REVIEW ARTICLE

Sedentary behaviour and its link to depression and anxiety in adults: a systematic review and meta-analysis

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Received: 28 April 2024 **Revised:** 18 June 2024 **Accepted:** 1 July 2024 **Available online:** September 2024
DOI: 10.55131/jphd/2024/220324

ABSTRACT

The increased mechanization and advancements in technology over the past few years have increased the time an individual spends sitting. Various studies have established links between non-communicable diseases and sedentary behaviour (SB). The risk of weight gain, diabetes, hypercholesterolemia, etc. has been associated with a sedentary lifestyle. Prolonged sedentary time has also been linked to poor mental health. Many studies report a positive relationship between a sedentary lifestyle and depression & anxiety, while some others have not established a clear link. The current review was conducted to examine the recent literature about the relationship between SB and depression & anxiety. An extensive review of the literature was conducted by using Google Scholar, Scopus, PubMed, and Science Direct databases using PRISMA guidelines. Sixteen articles were finally included in the review of which four studies reported odds ratio (OR) for anxiety. A pooled OR of 1.52 (95% CI 1.44-1.60) (p=0.000) was obtained for depression and 1.53 (95% CI 1.40-1.68) (p=0.000) for anxiety. Four studies conducted during COVID-19 also reported SB was linked to depression and anxiety. Sub-group analysis indicated that this relationship was impacted by a few confounders such as BMI, gender, activity levels, etc. SB increases the odds of depression and anxiety, which could be affected by other lifestyle factors. Therefore, it is vital to adhere to physical activity guidelines given by WHO, which would help in improving the mental well-being of individuals. There is a need for more RCTs with larger samples to understand the dose-response relationship between SB and mental health.

Key words:
anxiety; depression; mental health; mental well-being; sedentary behaviour

Citation:
Vaishali Pathak, Bani Tamber Aeri. Sedentary behaviour and its link to depression and anxiety in adults: a systematic review and meta-analysis. J Public Hlth Dev. 2024;22(3):305-320
(https://doi.org/10.55131/jphd/2024/220324)

INTRODUCTION

Sedentary behaviour (SB) can be defined as any activity that a person carries out in an awake state, where the energy expenditure is 1.5 metabolic equivalents (METs) or lower during sitting, lying down or in a reclined position.[1] Due to mechanization and advancements in technology, the nature of work that humans must do has changed, which has led to a massive reduction in physical activity.[2] This along with the fact that the occupational activities of a major population of the world involve prolonged sitting during their working hours has made the current environment for most of the population *pro-sedentary*. The number of hours spent sitting in a day is now considered an indicator of health.[3] Various studies have established links between non-communicable diseases (NCDs) and sedentary behaviour.[4]

The COVID-19 pandemic has further led to an increase in SB. People were confined to their homes which contributed to higher sitting time. Previously, travelling to work, walking around the office, etc. offered some physical activity throughout the day. Three years after the pandemic, many working adults continue to work from home. Therefore, the impact of SB could be much larger on both the physical and mental health of adults. Several studies conducted during this period have reported an increase in SB.[5,6]

SB has been associated with depression and anxiety (the two most common mental health disorders) in several studies.[7,8] Globally, the prevalence of depressive disorders in adults is 5% (WHO,2023),[9] whereas the prevalence of anxiety disorders increased by almost 50% since 1990.[10] This increasing prevalence has led to a recent shift towards studying the impact of SB on the mental well-being of an individual.

Few studies report a positive relationship between a sedentary lifestyle and depression & anxiety,[11,12] yet the results remain inconclusive as many studies have not found a significant relationship between the two.[13,14,15] The current systematic review and meta-analysis were conducted to study the recent literature reporting the relationship between SB and the two most common mental health issues i.e. depression & anxiety.

METHODOLOGY

An extensive review of literature was conducted by using Google Scholar, Scopus, PubMed, and Science Direct databases covering the past ten years (from January 2013 to December 2022). We used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[16] A comprehensive literature search was conducted using the following search strategy which included the keywords, (Sedentary lifestyle, sedentary behaviour, sitting, sedentary pattern) AND (Depression, depressive symptoms, anxiety, anxiety disorders) AND (adults).

