

The Relationship of Sleep Duration, Chronotype and the Risk of Depression: A Systematic Review and Meta-analysis

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Abstract: Depression is one of the greatest health challenges worldwide, and sleep is a major influencing factor in depression. This meta-analysis aimed to systematically integrate existing evidence by analyzing 34 observational studies from five electronic databases. Results revealed that short sleep duration (OR=1.78, 95% CI: 1.61–1.97), long sleep duration (OR=1.17, 95% CI: 1.02–1.34), neutral chronotype (N-type) (OR=1.27, 95% CI: 1.06–1.51), and evening chronotype (OR=2.09, 95% CI: 1.64–2.68) were associated with an increased risk of depression. Specifically, short sleep duration and evening chronotype were more significantly associated with the risk of depression. This meta-analysis demonstrated that both short and long sleep durations, and evening chronotype are associated with an elevated risk of depression. Due to substantial heterogeneity among studies, the evidence base remains limited. Future research should employ standardized methods, longitudinal designs, and investigate contextual factors to clarify underlying mechanisms.

Keywords: Sleep Duration, Chronotype, Depression, Meta-Analysis.

1. Introduction

Depression is one of the greatest health challenges worldwide. It affects more than 300 million people globally. According to statistics from the World Health Organization (WHO), depression is one of the leading causes of disability worldwide, and its disease burden is projected to become the highest by 2030. The treatment and prevention of depression have become a global public health concern. Sleep, as a major influencing factor of depression, has recently attracted increasing attention from scholars.

Our daily lives are regulated by at least three “clocks”: the social clock, the solar clock, and the biological clock. The biological clock is the 24-hour internal time-keeping system, entrained to the environmental light-dark cycle. The human circadian clock controls various physiological processes and is particularly noticeable in regulating sleep and wakefulness. Chronotype refers to an individual's preference for the timing of the sleep-wake cycle, also known as circadian preference. Chronotype can be viewed as a biological construct. It is largely regulated by the biological clock. Both genetic variation in clock genes and environmental factors contribute to the distribution of chronotype in the population. Chronotype is typically divided into three categories: morning chronotype, composed of individuals who prefer to go to bed early and rise early; evening chronotype, those who prefer to go to bed late and wake up late; and neutral chronotype.

Sleep alterations are common in patients with depression. Both long and short sleep durations are frequently observed in individuals with depression. Previous research has predominantly identified short sleep duration as a risk factor for depressive symptoms. However, recent studies have demonstrated that both long and short sleep durations can serve as risk factors for depression.

Circadian rhythm disturbances are common in patients with depression. In recent years, research on the relationship between chronotype and depression has garnered significant attention. Individuals with evening chronotypes are at an increased risk for emotional problems, including depressive symptoms. Studies have found that circadian preference is associated with sleep and mental health outcomes in a dose-response manner. Additionally, evening chronotype has been linked to depressive symptoms.

Although the associations between sleep duration, chronotype and depression have been studied, the findings have been inconsistent. This systematic review and meta-analysis aimed to synthesize the relationships between sleep duration, chronotype and the risk of depression, thereby providing guidelines for the prevention and treatment of depression.

2. Methods

This systematic review and meta-analysis was conducted in accordance with the Meta-analysis of Observational Studies in Epidemiology (MOOSE) checklist and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement. The study was registered in the International Prospective Register of Ongoing Systematic Reviews (PROSPERO; CRD4202455876).

2.1. Database Searching

We systematically searched the following five databases from their inception to June 2024: PubMed, Web of Science, Embase, PsycINFO, Scopus. The search strategy included the following terms: (sleep duration or chronotype or diurnal preference or circadian rhythm or circadian preference) and (depression or depressive symptom* or depressive disorder or depressive syndrome*).

