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Review Article

The Global Prevalence of Sedentary Time in Diabetes and Metabolic Syndrome: A Systematic Review and Meta-Analysis

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Abstract

Background: We aimed to determine the prevalence of sedentary time in diabetes and metabolic syndrome worldwide via a systematic review and meta-analysis study.

Methods: This study was conducted using the systematic review method following PRISMA 2020 criteria. Searches were conducted in PubMed, Scopus, ScienceDirect, Web of Science, and Google Scholar from January 2000 to December 2022. The heterogeneity of studies was measured using the I^2 test.

Results: The prevalence of sedentary time in diabetic patients was 52.3% (CI 95 %:46.2-58.2) and the prevalence of sedentary time in metabolic syndrome was 43.3% (95% CI: 31- 56.5). Also, the results of subgroup analysis show that the prevalence of inactivity in diabetic women was 60.3% higher than that of diabetic men. The prevalence of inactivity in patients with metabolic syndrome was 28.6% in men and women, respectively.

Conclusion: Sedentary time has a very high prevalence in metabolic syndrome and diabetic patients. In other words, almost half of these patients experience their life patterns. Therefore, effective and efficient efforts to improve activity and exercise in patients with diabetes and metabolic syndrome will have a more effective therapeutic effect and improve their quality of life.

Keywords: Sedentary time; Diabetes: Metabolic syndrome; Physical inactivity

Introduction

According to the International Diabetes Federation (IDF), metabolic syndrome is added with the presence of central obesity in at least two of the four cases that include: Increase in triglycerides (>150 mg / dL); decrease in cholesterol (HDL c) (<40 mg / dL in men, <50 mg / dL in women); hypertension (BP) (systolic blood pressure> 130 mm Hg or diastolic blood pressure> 85 mm Hg) and hyperglycemia (FPG> 100 mg / dL) (1). Almost a quarter of Europeans, Americans, and Canadians are affected by metabolic syndrome (2). Metabolic syndrome is an essential and exacerbating syndrome that increases the risk of type 2 di-

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agnosis by up to 5 times and the risk of heart disease by up to 2 times (3). Diabetes itself is a chronic disease characterized by a rise in blood glucose levels associated with a disturbance in fat and protein metabolism. Due to the lack of insulin in the pancreas or the inability of the cells to use insulin effectively, the blood glucose level in the cells increases (4). According to WHO, the prevalence of type 2 diabetes is higher in the Asian region (10 - 15%) than in the European and American regions (8 - 9%) (5).

Uncontrolled diabetes causes damage to the small and large vessels leading to loss of vision and kidney function, heart attacks, strokes, and lower limbs amputation (4). More than 90% of the incidence of type 2 diabetes is attributed to lifestyle risk factors (6).

Sedentary time, socioeconomic conditions, and high body mass index (BMI) are significantly associated with metabolic syndrome. Genetic background, physical activity level, diet, and history of diabetes influenced the prevalence of metabolic syndrome and its components (7). The genetic background, inactivity, age, smoking, and obesity can be mentioned as risk factors for type 2 diabetes (4). The term "sedentary time" is derived from the Latin root "sedere", which means "to sit" and includes any activity that involves energy expenditure of ≤1.5 metabolic units (METs). This is because whenever a person sits or lies down, he or she is exhibiting self-conscious behavior (8). Several prospective studies in the United States and Germany have reported that prolonged time in front of the television (sedentary time) is associated with an increase in type 2 diabetes (8-12). The physiological effects of sedentary time affect all body parts, including the cardiovascular system and endocrine glands.

The destructive effects of sedentary behavior on health are independent of the lack of moderate to vigorous physical activity (13). Biswas et al. also reported a similar report in 2015 (14). However, in recent years, there has been a great deal of interest in researching the relationship between slow-paced behaviors and health outcomes in recent years. Several recent studies have highlighted health risks associated with the duration of sedentary time. For example, sedentary behavior has been shown to increase the risk of type 2 diabetes (15, 16), cancer (17), and cardiovascular mortality (15, 16).