Inclusion criteria:

1. Studies published between 2013-2022, in the English language and their full-texts were available.
2. Articles that explored the relationship between depression and/or anxiety and SB as an outcome in adults (age ≥18 years) with an observational or interventional study design.
3. Articles reporting SB using accelerometers, standardized tools (IPAQ, GPAQ) or self-reported measures[17]
4. Articles that reported the relationship between SB (total or sedentary screen time) and depression and/or anxiety using odds ratios.

Exclusion criteria

1. Articles in languages other than English.
2. Articles including pregnant and lactating women as a sample.
3. Articles studying subjects with chronic diseases.
4. Conference abstracts, review articles, book chapters and editorials.

Protocol registration:

The protocol of the current meta-analysis was not registered.

Data extraction:

The title and abstracts were screened, and the articles were collected for the review process. Two reviewers conducted this screening independently. Full texts of relevant studies were reviewed to finalize their inclusion in the review. Articles were also examined by cross-referencing the short-listed articles. The following data was extracted: study design, the composition of the sample, sample size, methods used to evaluate SB and depression/anxiety symptoms and the findings of these articles (reported using odds ratio). The quality assessment of these articles was conducted by both authors using AXIS tool[18]. This tool uses 20 components to assess the quality of the studies. A score of 0-20 can be obtained, with a higher score indicating a higher quality study, which further indicates a lower risk of bias.

Statistical analysis:

The odds ratio, along with 95% confidence intervals were used to calculate the pooled effect of SB on depression and anxiety. I^2 values were computed to study the heterogeneity between the studies. An I^2 value of <40% indicates low heterogeneity, whereas, values of 30-60%, 50-90%, and 75-100 account for moderate, substantial and considerable heterogeneity respectively[19]. The fixed effects model was used to conduct this analysis. The forest plots were generated. Publication bias was assessed by using Egger's linear regression statistics and funnel plot. The analysis was performed using STATA (version 15.0).

RESULTS

Articles selected

Initial screening of articles based on their titles and abstracts resulted in a shortlisting of 121 articles. After removing duplicates, 89 articles remained. Full texts of these remaining articles were reviewed to finalize the ones to be included in the review. Articles meeting the inclusion criteria (n=19) were included in the review. The relationship between SB and anxiety was reported in four studies, whereas SB and depression were reported in 16 articles. Of these 16 articles reporting depression, three articles were excluded from the meta-analysis, as the weight distribution was unequal and was contributing to the heterogeneity (I^2=99.8%)[20-22]. After excluding these articles, although still high, the I^2 value was reduced to 88%. Therefore, we finally included 13 articles studying SB and depression. Figure 1 shows the article selection process. One study[12] reported the relationship between both depression and anxiety with SB and was common for both factors. Thus, the total number of studies included in the current review was 16.

The characteristics of the articles included are discussed below.

Study characteristics:

Study design: All the 16 articles included in the study, had an observational study design (three were cohort studies [23-25], two were longitudinal cross-sectional studies[26,27] and 11 were cross-sectional studies [2,6,12,28-35].

The details of the articles included are presented in Table 1.

Sample size and composition: The sample sizes ranged from n=535 [33] to n=49025 [35]. The studies with females as their sample[26,29,33], whereas, all others had both male and female subjects.

Measures of SB: The SB was assessed as:

(a) *Sedentary screen time:* measured using total screen time and TV-viewing time. [6,12,23,27,31,33,35]

(b) *total sedentary time*[2,24-26, 28-29,30, 32,34].

This information was collected using:

(a) Standardized tools like the International Physical Activity Questionnaire (IPAQ)[34], Global Physical Activity Questionnaire (GPAQ) [32] and Physical Activity Rank Scale-3 [12].

(b) Self-reported sedentary time by the participants [6,23,25- 31,33,35]

(c) Use of accelerometers and pedometers [2,24].

Measures of mental health: The data collection to study depression and anxiety symptoms were conducted by using:

(a) Standardized tools such as (i) CIDI[30,32], (ii) Self-rating Anxiety Scale [12], (iii) Centre for Epidemiological Studies-Depression (CES-D)[12,27,29], (iv) Patient Health Questionnaire (PHQ)[23,25,33,34,35], (v) Beck Depression Inventory (BDI)[28] (viii) HADS-A[2].