2.2. Inclusion and Exclusion Criteria

Studies were eligible if they fulfilled the following criteria: (1) Population: Participants were relatively healthy individuals of any age. Studies involving shift workers were excluded. (2) Exposure: Sleep duration was divided into at least three groups (e.g., long sleep group, short sleep group, normal sleep group), studies where sleep duration was divided into two or no groups were excluded; Chronotype was divided into at least three groups (e.g., morning chronotype, evening chronotype, neutral chronotype), studies where chronotype divided into two or no groups were excluded. (3) Outcome: Studies using depressive symptoms as primary or secondary outcome were included. (4) Study design: The included studies were prospective cohort study or cross-sectional studies. (5) Statistical data: Studies were included if they provided adjusted or unadjusted odds ratios (ORs), hazard ratios (HRs), or relative risks (RRs) and their corresponding 95% confidence intervals (CIs) or sufficient data to calculate them.

2.3. Data Collection

A data collection form was created by the first researcher and reviewed by the second researcher. Two researchers independently extracted data from the included articles and recorded this information into the collection form. The following information from the included studies was collected: the first author, year of publication, country, study population, sample size, study design, participants' average age or age range, participants' gender, sleep indicators and their measurement methods, depression measurement methods, effect estimates, and their corresponding 95% confidence intervals (CIs).

2.4. Study Quality Assessment

Two researchers independently evaluated the methodological quality of the included prospective cohort studies using the Newcastle–Ottawa Scale (NOS). For the included cross-sectional studies, the methodological quality was assessed using a quality assessment tool for analytical cross-sectional studies consisting of eight items. Two researchers made judgments of “yes”, “no”, “unclear” or “inadaptation” for each evaluation item respectively and determined whether to include or exclude the study after discussion. The NOS comprises eight items, divided into three categories: selection, comparability, and outcome. Study quality scores ranged from zero to nine. Studies with scores above six were classified as high quality, scores of five and six were classified as medium quality, and scores below five were classified as low quality.

2.5. Meta-analysis

Meta-analysis was performed using Stata/MP version 18.0. A random-effects meta-analysis model was adopted to investigate the relationships of sleep duration and chronotype with the risk of depression separately. The odds ratio (OR) was used as the effect estimate to assess the association between sleep duration, chronotype and depression. Analyses of adjusted or unadjusted ORs, hazard ratios (HRs), or relative risks (RRs) and their corresponding 95% confidence intervals (CIs) were conducted separately. When available, multivariable-adjusted ORs were preferentially pooled. If adjusted estimates were unavailable, unadjusted estimates were pooled. In sensitivity analysis, the leave-one-out method was applied to examine the influence of individual studies on

the pooled ORs. Heterogeneity was quantified using I^2 statistics, with values less than 25%, between 25% and 50%, and greater than 75% representing low, moderate, and high levels of heterogeneity, respectively. Subgroup analysis and meta-regression analysis were performed to explore potential sources of heterogeneity. Publication bias was evaluated using funnel plots and Egger's tests.

3. Results

3.1. Literature Search

A total of 1440 records were identified through database searches, with 208 from PubMed, 279 from Web of Science, 412 from Embase, 186 from PsycINFO, and 355 from Scopus. After removing duplicate records, 529 records remained. Following the screening of titles and abstracts, 79 full-text articles were retrieved. After reviewing the full-text articles, 17 irrelevant studies, and 21 studies that did not provide sufficient data to calculate risk estimates were excluded. Additionally, sleep indicators in four studies were divided into two groups, the subjects of two studies were shift workers, and one study was a pilot study. Finally, 34 studies were included in the meta-analysis: four longitudinal studies on sleep duration, 16 cross-sectional studies on sleep duration, and 14 cross-sectional studies on chronotype. Fig. 1 illustrates the flowchart of the article selection process.