Considering the impact of sedentary time on the above diseases and the increasing trend of this behavior in developed and developing societies, as well as the recent studies that reported different results on the impact or lack of sedentary time on many diseases such as diabetes and metabolic syndrome, a comprehensive study should be conducted that could extend the findings of this study to the global level in general. Considering that such a study has not been conducted in a review form to have a comprehensive review of all results and report a homogeneous prevalence.

Therefore, we aimed to determine the prevalence of sedentary time in diabetes and metabolic syndrome worldwide via a systematic review and meta-analysis study to take a practical step towards improving lifestyle and maintaining and promoting healthy levels.

Methods

This study was conducted via a systematic and Meta-analysis method following PRISMA 2020 instructions (Preferred Reporting for Systematic and Meta - Analysis). It investigated the prevalence of sedentary time in metabolic syndrome and diabetes. The databases Popular Science, Scopus, PubMed, Web of Science (WoS), and Google search engine were searched for this study.

Keywords were extracted from the Medical Subject Headings (MeSH) database. Keywords related to the study were: "Prevalence", "sedentary time", "physical inactivity", " diabetes", " metabolic syndrome", "outbreak", "sedentary lifestyle" and "sedentary behaviors", "NIDDM" based on the Mesh browser. The search strategy in each database was determined by using the Advanced Search option and using all possible keyword combinations with the help of AND, and OR operators.

Inclusion and Exclusion Criteria

Criteria to Inclusion studies were: cross-sectional studies that have examined the prevalence of sedentary time in Diabetes and metabolic syndrome, observational studies, full texts were available to the research team, and studies in which the necessary information was reported (prevalence rate, sample size). Criteria to exclude studies were: studies that had a focus on animal contexts, review articles of any sort, case reports and case series, and experimental and clinical trials studies.

All possible combinations of these words were identified as the search strategy for each of the databases. The time period of this study was from January 2000 to December 2022, all relevant studies were identified, and the information of these studies was transferred to the information management software (Endnote). To check the publication of new articles in this field, as well as to access the latest published studies, an alert was created in several important databases, including PubMed and Scopus. Also, to access all related studies, the sources of articles that met the inclusion criteria were manually reviewed. In general, 3 researchers were involved in reviewing and screening the searched articles. To avoid errors and mistakes, all steps of article search, study selection, quality evaluation, and data extraction were performed by two researchers independently. If there was a difference of opinion between the researchers regarding the inclusion of the article in the study, to avoid the risk of bias for specific studies, a final agreement was reached first through discussion and in some cases with the participation and opinion of a third researcher.

Qualitative assessment of studies

The Newcastle-Ottawa scale was used to examine the studies in terms of selecting participants, comparing groups, and identifying results. In this classification, studies are divided into three categories: low quality (0 - 3 stars), medium quality (4 - 6 stars), and high quality (7 - 9 stars).

Statistical analysis

Ethics approval was received from the ethics committee of deputy of research and technology, Kermanshah University of Medical Sciences. Begg and Mazumdar rank correlation test at a significance level of 0.1 and the corresponding funnel plot was used to examine the publication bias due to many samples. Data analysis was performed using the software (version 2) Comprehensive Meta-Analysis.

Results

Based on the information presented in Fig. 1 and PRISMA 2020, 1413 articles were included in the data collection software (Endnote) after a systematic search of 5 electronic databases. After removing duplicate articles, as well as irrelevant articles based on the mentioned inclusion criteria, finally 17 articles were examined for meta-analysis (Table 1).

Table 1 summarizes the general information of the analyzed articles. All of the studies were cross sectional. Seven articles in India and other articles in the United States, Israel, Chile, Cameroon, Ireland, Ethiopia, Indonesia, the Zambia and the Caribbean. The percentage of the male population in the studies varied between 30 and 85 % and all the subjects studied for more than 18 years (Table 1).

