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Effect of Short Sleep Duration on the Risk of Cardiovascular Diseases: A Meta-Analysis

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ABSTRACT

Background: Understanding the impact of short sleep duration on cardiovascular disease incidence is crucial for comprehending its potential health implications. This study aimed to analyze and estimate the magnitude of the effect of short sleep duration on the risk of cardiovascular disease incidence based on similar previous primary studies.
Subjects and Method: This research is a systematic review and meta-analysis conducted by following the PRISMA flow diagram and PICO model. Population: general population without prior cardiovascular diseases, Intervention: short sleep duration, Comparison: adequate sleep duration, and Outcome: the Incidence of cardiovascular diseases. The process of searching for articles through Google Scholar, ProQuest, and PubMed journal databases by selecting articles published from 2010 to 2024. The keywords used include: "Cardiovascular Diseases," AND "Incidence," AND "Sleep Duration," AND "cohort Studies. The inclusion criteria were full paper articles, open access with a cohort study design, and articles in English. Data were analyzed using RevMan 5.3.
Results: A total of 9 cohort studies involving 564,287 respondents from Africa, Europe, and Asia were selected for a systematic review and meta-analysis. The results of the meta-analysis showed that people with short sleep duration had a 1.20 times risk of experiencing cardiovascular disease compared to people with adequate sleep duration (aHR = 1.20; 95% Cl = 1.14 to 1.25; p<0.001). This meta-analysis has heterogeneity I^2= 39%, so it uses a fixed effect model.
Conclusion: Insufficient sleep duration could elevate the likelihood of cardiovascular disease occurrence.

Keywords: Cardiovascular disease, incidence, short sleep, sleep duration.

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BACKGROUND

Cardiovascular diseases (CVDs), encompassing ischemic heart disease, stroke, heart failure, peripheral arterial disease, and various other cardiac and vascular conditions, represent the primary cause of worldwide mortality and significantly impact quality of life. In 2017 alone, CVDs were responsible for approximately 17.8 million deaths globally, resulting in the loss of 330 million years of life and an additional 35.6 million

years lived with disability (GBD 2017; Kyu et al., 2018).

Sleep, an essential daily activity, holds paramount importance for maintaining optimal health. Increasingly, sleep-related issues, encompassing inadequate or poor-quality sleep, emerge as a significant yet often underestimated determinant of health. Beyond primary sleep disorders, suboptimal sleep patterns can independently contribute to various molecular, immune, and neural alterations that are implicated in the onset and progression of diseases (Ferrie et al., 2011; Watson et al., 2015).

Recent research indicates a link between sleep disturbances, such as insomnia (Zheng et al., 2019) characterized by short or long sleep duration, daytime sleepiness, difficulty initiating sleep (Peppard et al., 2013), and CVD. A recent meta-analysis of 17 cohort studies revealed a notable increase in CVD mortality associated with insomnia, with a hazard ratio (HR) of 1.33 and a 95% confidence interval (CI) ranging from 1.13 to 1.57. Moreover, the analysis highlighted heightened risks of specific CVD types, such as myocardial infarction (MI), coronary heart disease (CHD), and stroke (Li et al., 2014).

This paper is particularly significant as it fills a notable gap in existing research, as no prior meta-analysis has specifically focused on the association between short sleep duration and cardiovascular disease risk in subjects without a prior history of CVD. By addressing this gap, the study provides novel insights into the relationship between sleep duration and cardiovascular health, offering valuable implications for preventive healthcare strategies and clinical management approaches. A systematic review and meta-analysis of this study was conducted with the aim to analyze and estimate the magnitude of the effect of short sleep duration on the risk of cardiovascular disease incidence based on similar previous primary studies.

SUBJECTS AND METHOD

1. Study Design

This study employs a systematic review and meta-analysis methodology, utilizing secondary data sourced from online databases like Google Scholar, ProQuest, and PubMed spanning from 2010 to 2024. The search terms employed encompass "Cardiovascular Diseases," AND "Incidence," AND "Sleep Duration," AND "Cohort Studies".