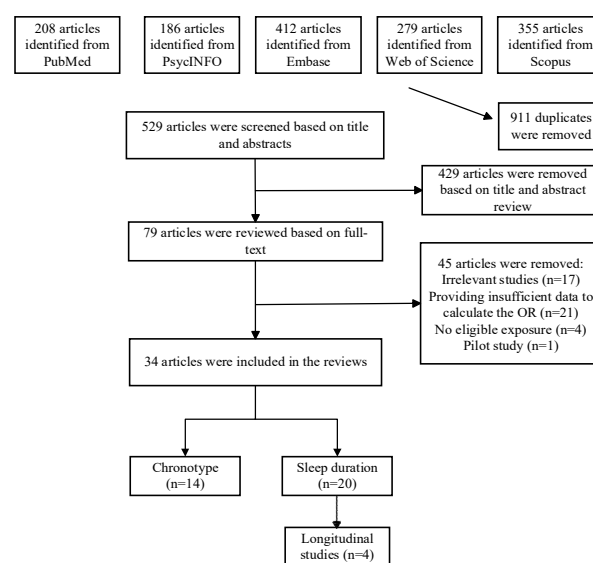


Fig. 1 PRISMA flowchart of literature search

3.2. Study Characteristics

The meta-analysis included 715,060 participants. Sample sizes ranged from 200 to 225,915. Four longitudinal studies included 254,271 participants, sixteen cross-sectional studies included 227,028 participants, fourteen cross-sectional studies on chronotype included 233,761 participants. Among the included studies, four longitudinal studies on sleep duration were conducted in Asia. Among sixteen cross-sectional studies on sleep duration, twelve were conducted in Asia, two in Europe, and two in North America. Among fourteen cross-sectional studies on chronotype, nine were conducted in Asia, four in Europe, and one in South America. All studies measured sleep duration and chronotype using self-report questionnaires or scales, and depression was assessed using the same method.

3.3. Study Quality

According to the NOS, among the included longitudinal

studies, three were of moderate quality, and one was of weak quality. The quality scores of the included cross-sectional studies are presented in Table 1.

Table 1. Quality assessment of included cross-sectional studies

Study	①	②	③	④	⑤	⑥	⑦	⑧
Qu et al, 2023	B	A	A	D	A	A	A	A
Kjørstad et al, 2022	B	A	B	D	B	B	B	A
Li et al, 2020	B	A	A	D	A	A	A	A
Koo et al, 2021	A	A	A	D	A	A	A	A
Lemke et al, 2023	A	A	A	D	A	A	A	A
Zhou et al,2021	A	A	A	D	B	B	A	A
Norbury et al,2019	B	B	B	D	A	A	A	A
Chang et al, 2022	A	A	A	D	B	B	A	A
Mao et al,2024	B	A	A	D	A	A	A	A
Hidalgo et al,2009	A	A	A	D	A	A	A	A
Randler et al, 2012	B	B	A	D	B	B	A	A
Merikanto et al, 2015	C	B	A	D	A	A	B	A
Lv et al, 2021	A	A	A	D	B	B	A	A
Kim et al,2023	A	A	A	D	A	A	A	A
Kim et al, 2020	A	A	A	D	A	A	A	A
Dong et al,2022	A	A	B	D	A	A	A	A
Chen et al,2020	B	A	B	B	A	A	A	A
Zhang et al,2023	A	A	B	A	A	A	A	A
Ouyang et al,2019	A	A	B	B	A	A	A	A
Yong et al,2024	A	A	B	C	A	A	A	A
Sakamoto et al, 2013	A	A	B	C	A	A	A	A
Wang et al,2024	A	C	B	B	A	A	A	A
Luo et al,2022	A	A	B	B	B	B	A	A
Zhou et al,2022	A	A	B	B	A	A	A	A
Lin et al,2023	B	A	B	B	A	A	A	A
Gao et al,2023	B	A	B	A	A	A	A	A
Andishmand et al,2023	B	A	B	B	A	A	A	A
Wu et al,2023	B	A	B	B	A	A	A	A
Zhang et al,2021	A	A	B	B	A	A	A	A
Anujoo et al,2021	A	A	B	B	A	A	A	A