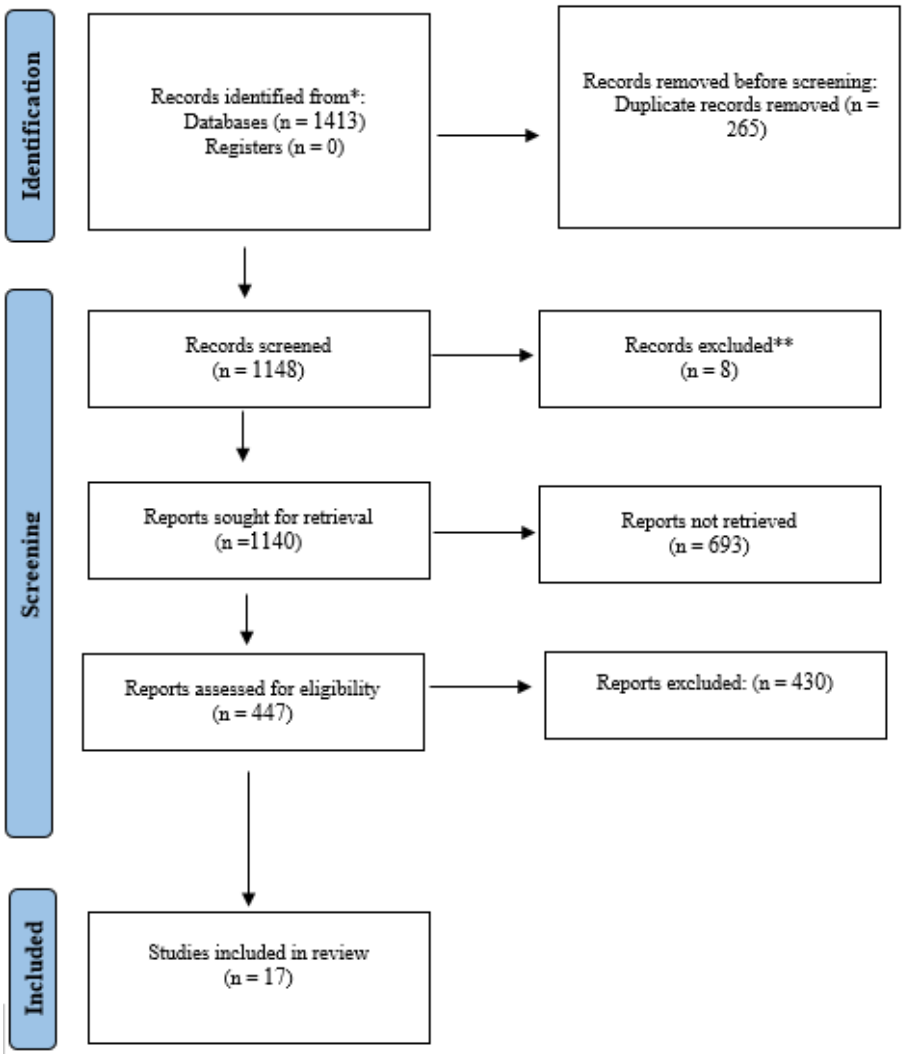

Fig. 1: The systematic review process based on Prisma criteria

Table 1: Summary of characteristics of included studies

Author (Reference)	*Year*	*Country*	*Type of dis-ease*	*Study popula-tion*	*Mean age Or Range of age (yr)*	*Prevalence of sedentary time%*
Colleen O'Brien Cherry (18)	2014	Caribbean nation ofSt. Lucia	MS	499	18-99	32.06
Prakash C. Deedwania (19)	2014	India	MS	6198	40-69	38.2
Rajeev Gupta (20)	2004	India	MS	345	30-59	26.66
P.C. Negi (21)	2019	India	MS	418	48±10	57.89
Muthuswamy Ravikiran (22)	2010	India	MS	1008	≥40	63.6
Sultana jesmin ahmed (23)	2016	India	DM	62	40-49	67.74

Table 1: Continued….

Elina das (24)	2015	India	DM	32	46-60	65.62
			pre-di-abetes	56	31-45	55.35
Marı´a P. Bertoglia (25)	2010	Chile	T2DM	1436061	46.37 ± 18.68	53.55
S. P. Vibha (26)	2018	India	DM	620	51-70	50.96
Eszter P. Vamos (27)	2008	Ireland	DM	783	-	70.24
Sylvain Raoul Simeni Njonnou (28)	2020	Cameroon	DM	41	20-39	82.9
Lemma Demissie Regassa (29)	2021	Ethiopia	T2DM	454	48.39	27.31
Laurentius A. Pramono (30)	2010	Indonesia	UDDM	778	>48	30.33
Ifechukwude Obiamaka Okwechime (31)	2015	USA	pre-di-abetes	2983	>45	33.72
			DM	5189	>45	39.91
Elias Msopa (32)	2019	Zambia	DM	15	>45	66.66
Luisa Sorio Flor (33)	2017	Brazil	DM	935	40-64	44.81
Galit Geulayov (34)	2010	Israel	DM	683	60.7	56.36
				423	61.4	54.37

