recent evidence that reports the contrary. A 2019 systematic review concluded that work-break frequencies or break type may have no effect on musculoskeletal pain, fatigue, and discomfort. Despite this conclusion, the authors report that the evidence behind these claims was of low quality, denoting a need for higher quality research in this area of ergonomics (Luger et al., 2019). This represents a gap in the current body of evidence in



which this systematic review attempts to fill through the inclusion of higher quality research studies that have been recently published.

#### (1) Beneficial mental/cognitive effects

The literature provides an extensive amount of information on the benefits linked with active microbreaks, and on the improvement of both cognition and mental health in sedentary workers. Employees almost always experience job-related stress from an array of stressors consisting of pressure to complete tasks, excessive work demands, and in management of handling their work responsibilities. Regularly providing employees with short bouts of light intensity exercise has shown a reduction in work-related tensions/stress and a surge in enhanced cognition.

Kar and Hedge have integrated a formal design of a sit-stand-walk intervention, specifically following the 20 minutes of sitting, eight minutes of standing, and two minutes of walking guidelines at the participants selected pace (Kar & Hedge, 2020). Results showed an increase in perceived mental fatigue, although compared to groups who either participated in sitting or standing alone, was still of a lower magnitude. Therefore, all groups had an increase in mental fatigue, but the lowest increase belonged to the sit-stand-walk group. However, in contrast, another study which also used walking, used parameters in which the walk was of light intensity with a grade of 9 on the Borg RPE scale and for a period of 3 minutes. As the intervention of choice for the active microbreak, there was a significant decrease in reported mental fatigue levels compared to the control group in which the participants remained seated unless to use the bathroom (Wennberg et al., 2016). Mainsbridge et al., found that incorporating movement alongside sedentary behaviors, can be beneficial to the mental health of office workers, as there was a reduction in stress levels subsequent to frequent active microbreaks throughout the workday compared to those who worked as normal and did not engage in active microbreaks (Mainsbridge et al., 2020). These movements consisted of 65 different choices such as chair squats, stair climb, and walking, to name a few. (Mainsbridge et al., 2020).

Alternative research completed by Bergouignan et al., was able to come to similar conclusions and determine that 5-minute microbreak bouts throughout the day are associated with superior cognitive performance, mood, and less fatigue compared to both uninterrupted sitting and a prolonged exercise for 30 minutes (Bergouignan et al., 2016). In addition, the experimental group with the microbreak intervention had sustained effects that lasted all day, while the group performing a single bout of 30 minutes of exercise had effects that did not last throughout the afternoon.

Improving upon employee mental health is cost-effective. Effects of long-term stress due to work can increase the chances of developing physical ailments, in addition to depression, fatigue, and a lack of motivation. Incorporating active microbreaks throughout the day is an effective prevention design, in conjunction with significant health benefits, and should be applied to most if not all workspaces that partake in sedentary working behaviors.

#### (1) Beneficial metabolic effects

Two articles included in this review directly addressed the benefits that taking an active work break can have on health/metabolic measures for those in sedentary working conditions. One article reported that while blood pressure, total cholesterol, HDL, and triglycerides level did not significantly change, blood glucose AUC levels showed a significant improvement with a large effect size with the introduction of an active break to interrupt sitting time following consumption of two standardized test drinks (Bailey & Locke, 2015). This indicates that breaking up sedentary activity with light exercise can have a favorable impact on postprandial glucose, which in turn will help to reduce the risk of cardiometabolic diseases.

Another study that is not included in this review conducted a similar study and reported similar findings when comparing a condition of uninterrupted sitting with two of sitting broken up with

light to moderate intensity exercise, the latter conditions yielding a significant reduction in postprandial glucose as opposed to the former (Dunstan et al., 2012). This further supports the findings of Bailey and Locke (2015) which conclude that microbreaks have a favorable effect on postprandial glucose levels. Postprandial glucose can have a substantial impact on the level of fatigue a sedentary worker may feel, and the favorable results showcased by studies exploring the effects of microbreaks in sedentary settings support their performance as a beneficial practice.

A second article included in this review comparing participants in two conditions, one of uninterrupted seated activity and the other with an additional introduction of light intensity walking every 30 minutes, found that for the sedentary condition, plasma levels of dihydroxy phenylalanine (DOPA) and heart rate significantly increased in the sedentary condition when compared to the active condition (Wennberg et al., 2016). It can be inferred that prolonged seated work can lead to these unfavorable changes, which in turn can lead to increased levels of fatigue during work hours.

#### (1) Beneficial productivity effects

There is a moderate amount of evidence focusing on microbreaks and the effect that has on workers' productivity. Kar and Hedge (2020) found that there was no statistically significant difference in mean typing speed and change in physical position during work. Galinsky et al. (2007) reached the same conclusion. Galinsky et al. (2007) found that, while productivity wasn't affected by microbreaks, there was a significant decrease in other, negative, impacts that microbreaks can help subside. This begs the argument that, even though productivity isn't necessarily increased with active microbreaks, it also isn't typically found to inhibit productivity.

However, Hedge and Evans (2001) found that there was a "59% decrease in the error rate between the pre-test and post-test conditions." This study identified microbreaks as a key factor in reducing errors when microbreaks are based on the participant's work intensity (Hedge & Evans, 2001). Another study conducted by Hennfng et al. (2010) sought out to identify the effects of microbreaks had on keystroke rate, error rate, correction rate, and heart rate variability. Twenty participants partook in this study. Hennfng et al. (2010) identified, through a comparison of keystroke output and correction rate before and after the microbreak, that microbreaks decreased performance levels momentarily. While Hennfng et al. (2010) decided to put a focus on rest breaks with a varied duration, Hedge and Evans (2001) incorporated stretching and relaxation exercises. This aids in emphasizing the implementation of an active microbreak instead of a resting microbreak in regards to the participant's productivity.

## 5. Conclusion

The researchers encourage the introduction and implementation of active work breaks in the daily life of an office worker. Based on the moderate-to-high quality evidence provided in this systematic review, the data suggests that there are some benefits associated with the introduction of active microbreaks (2–3 minutes of light intensity activity for every 30 minutes of sedentary work). Active microbreaks seems to lead to improvement in the physical, mental, and metabolic functions of the human body without posing detrimental effects to employee's productivity. Active microbreaks may have the potential to decrease musculoskeletal discomfort, improve cardiometabolic markers, and help provide relief from fatigue and stress experienced throughout the workday.

### 5.1. Clinical implications and future research

This systematic review recommends that employers and employees in sedentary workplaces should consider active microbreaks as a viable, easily implemented solution in combating the deleterious health consequences related to sedentary behavior. Future research should focus on providing further high-quality evidence regarding the use of active microbreaks in the workplace.

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