(b) One study also used diagnosis by a clinician for the same [24]

(c) Validated self-developed questionnaires[6,26,31]

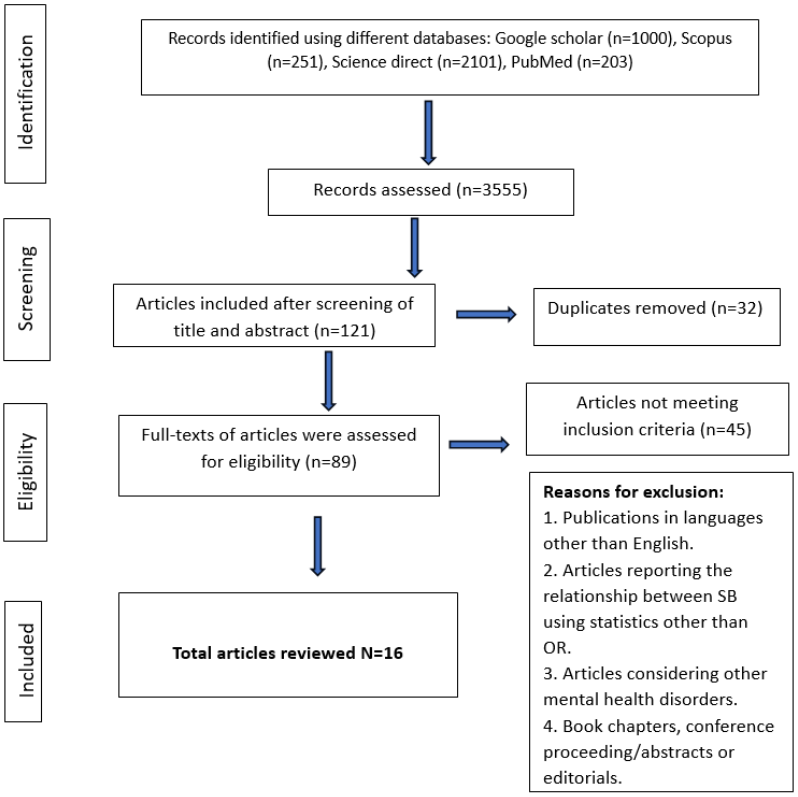

Figure 1. Article selection process

Relationship between SB and depression & anxiety

On conducting the meta-analysis, a pooled odds ratio of 1.52 (95% CI 1.44-1.60) (p=0.000) was obtained, indicating that SB significantly increased the odds of depression (Figure 2). Similar results were reported for anxiety as well (OR: 1.53 95% CI 1.40-1.68) (p=0.000) (Figure 3). The I^2 values of 88% and 67.9% were obtained for depression and anxiety respectively. This indicated that the heterogeneity between the studies included in this meta-analysis was very high.

To find out the potential source of this high heterogeneity, sub-group analysis was conducted for confounders: gender (combined and women), assessment of SB (total sitting time and total screen time), whether adjusted for BMI and physical activity. Results of the sub-group analysis indicated: (a)gender: The I^2 value was high for studies with just women as their sample i.e. 80.9% (p=0.005) and for studies with both genders as well i.e. 88.2%(p=0.000); (b) assessment of SB: Studies using the total sitting time to measure SB had I^2 value of 89.0% (p=0.000), while those with self-reported screen time was moderate i.e. 41.2% (p=0.147); (c) adjusting for BMI: Studies that did not adjust for BMI had a moderate I^2 value i.e. 65.6% (p=0.033) and it was 83.3% (p=0.000) for studies that adjusted for BMI; (d)adjusting for physical activity: The I^2 value for studies that adjusted for physical activity was 90.6% (p=0.000) and 67.4% (p=0.009) for studies that did not adjust for the same.

As the number of studies reporting the relationship between SB and anxiety was less than 10, sub-group analysis was not conducted.

Risk of bias: On assessing the quality of the studies, it was evident that most of them were of good quality, with the score ranging from 16-20, (mean ±SD =18.81±1.16).

Publication bias: On using Egger's linear statistics, we obtained a p-value of 0.10 (>0.05), which stated that there was a non-significant publication bias. This was also observed in the funnel plot obtained (figure 4).