Diabetes

Investigating heterogeneity and publication bias

Based on the heterogeneity results (I^2: 98.4), the random effects method was used to analyze the results. Based on the statistical results of the Begg and Mazumdar rank correlation test and the funnel plot, there was no diffusion bias in the studies. The results show that the publication bias was not significant (p: 0.320) (Fig. 2).

Prevalence of Sedentary time in Diabetes

The results of the meta-analysis and in the study of 12 studies with a sample size of 1446076 showed that the prevalence of sedentary time in diabetic patients was also found to be 52.3% (CI 95 %:46.2-58.2) (Fig. 3), as well as the results of subgroup analysis, also show that the prevalence of sedentary time in female - sex suffers higher than male 60.3% (CI 95%: 44.9-73.9), Heterogeneity in systematic review and meta-analysis studies can be caused by the race of the studied population, sample size, year of study, nutrition and diet status, gender and other variables, therefore, considering that gender is one of the most important influencing factors, subgroup analysis It was done based on gender (Table 2).

Table 2: Subgroup analysis table of the prevalence of sedentary lifestyle in individuals with diabetes by gender

Sex	*Number of studies*	*Sample size*	*Heterogeneity*	*Prevalence (95% CI)*
Male	4	645036	83.5	56.5 (51.3-61.7)
Female	4	775587	98.3	60.3 (44.9-73.9)

Fig. 2: Funnel plot of the prevalence of sedentary time in diabetes patients

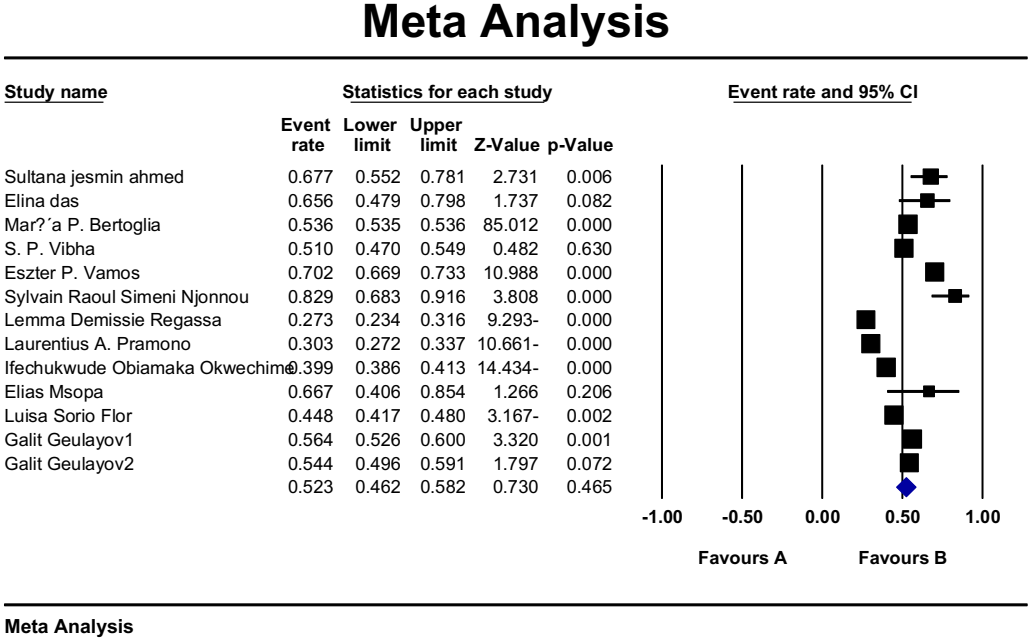

Fig. 3: The Forest plot the prevalence of sedentary time in diabetics based on the random effect's method

Metabolic syndrome

Investigating heterogeneity and publication bias

Based on the heterogeneity results (I^2: 98.7), the random effects method was used to analyze the results. Based on the statistical results of the Begg and Mazumdar rank correlation test and the funnel plot, there was no diffusion bias in the studies. Publication bias was not present in the studies (p: 1.000) (Fig. 4).