①Are the inclusion criteria for the sample clearly defined?②Are the study subjects and study sites described in detail? ③ Is the measurement of exposure factors reliable and valid?④Is there an objective, consistent standard for defining a disease or health problem?⑤Are confounders identified?⑥Are measures in place to control confounders?⑦Are the outcome measures reliable and valid?⑧Is the data analysis method appropriate? A=Yes, B=No, C=Nuclear, D=Inadaptation

3.4. Data synthesis

3.4.1. Longitudinal Study Results

The longitudinal study results showed that short sleep duration was associated with an increased risk of depression compared to the normal sleep group (OR=1.24, 95% CI: 1.06–1.46, $I^2 = 62.1\%$). However, long sleep duration was not found to increase the risk of depression (OR=0.92, 95% CI:

0.79–1.08, $I^2 = 84.6\%$).

3.4.2. Cross-Sectional Study Results (sleep duration)

As shown in Fig. 2, the cross-sectional study results indicated that both short sleep duration (OR=1.78, 95% CI: 1.61–1.97, $I^2 = 94.0\%$) and long sleep duration (OR=1.17, 95% CI: 1.02–1.34, $I^2 = 90.9\%$) were associated with an increased risk of depression compared to the normal sleep group.

Notably, short sleep duration was more significantly associated with the risk of depression.