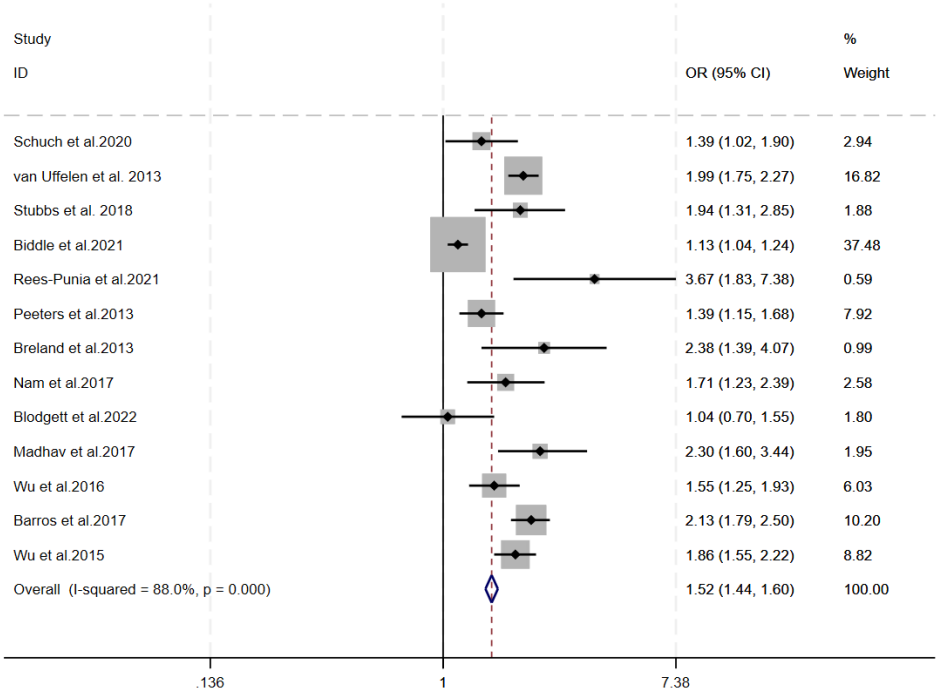

Figure 2. Forest plot showing the relation between SB and depression

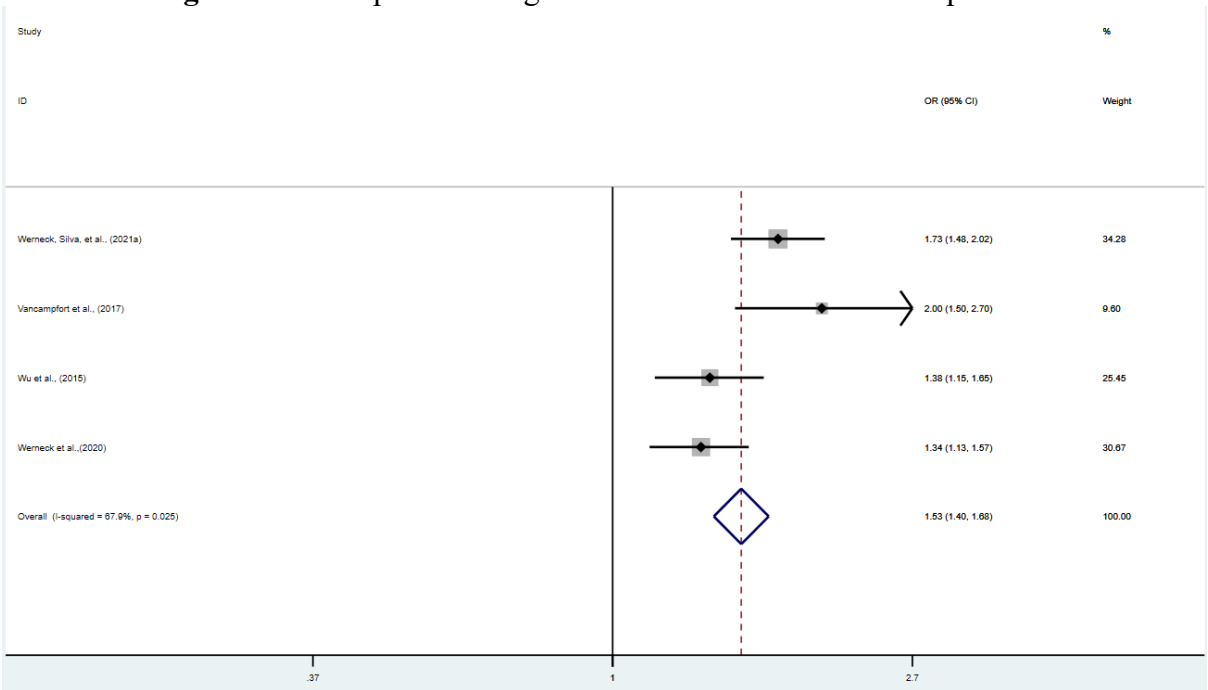