2. Steps of Meta-Analysis

1) Create research questions using the PICO model, which involves defining the Population, Intervention, Comparison, and Outcome.
2) Search for primary study articles from electronic databases such as Google Scholar, PubMed, and Science Direct
3) Screening articles with Critical Appraisal assessment of primary research.
4) Extract data and enter size effect from each primary study into RevMan 5.3.
5) Conducting interpretation and conclusion of study results.

3. Inclusion Criteria

The study's inclusion criteria comprised full paper and open-access articles employing an observational cohort study design. The relationship's magnitude was assessed using adjusted hazard ratios. Additionally, the article stipulates that the study population consists of general patients without prior cardiovascular diseases. The intervention under scrutiny is short sleep duration, and the primary outcome examined is the incidence of cardiovascular disease.

4. Exclusion Criteria

The study's exclusion criteria encompassed articles not in English and those employing cross-sectional, case-control, or Randomized Controlled Trial (RCT) designs. Additionally, articles lacking adjusted hazard

ratio data and those published before 2000 were excluded from the analysis.

5. Operational Definition of Variables

Cardiovascular diseases (CVD): encompass a range of conditions affecting the heart and blood vessels, distinct from congenital heart disease or stroke.

Short sleep duration: is duration of sleep totaling less than 7 hours per day or night.

6. Study Instruments

The article search process adheres to the PRISMA flow diagram for systematic reviews. Furthermore, the quality of the research was evaluated utilizing the Cohort Study Checklist released by the Critical Appraisal Skills Program (CASP) in 2018.

7. Data Analysis

The analysis was conducted using RevMan 5.3 software, analyzing a total of 564,287 samples. The findings are depicted through a forest plot, while the potential for bias is visually assessed using a funnel plot.

RESULTS

The outcomes of the article search are illustrated in Figure 1, revealing 3,765 articles initially identified from the utilized databases. After removing duplicate data from 45 articles, a total of 3,675 articles remained. From this filtered selection, 129 articles were initially considered, and ultimately, 15 full-text articles meeting the criteria were obtained. Following qualitative assessment, 9 articles meeting quantitative criteria underwent the meta-analysis.