3.4.3. Cross-Sectional Study Results (chronotype)

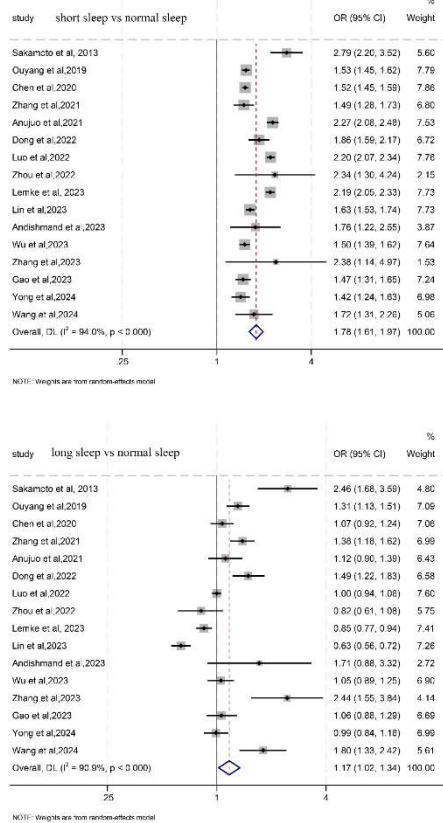


Fig. 2 Forest plot of cross-sectional studies on sleep duration

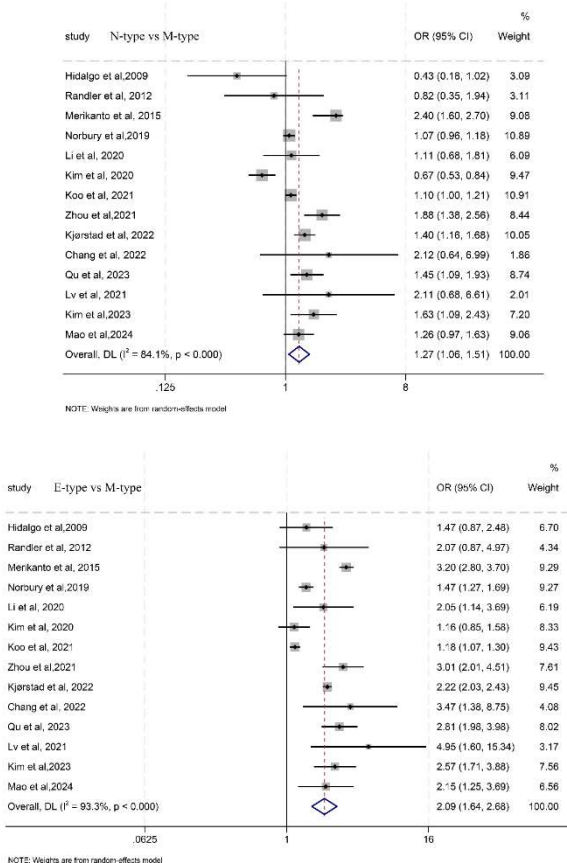


Fig. 3 Forest plot of cross-sectional studies on chronotype

As shown in Fig. 3, the cross-sectional study results revealed that both neutral chronotype (N-type) (OR=1.27, 95% CI: 1.06–1.51, I²=84.1%) and evening chronotype (E-type) (OR=2.09, 95% CI: 1.64–2.68, I²= 93.3%) were associated with an increased risk of depression compared to morning chronotype (M-type). Furthermore, evening chronotype was more significantly associated with the risk of depression.

3.5. Subgroup Analyses

3.5.1. Subgroup Analyses of Sleep Duration and Risk of Depression

In subgroup analyses of sleep duration and the risk of depression, the pooled ORs slightly varied by geographic location, participants' mean age, gender, and sample size. Geographic location may be a source of heterogeneity for both short sleep duration and long sleep duration, while age may be a source of heterogeneity only for long sleep duration (p < 0.05).

3.5.2. Subgroup Analyses of Chronotype and Risk of Depression

In subgroup analyses of chronotype and the risk of depression, the pooled ORs slightly varied by geographic location, participants' mean age, gender, and sample size. However, no significant sources of heterogeneity were identified (p > 0.05).

3.6. Meta-regression analysis

3.6.1. Meta-Regression Analysis of Sleep Duration and Risk of Depression

In the meta-regression analysis of sleep duration and the risk of depression, sample size, participants' mean age, gender, and geographic location were included as covariates. However, no significant sources of heterogeneity were identified.

3.6.2. Meta-Regression Analysis of Chronotype and Risk of Depression

In the meta-regression analysis of chronotype and the risk of depression, sample size, participants' mean age, gender, and geographic location were included as covariates. However, no significant sources of heterogeneity were identified.

3.7. Sensitivity Analysis

In the sensitivity analysis, the leave-one-out method was adopted to examine the influence of individual studies on the pooled odds ratios (ORs). For sleep duration and risk of depression: In cross-sectional studies, the pooled ORs for depression ranged from 1.73 (95% CI: 1.57–1.92) to 1.81 (95% CI: 1.63–2.01) for short sleep duration and from 1.12 (95% CI: 0.99–1.28) to 1.21 (95% CI: 1.08–1.37) for long sleep duration. The results indicated that none of the individual studies had an excessive influence on the pooled effect estimates. For chronotype and risk of depression: The pooled ORs for depression ranged from 1.19 (95% CI: 1.02–1.39) to 1.36 (95% CI: 1.15–1.60) for neutral chronotype and from 1.98 (95% CI: 1.57–2.5) to 2.21 (95% CI: 1.71–2.86) for evening chronotype. The results demonstrated that none of the individual studies overly influenced the pooled effect estimates.

3.8. Publication Bias

The funnel plots of cross-sectional studies on sleep duration and chronotype showed basic symmetry on both sides (Fig. 4, Fig. 5). The results of Egger's test (P = 0.04)

indicated slight publication bias for the analysis of the association between short sleep duration and the risk of depression in cross-sectional studies. In addition, the results of Egger's test showed no evidence of publication bias for the analyses of short sleep duration in longitudinal studies ($P = 0.09$), long sleep duration in cross-sectional studies ($P = 0.60$) and longitudinal studies ($P = 0.95$), neutral chronotype ($P = 0.40$), evening chronotype ($P = 0.50$), and their respective associations with the risk of depression.