Prevalence of Sedentary time in metabolic syndrome

The results of a meta-analysis and review of 5 studies (18-22) with a sample size of 8468 showed that the prevalence of sedentary time in metabolic syndrome was found at 43.3% (95% CI: 31- 56.5) (Fig. 5), as well as the prevalence of sedentary lifestyle in patients with metabolic syndrome exceeded the results of subgroup analysis in both sexes respectively 28.6% (95 % CI: 16.9 - 44.1), 28.6% (95 % CI: 16.3 - 45.1) (Table 3). Fig. 3 and 5 show the Meta-analysis. The centerline of each line segment indicates the prevalence of each study, and the diamond forms the population prevalence for the entire study.

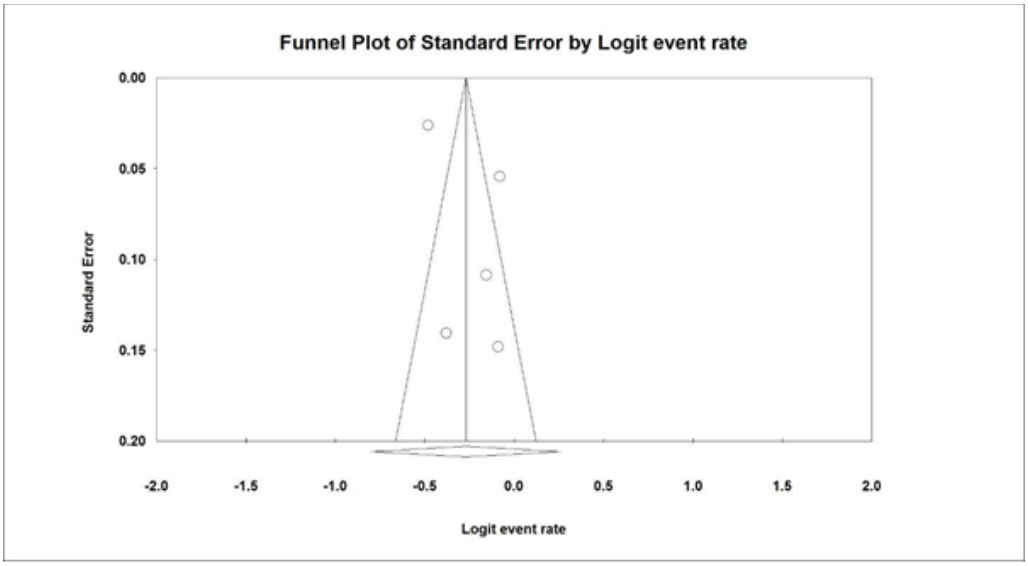

Fig. 4: The funnel plot to investigate the prevalence of sedentary time in metabolic syndrome

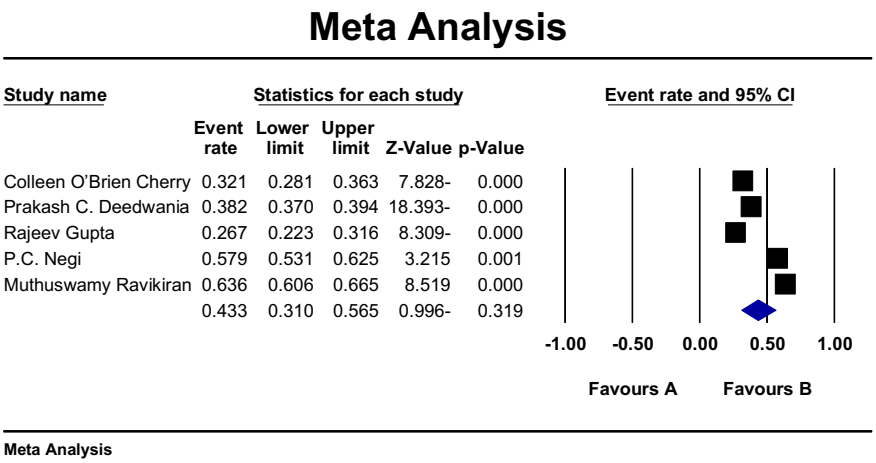

Fig. 5: Forest plot of the sedentary time plot to investigate the prevalence of sedentary time in metabolic syndrome (random effect's method).