Figure 3. Forest plot showing the relation between SB and anxiety

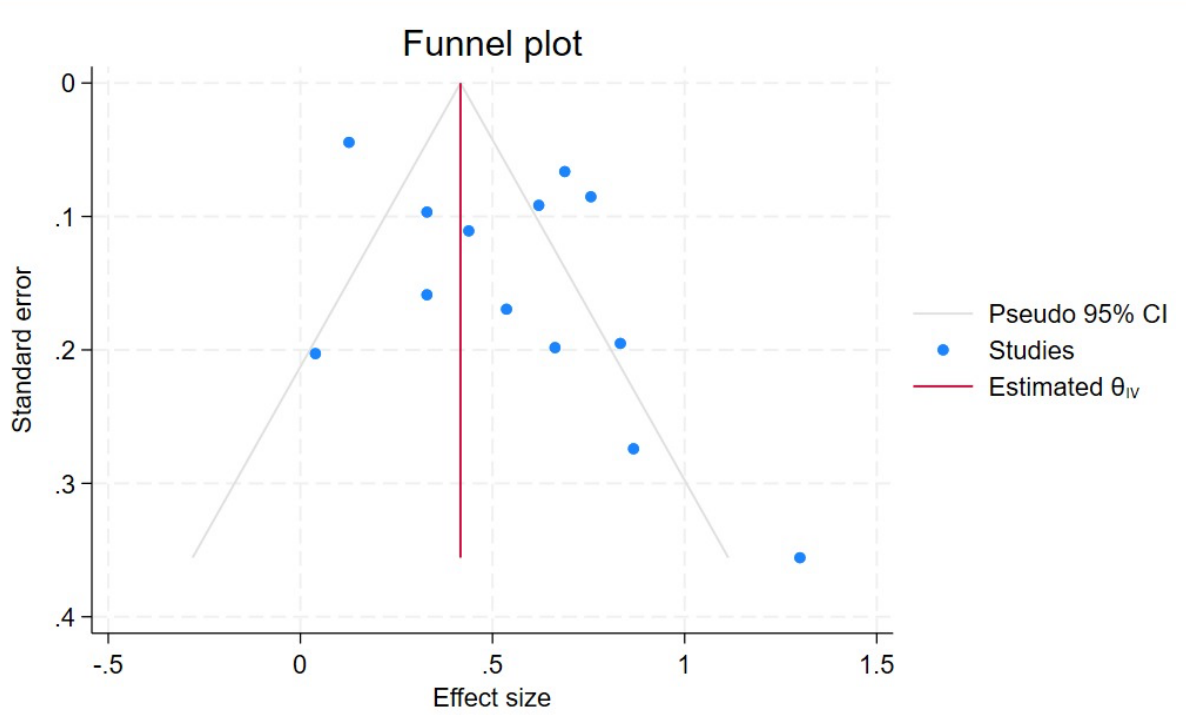

Figure 4. Funnel plot for articles studying the relationship between SB and depression