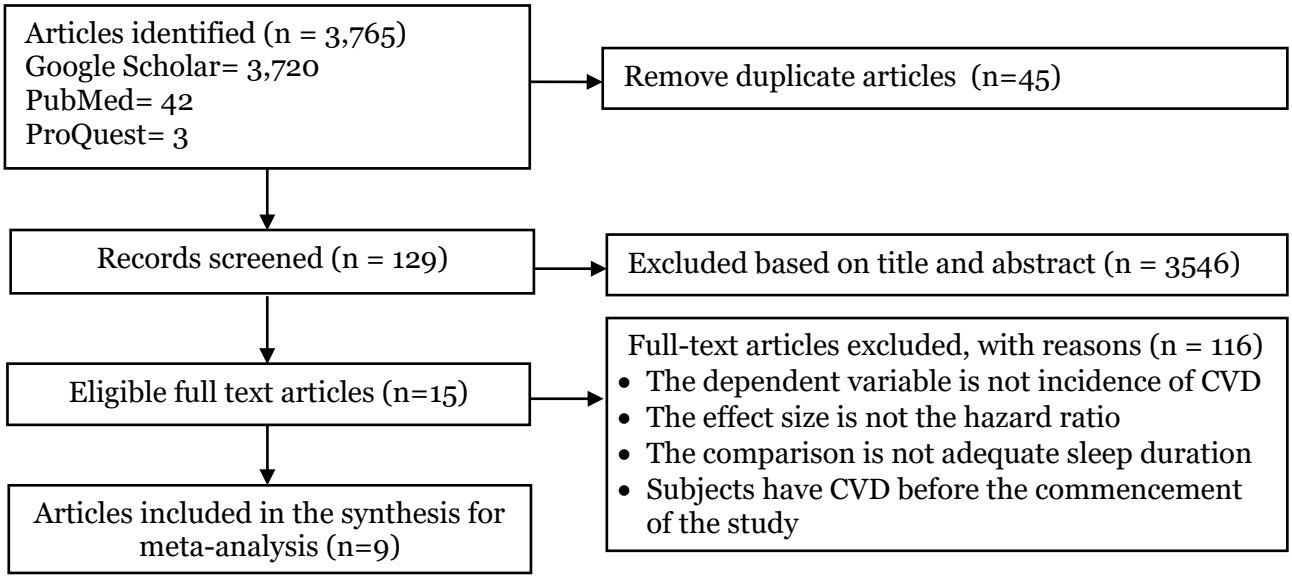

Figure 1. PRISMA flowchart from studies on the effect of short sleep duration on the risk of cardiovascular disease incidence

Figure 2 illustrates the geographical distribution of the articles included in this meta-analysis. A total of ten studies were analyzed, originating from various continents. Specifically, one study was conducted in the Americas, four studies were from Europe, another four from Asia, and one study came from Africa. This global distribution highlights the diverse regional perspectives.

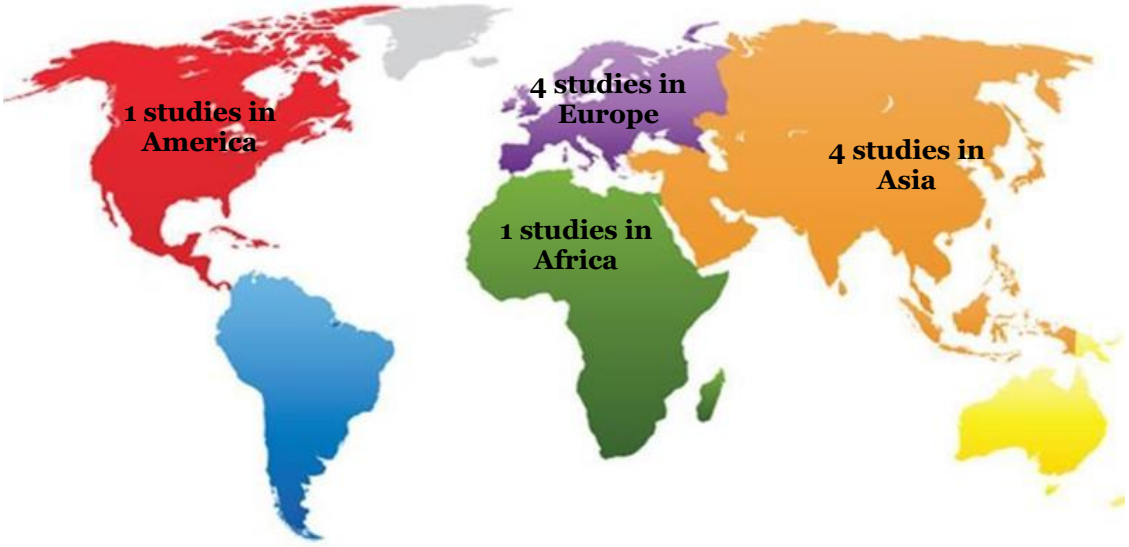

Figure 2. Map of the distribution of articles included in the meta-analysis

Table 1. Results of the quality assessment of the cohort study on the meta-analysis