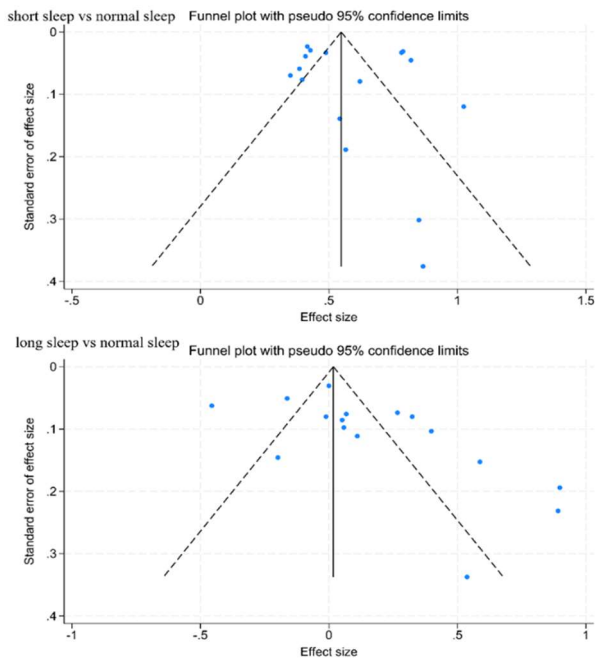


Fig. 4 Funnel plot of cross-sectional studies on sleep duration

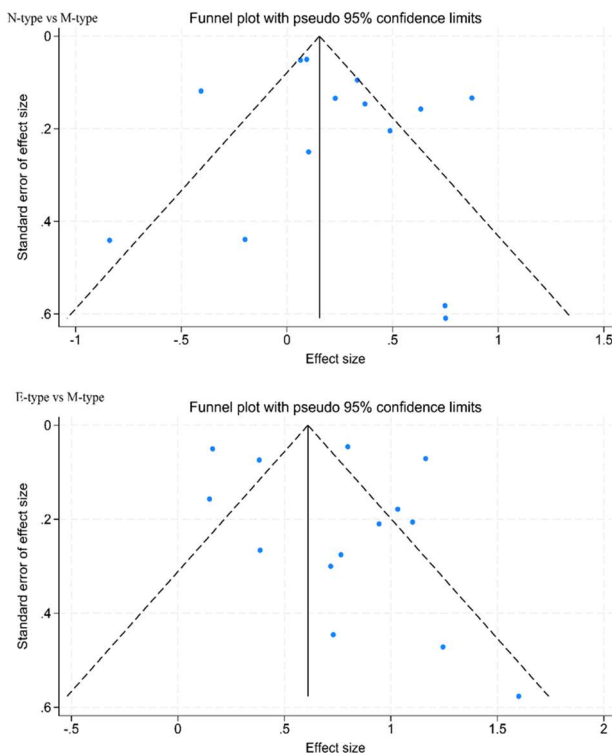


Fig. 5 Funnel plot of cross-sectional studies on chronotype

4. Discussion

This meta-analysis investigated both longitudinal and cross-sectional associations between sleep duration, chronotype, and the risk of depression, highlighting the critical role of sleep-related factors in depression development. However, due to the limited number of longitudinal studies on sleep duration ($n=4$), these findings require further validation to strengthen their reliability.

4.1. Sleep Duration and the Risk of Depression

Longitudinal studies demonstrated that short sleep duration was significantly associated with an increased risk of depression ($OR=1.24$, 95% CI: 1.06–1.46), whereas long sleep duration did not appear to elevate this risk ($OR=0.92$, 95% CI: 0.79–1.08). These findings suggested that sleep deprivation may have acted as a risk factor for depression, potentially mediated by neuroendocrine dysfunction impaired emotional regulation, and cognitive decline. In contrast, cross-sectional studies indicated that both short sleep duration ($OR=1.78$, 95% CI: 1.61–1.97) and long sleep duration ($OR=1.17$, 95% CI: 1.02–1.34) were associated with a higher risk of depression. Together, these results suggested a potential U-shaped relationship between sleep duration and depression risk, where deviations from the average sleep duration—both shorter and longer—may have increased vulnerability to depression.