Table 1. Characteristics of studies included in the review

S.No.	Study	Country	Sample	SB assessment	Depression/ anxiety assessment	Results	Study design	Risk of bias score
1.	Schuch et al. [28]	Brazil	937 adults (18-35years)	Online questionnaire	BDI (Dozois et al., 1998), BAI (Beck et al. 1988)	≥10 hours of sedentary behaviour was significantly associated with depression, but not anxiety.	Cross-sectional	17
2.	Van Uffelen et al. [29]	Australia	8950 women, (50-55 years)	Questionnaire	CES-D (Radloff, 1977)	Women with SB >7h/day and no physical activity had higher odds of depression	Cross-sectional	20
3.	Stubbs et al., [30]	China, Ghana, India, Mexico, Russia, and South Africa	42469 adults (>25 years)	Self-reported total sitting time	Composite International Diagnostic Interview (Kessler & Üstün, 2004)	Depressed individuals had a higher tendency to be sedentary.	Cross-sectional	20
4.	Werneck, Silva, et al. [6]	Brazil	43995 adults	Questionnaire	Questionnaire	Previously active participants reported a reduction in physical activity which was associated with poor mental health. TV viewing increased as compared to the pre-pandemic period	Cross-sectional	19
5.	Vancampfort et al. [32]	China, Ghana, India, Mexico, Russia, and South Africa	42469 adults from 6 LMICs	GPAQ	CIDI (Kessler & Üstün,2003)	Anxiety symptoms were associated with high sedentary time.	Cross-sectional	19
6.	Wu et al. [12]	China	4747 College students	Physical Activity Rank Scale-3(Liang,1994),	self-rating anxiety scale, (Zung, 1971) CES-D	High sedentary time had a positive association with depression, anxiety and poor sleep	Cross-sectional	20

S.No.	Study	Country	Sample	SB assessment	Depression/ anxiety assessment	Results	Study design	Risk of bias score
				a questionnaire to estimate sedentary time	(Radloff, 1977)			
7.	Biddle et al. [2]	United Kingdom	1574 adults	activPAL monitor	HADS (Zigmond & Snaith, 1983), Health-Related Quality of life using the EQ-5D-5L('EuroQol,1990)	There was an increase in the odds of depression with an increase in total and prolonged sitting time. This relationship was not observed for anxiety.	Cross-sectional	18
8.	Rees-Punia et al. [25]	U.S. & Puerto Rico	2240 adults from Cancer Prevention Study-3 (CPS-3)	Questionnaire	PHQ-4 (Kroenke et al., 2009)	Compared to subjects with no change in sedentary time, the ones who became less active during the pandemic had higher depressive symptoms. This relationship was not observed with anxiety symptoms.	Prospective cohort	20
9.	Peeters et al. [26]	Australia	9592 middle-aged women	Self-reported total sitting time	History of incidence of 19 diseases, including depression and anxiety	Prolonged sitting time (>9 hours/day) increased the odds of depression.	Longitudinal and Cross-sectional	19
10.	Breland et al. [33]	U.S.	535 over-weight and obese women	Self-reported screen time	PHQ-8 (Kroenke, Strine, et al., 2009)	In minority women from the US, screen time may be an important risk factor for depression	Cross-sectional	16

S.No.	Study	Country	Sample	SB assessment	Depression/ anxiety assessment	Results	Study design	Risk of bias score
11.	Nam et al. [34]	South Korea	4415 adults	IPAQ (CRAIG et al., 2003)	PHQ-9(Kroenke et al., 2001)	Higher sitting time was associated with a higher risk of MDD. Reducing sitting time in people with MDD reduced symptoms.	Cross-sectional	18
12.	Blodgett et al. [24]	U.K.	4738 adults	Accelerometer	Diagnosis by doctor, subjects taking anti-depressants	Subjects with depression had higher SB and sleep time	Cohort	19
13.	Madhav et al. [23]	U.S.	3201	Self-reported screen time	PHQ-9	Screen time of >6 h/day was associated with moderate-to-severe depression symptoms	Cohort	18
14.	Werneck et al. [31]	Brazil	38353	Self-developed tool to assess TV viewing	One item to evaluate anxiety	anxiety (OR = 1.34 [95% CI: 1.13–1.57]	Cross-sectional	19
15.	Wu et al. [27]	China	2521	self-reported screen-time	CES-D, SAS	high ST was significantly positively associated with higher odds of anxiety and depression.	Cross-sectional & longitudinal	20
16.	Barros et al. [35]	Brazil	49025	Self-reported	PHQ-9	TV viewing for more than 5 hours a day was associated with a higher risk of depression.	Cross-sectional	19

SB and depression & anxiety during COVID-19 pandemic:

The current review included four studies that examined the relationship of SB with depression and anxiety during the COVID-19 pandemic [6,25,28,31]. A pooled sub-group analysis was conducted to determine if these studies conducted during the COVID-19 period were statistically different from studies conducted before the pandemic. Heterogeneity between these two groups was not statistically significant (p=0.724) indicating that the impact of SB on mental health was not impacted by the pandemic and these studies were therefore included in our review. All four studies conducted during the pandemic support the finding that increased SB leads to increased odds of depression and anxiety.