Authors (Year)	Criteria												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
Amagai et al. (2010)	2	2	1	2	2	2	2	2	2	2	2	2	23
Canivet et al. (2014)	2	2	1	2	2	2	2	2	2	2	2	2	23
Gianfagna et al. (2016)	2	2	1	2	2	2	2	2	2	2	2	2	23
Hamazaki et al. (2011)	2	2	1	2	2	2	2	2	2	2	2	2	23
Hoevenaar-Blom et al. (2011)	2	2	1	2	2	2	2	2	2	2	2	2	23
Tao et al. (2021)	2	2	1	2	2	2	2	2	2	2	2	2	23
Wang et al. (2019)	2	2	1	2	2	2	2	2	2	2	2	2	23
Wang et al. (2020)	2	2	1	2	2	2	2	2	2	2	2	2	23
Westerlund et al. (2013)	2	2	1	2	2	2	2	2	2	2	2	2	23

Description of question criteria:

1 = Does the cohort study address the clinical problem clearly?
2 = Were the cohorts (study subjects in both exposed and non-exposed groups) selected in the right way?
3 = Are social isolation and loneliness accurately measured to minimize bias?
4 = Were the outcomes (cardiovascular disease status and death) accurately measured to minimize bias?
5 = Did the researcher identify all important confounding factors? Does the researcher account for confounding factors in the design and/or analysis?
6 = Does the research subject complete the research time in full? Were the research subjects followed up for a sufficiently long time?
7 = Are the results of this study reported in the aHR?
8 = Are the results precise?
9 = Can the results be trusted?
10 = Are the results applicable to the local (local) population?
11 = Are the results of this study compatible with the available evidence?
12 = Does the implications of this research suitable for practice?

Description of the answer score:

0 = No
1 = Hesitant
2 = Yes

Table 2. Summary of cohort studies on the effect of short versus adequate sleep duration on the risk of cardiovascular disease incidence

Author (year)	Country	Sample	P	I	C	O
Amagai et al. (2010)	Japan	11,367	General Population	Sleeping <5.6 h/d	Sleeping 7.0–7.9 h/d	Risk of CVD in Men and Women
Canivet et al. (2014)	Sweden	13,617	General Population	Sleeping <6 h/d	Sleeping 7–8 h/d	Risk of CVD in Men and Women
Gianfagna et al. (2016)	Italy	2277	General Population	Sleeping <6 h/d	Sleeping 7–8 h/d	Risk of CVD in Men and Women
Hamazaki et al. (2011)	Japan	2282	General Population	Sleeping <6 h/d	Sleeping 7.0–7.9 h/d	Risk of CVD in Men and Women
Hoevenaar-Blom et al. (2011)	Netherland	20,432	General Population	Sleeping <6 h/d	Sleeping 7 h/d	Risk of CVD in Men and Women
Tao et al. (2021)	China	407,500	General Population	Sleeping <5 h/d	Sleeping 7.0 h/d	Risk of CVD in Men and Women
Wang et al. (2019)	America, Asia, and Africa	116,632	General Population	Sleeping <6 h/d	Sleeping 6–8 h/d	Risk of CVD in Men and Women
Wang et al. (2020)	China	352,413	General Population	Sleeping 4.9-4.2 h/n	Sleeping 7.4-7.5 h/n	Risk of CVD in Men and Women
Westerlund et al. (2013)	Sweden	41,192	General Population	Sleeping <5 h/d	Sleeping 7.00 h/d	Risk of CVD in Men and Women

Table 3. Adjusted Hazard Ratio (aHR) effect of short versus adequate sleep duration on the risk of cardiovascular disease incidence

Author (year)	aHR	CI 95%	
		Lower Limit	Upper Limit
Amagai et al. (2010)	2.14	1.11	4.13
Amagai et al. (2010)	1.46	0.70	3.04
Canivet et al. (2014)	1.00	0.80	1.30
Canivet et al. (2014)	1.20	0.90	1.80
Gianfagna et al. (2016)	1.14	0.84	1.53
Hamazaki et al. (2011)	3.49	1.30	9.40
Hoevenaar-Blom et al. (2011)	1.11	0.97	1.27
Tao et al. (2021)	1.23	1.16	1.31
Wang et al. (2019)	1.10	0.98	1.25
Wang et al. (2020)	1.47	1.05	2.05
Westerlund et al. (2013)	1.24	1.06	1.44