Table 3: Subgroup analysis table of the prevalence of sedentary lifestyle in metabolic syndrome patients by gender

Sex	*Number of studies*	*Sample size*	*Heterogeneity*	*Prevalence (95% CI)*
Male	2	172	85.4	28.6 (16.9-44.1)
Female	2	572	92.7	28.6 (16.3-45.1)

Discussion

So far, many studies have investigated the impact of sedentary time on the incidence of various diseases such as diabetes, metabolic syndrome, etc., but there is a lack of a systematic evaluation and critique that can extend existing results globally. Therefore, the present study aimed to determine the prevalence of sedentary time in patients with diabetes and metabolic syndrome through a systematic review and meta-analysis in order to take an effective step towards improving lifestyle and maintaining healthy levels. After conducting a systematic review according to the criteria set by the authors, 17 cross-sectional studies were used for analysis. The result was that the prevalence of sedentary time in diabetes and metabolic syndrome was 52.3% and 43.3%, respectively.

The study conducted by Elina das in India and the study conducted by Maria P. Bertoglia in Chile reported a low prevalence of sedentary time in patients with type 2 diabetes, 55.35 and 53.55 percent, respectively (24, 25).

On the other hand, in the studies conducted in Cameroon and in Ireland, the prevalence of sedentary time was reported to be 82.9 and 70.24 percent, respectively, which is not statistically consistent with the present study (27, 28). In the case study conducted in Ethiopia, the prevalence of sedentary time was reported to be 27.3 percent, which suggests a low prevalence of this habit among diabetic patients (29).

Sedentary time and a high-calorie diet are weight gain factors that increase the risk of type 2 diabetes. Sedentary time leads to an increase in fat deposits and a decrease in pancreatic activity, such as the body's ability to tolerate glucose. Several studies have examined the effects of a range of slow behaviors on health. In the studies conducted by Hu and colleagues, watching television was a slow behavior associated with an increased risk of diabetes in type 2 diabetes (35, 36). Two hours per day increased the risk of developing type 2 diabetes, while every 2 hours increased the risk of developing type 2 diabetes by 7%. (35, 36).

Regarding metabolic syndrome, most studies were not consistent with the present study in reporting the prevalence of sedentary lifestyle in patients, but a study reported similar statistics (22). One proven effect of sedentary behavior is metabolic dysfunction characterized by increased plasma triglyceride levels, decreased high-density lipoprotein (HDL) cholesterol, and decreased insulin sensitivity. For example, Hamburg et al. examined the effects of 5 days of complete bed rest on metabolic health in 22 volunteers (37). Study participants spent more than 23.5 hours a day in bed, getting out of bed only for personal hygiene issues. At the end of the study, despite no changes in body weight, they experienced significant increases in total cholesterol, plasma triglycerides, glucose, and insulin resistance. Changes in carbohydrate metabolism were particularly evident, and participants experienced a 67% higher insulin response (37). Prolonged doses of sedentary behavior can lead to a significant increase in metabolic risk (37), and similar results have been reported by Yanagibori et al (38).

This study had some limitations. Due to the cross-sectional nature of the included studies, it was not possible to investigate the effect of inactivity on the incidence of metabolic syndrome and diabetes. Also, the limited studies made it impossible to study subgroups by continents and other criteria.

Conclusion

Sedentary time has a very high prevalence in patients with metabolic syndrome and diabetes. In other words, almost half of these patients experience a sedentary lifestyle pattern. Therefore, without proper intervention in the lifestyle of these patients, it may lead to increased metabolic syndrome and diabetes. This necessitates immediate intervention strategies to change the patients' lifestyle by addressing light-related behaviors.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or

falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Funding

No financial support was received.

Conflict of interests

The authors declare that they have no conflict of interest

Availability of data and materials

Datasets are available through the corresponding author upon reasonable request.

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