The importance of physical activity during the period of high SB was reported by Schuch et al. (2020)[28], where it was found that subjects who performed ≥30 mins of moderate-vigorous physical activity, reported 30% less depressive/anxiety symptoms. Subjects from their study who were sedentary for ≥10 hours/day were 39% more likely to have depressive symptoms.

Therefore, a clear link between high SB and depression and anxiety symptoms emerged which was not impacted by the pandemic period. Sedentary behaviour at any time would be linked with depression and anxiety.

DISCUSSION

Depression and anxiety are the two most common mental health disorders in the world in the adult population [36]. It was evident from the findings of the current review, that SB was associated with higher odds of both depression and anxiety. The findings of the current meta-analysis are supported by other similar articles. Higher screen-time-based SB was linked to depression as reported by a meta-analysis conducted by Wang et al. (2019)[37]. The link between SB and anxiety was reported by Allen et al. (2019)[17]. The COVID-19 pandemic further exacerbated this lifestyle-related problem. There was an increase in the sitting time of people as they were confined to their homes and this change influenced the mental health of individuals [38]. There was also an increase in screen time, which further increased SB and was associated with increased levels of depression and anxiety symptoms [39]. With people confined to their homes, the level of physical activity (which has a protective effect on depression & anxiety) was also reduced [40]. Thus, irrespective of the COVID-19 pandemic, the review indicated that high SB could increase the risk of depression and anxiety among adults.

A plausible explanation for the relationship between SB and depression & anxiety could be an increase in interleukin-6 levels (IL-6) due to a higher sedentary time spent. An increase in IL-6 levels is linked to depression [41]. This relationship was reported by Endrighi et al., (2016)[42] who observed that SB increased IL-6 levels, which further led to an increase in a negative mood. Several studies report that the introduction of breaks in sitting time can improve the inflammatory bio-markers levels (IL-6 and C-reactive protein) in the body, indicating the benefits of these breaks in preventing depression and anxiety [43,44]. Being physically active also promotes the secretion of neurotransmitters like serotonin and endorphins which can help to lower depression and anxiety symptoms [45,46]. Apart from that, sedentary screen time is known to cause anxiety by inducing changes to the sleep patterns of an individual [22].

The results of our meta-analysis indicate that one must take measures to reduce the number of hours a day they spend in SB. Measures such as setting

reminders every day after a fixed time, moving around, walking to places whenever it is possible, along ensuring regular engagement in physical activity could be beneficial. Replacing 60 minutes of sedentary time with moderate-intensity physical activity reduced depression and anxiety symptoms by 13% and 7% respectively [47]. At the policy level, it is essential to raise awareness should be created among people regarding the reduction in SB along with the benefits of being physically active.

The current review has the following limitations: The majority of the studies included in the review had a cross-sectional study design, which examines the exposure and outcome at the same point in time, therefore making causal inferences difficult [48]. Apart from that, several studies had self-reported sedentary time as a way to assess SB, which could have been a source of error due to under/over-estimation by the subjects. Many articles mentioned their samples as adults but included subjects even above the age of 65 years, who are elderly. Elderly subjects generally have a higher sedentary time as compared to adults <65 years of age. This may have contributed to the high SB reported in these studies. The number of hours of sitting taken as a reference was also different in the studies included in the current review. These could have been contributors to the high heterogeneity reported in the analysis. The current meta-analysis also did not cater to the differences in the study designs of the included articles.

RECOMMENDATIONS

It is vital to adhere to physical activity guidelines given by the World Health Organization (WHO,2020)[49], which have proven to lower depression & anxiety symptoms [50], thereby promoting mental well-being.

Furthermore, there is a need for more RCTs with larger samples to establish the relationship between SB and depression & anxiety to ensure these common mental health disorders can be prevented by understanding the dose-response relationship between these variables.

ACKNOWLEDGEMENTS

The authors thank the University Grants Commission (UGC) and express their gratitude to the Institute of Home Economics (Delhi University).

FUNDING

The current article was not funded.

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