Table 3 presents the adjusted hazard ratios (aHRs) comparing the risk of cardiovascular disease (CVD) incidence between individuals with short sleep duration and those with adequate sleep duration across the included studies. Notably, the studies by

Amagai et al. (2010) and Canivet et al. (2014) are listed twice in this table. This is because each of these studies reported separate effect sizes for male and female participants. As both sets of gender-specific results provided distinct and relevant data, they were treated as individual entries and included separately in this meta-analysis.

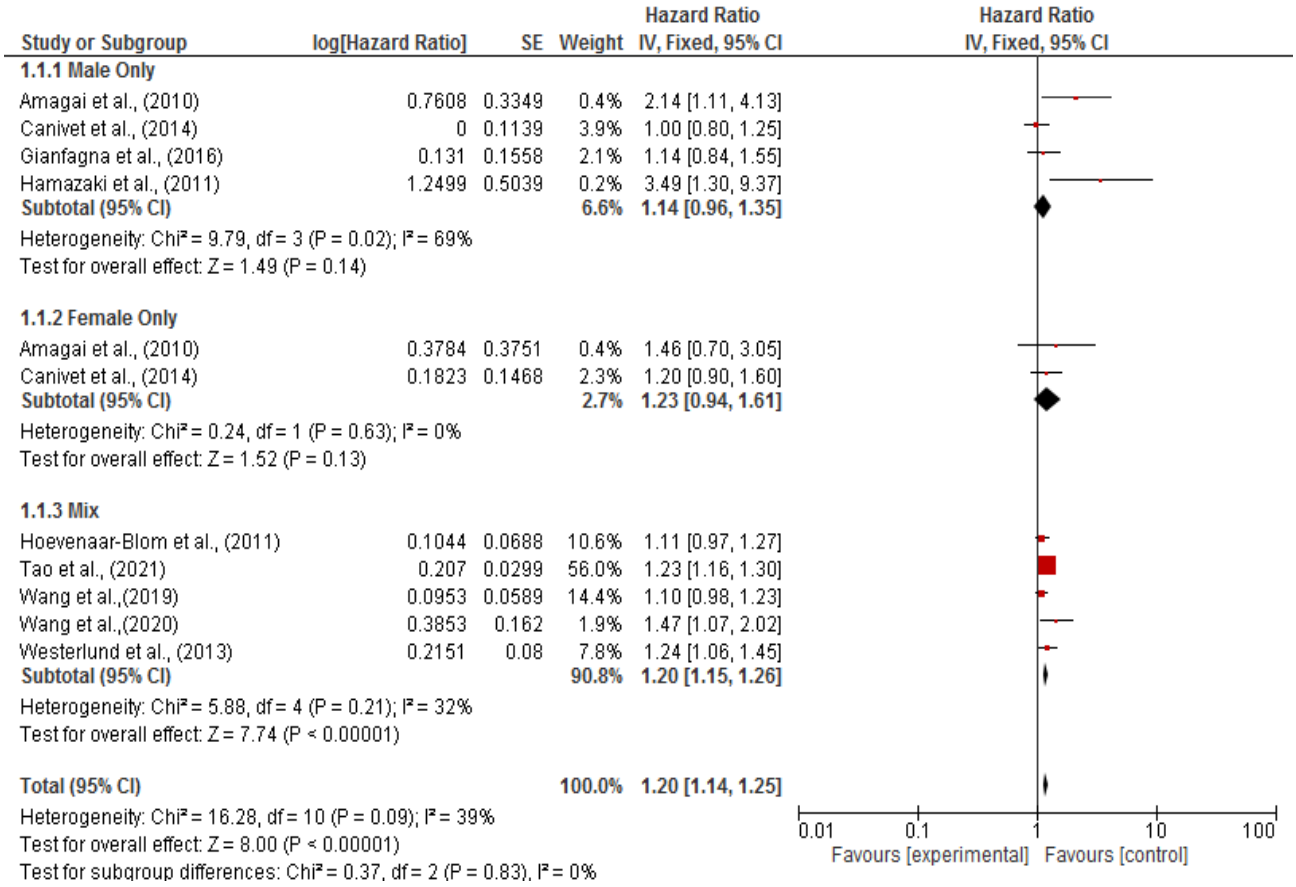

Figure 3. Forest Plot Effect of Short Sleep Duration on the Incidence of CVD

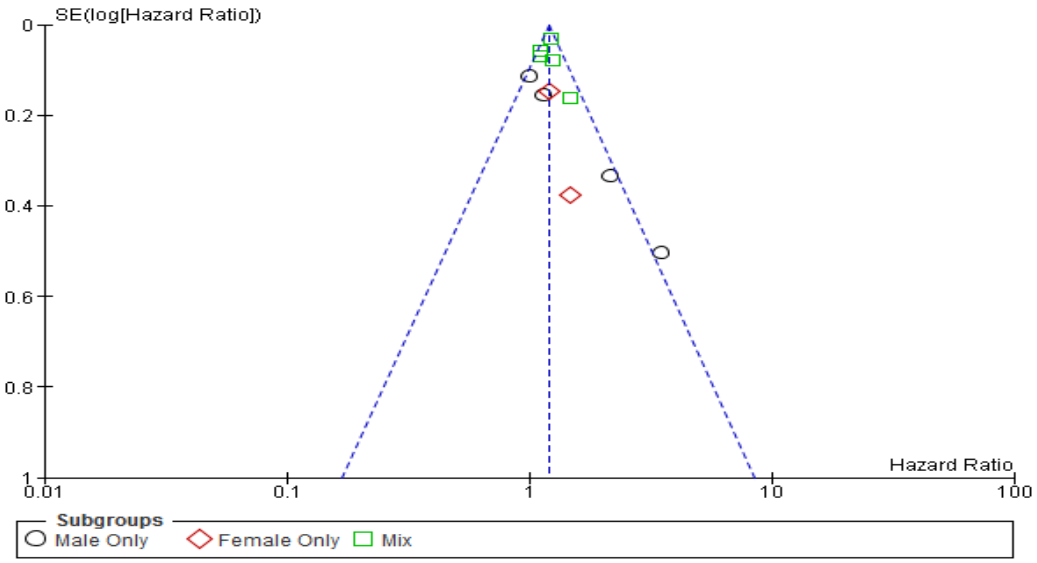

Figure 4. Funnel Plot Effect of Short Sleep Duration on the Incidence of CVD

Based on the results of the analysis in Figure 3, it can be seen that as many as 10 articles report that short sleep duration per day or night can increase the risk of Incidence of CVD. Based on the results of the sub-group analysis there is a low heterogeneity between experiments (I^2= 39%) so the Fixed Effect Model (FEM) is used. The results of this study showed that short sleep duration per day or night had a 1.20 times risk of developing CVD compared to people who had adequate sleep duration (aHR = 1.20; 95% Cl = 1.14 to 1.25; p<0.001).

Based on Figure 4 Funnel Plot of the influence of short sleep duration per day or night can on Incidence of CVD, the plots on the right and left sides are asymmetrical to each other and do not form an inverted funnel. The left plot has a standard error between >0 to <0.2 and the right plot has a standard error between >0 to < 0.6. This identifies that in this study there is a real bias (overestimate).

DISCUSSION

A systematic review and meta-analysis of this study have found that short sleep duration may elevate the risk of CVD incidence, with an aHR of 1.20, and a 95% CI ranging from 1.14 to 1.25 (p < 0.001). This aligns with the findings of a meta-analysis conducted by Huang et al. (2022), which demonstrated that an optimal sleep duration of 7.5 hours per night is associated with a decreased risk of cardio-cerebrovascular disease in adults (p= 0.050).

This meta-analysis study aligns with previous research (Cappuccio et al., 2011; Itani et al., 2017; Yin et al., 2017) indicating that short sleep duration serves as a predictor or marker of cardiovascular outcomes. However, it distinguishes itself by utilizing different effect sizes, focusing on samples without a previous history of CVD, and including studies published between the years 2010 and 2014.

Growing evidence suggests that genetic predispositions and early-life environmental influences, including aspects such as the natural environment, fetal conditions, and childhood socioeconomic status, may play significant roles in shaping sleep patterns and cardiovascular well-being. Nonetheless, it remains uncertain whether these factors might directly contribute to the observed link between sleep habits and CVDs. While studies have highlighted the potential influence of genetic and environmental factors on both sleep behaviors and cardiovascular health, the intricate interplay between these variables and their specific contributions to the development of CVDs remains a subject of ongoing investigation. Further research is needed to elucidate the complex mechanisms underlying the relationship between sleep patterns and cardiovascular outcomes, particularly regarding the potential mediating or moderating effects of genetic predispositions and early-life environmental exposures. Clarifying these relationships could offer valuable insights into the multifaceted pathways through which sleep habits impact cardiovascular health, thereby informing preventive strategies and targeted interventions to mitigate the burden of CVDs (Genderson et al., 2013; Song et al., 2014; Riggs et al., 2018; Ai et al., 2021; Dashti et al., 2021; Wang et al., 2022).

Sleep duration, particularly short sleep, along with sleep disorders, has emerged as a factor linked to adverse cardiometabolic risks, encompassing conditions such as obesity, hypertension, type 2 diabetes mellitus, and cardiovascular disease (St-Onge et al., 2016). Sleep is crucial for maintaining overall health, with adults typically needing 7 to 9 hours of sleep each night to support cardiovascular and metabolic

well-being. Short sleep duration, defined as ≤ 6 hours per night, has been linked to increased sympathetic activity and inadequate reduction in nighttime blood pressure, contributing to hypertension by placing sustained stress on the heart and blood vessels. Sleep deprivation, whether acute or chronic, can hasten the development of atherosclerosis through various pathways, including heightened oxidative stress, elevated cholesterol levels, and increased levels of inflamematory markers like interleukin-6 (IL-6), tumor necrosis factor-α (TNF-α), and C-reactive protein (CRP). Additionally, short sleep can disrupt glucose regulation, increase insulin resistance, and alter hunger hormones, promoting obesity and type 2 diabetes. These metabolic disturbances are associated with thickening of the carotid artery walls and reduced vascular function, both indicators of atherosclerosis. Thus, short sleep duration contributes to cardiovascular risk through multiple mechanisms, including hypertension, atherosclerosis, inflammation, and metabolic dysfunction (Beaman et al., 2021).

In conclusion, our systematic review and meta-analysis underscore the association between short sleep duration and increased CVD risk. Notably, our study stands out for its focus on subjects without prior CVD history and the inclusion of studies from 2010 to 2014. Genetic predispositions and early-life environmental factors likely influence sleep patterns and cardiovascular health, warranting further investigation. Understanding these complex relationships is crucial for informing preventive strategies. Short sleep duration has emerged as a significant risk factor for adverse cardiometabolic outcomes, including obesity, hypertension, and type 2 diabetes. Overall, adequate sleep duration is pivotal for maintaining cardiovascular and metabolic well-being, emphasizing the importance of promoting healthy sleep habits.

AUTHOR CONTRIBUTION

Anas Rahmad Hidayat is the main researcher who has a topic, seeks, collects, review and analyze research data.

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CONFLICT OF INTEREST

The authors declare that the study was conducted in the absence of any comercial or financial relationships that could be construed as a potential conflict of interest.

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