4.2. Chronotype and the Risk of Depression

Cross-sectional studies revealed that both neutral chronotype (N-type) ($OR=1.27$, 95% CI: 1.06–1.51) and evening chronotype (E-type) ($OR=2.09$, 95% CI: 1.64–2.68) were significantly associated with an increased risk of depression, with the evening chronotype posing a higher risk. This finding may be related to the greater susceptibility of evening-type individuals to social jet lag. Social jet lag refers to the mismatch between an individual's biological clock and societal schedules. Evening chronotype individuals often find their inherent biological clocks mismatched with the work and sleep schedules of modern society. This misalignment can lead to chronic sleep deprivation and disruptions in circadian rhythms. Furthermore, nighttime exposure to artificial light, particularly the blue light emitted by electronic devices, suppresses the secretion of melatonin, further exacerbating circadian rhythm disturbances. Research has shown that circadian rhythm disruption is closely associated with the onset of depression, placing evening chronotype individuals at a higher risk of mental health issues.

The meta-analysis has revealed significant heterogeneity in the relationship between sleep duration and chronotype with the risk of depression. This heterogeneity may stem from variations in study design, sample characteristics, and research environments. In terms of study design, most studies predominantly employed subjective methods to measure sleep metrics and depressive symptoms. Sleep metrics were assessed through questionnaires such as the Munich Chronotype Questionnaire (MCTQ), self-reported questionnaires, and the Morning and Evening Questionnaire (MEQ). Similarly, the evaluation of depressive symptoms relied on various scales, such as Patient Health Questionnaire-9 (PHQ-9), the Beck Depression Inventory (BDI), and the Center for Epidemiologic Studies Depression (CES-D). Differences in the scoring criteria and sensitivity of these scales may have influenced the consistency of the results.

Meanwhile, variations in sample characteristics further contributed to the diversity of the findings. For instance, the studies encompassed a wide age range from adolescents to adults, with subgroup analyses indicating that prolonged sleep duration was associated with an increased risk of depression only in individuals aged 30 and above, while no such association was observed in those under 30. Additionally, the geographical distribution of the samples was diverse, spanning regions such as Asia, Europe, and North America. Subgroup analyses showed that the association between long sleep duration and depression risk was significant only in North America, while no significant association was found in Asia or Europe. This phenomenon may be related to differences in lifestyle habits, cultural backgrounds, and societal pressures across regions.

This study provided preliminary evidence regarding the relationship between sleep duration and chronotype with the risk of depression; however, some notable limitations should be acknowledged. Firstly, data on sleep duration and chronotype were collected based on participants' self-reported questionnaires or scales, a method that may have been subject to recall bias and measurement bias. Due to the lack of objective measurement tools, the estimation of the true associations between these factors and depression risk may have been affected by misclassification. Therefore, future studies were suggested to prioritize the use of standardized and objective measurement methods (e.g., actigraphy or polysomnography) to assess sleep indicators more accurately. Secondly, the majority of studies included in this meta-analysis were cross-sectional in design, a type of study that could not establish causal relationships between variables. To gain a deeper understanding of these associations, future research was recommended to incorporate more longitudinal designs to verify the causal pathways between sleep indicators and depression risk.

5. Conclusion

This meta-analysis revealed that sleep duration is associated with an increased risk of depression, with both short and long sleep durations showing elevated risks. Among all chronotypes, the evening chronotype was most strongly linked to a higher likelihood of depression. Although these findings provide preliminary evidence, significant heterogeneity among studies and a limited evidence base suggest caution in interpretation. Future research should prioritize standardized and objective measurement methods, incorporate longitudinal designs, and investigate demographic, environmental, and cultural factors to better understand the mechanisms underlying the relationships between sleep duration, chronotype, and depression risk. Such efforts will inform more effective prevention and intervention strategies for depressive symptoms.

The ancient art form of ink painting is undergoing unprecedented changes and expansion in the context of contemporary culture. When artists turn their attention to the Yi culture in the southwest, the encounter of two profound traditions gives birth to unique visual expression possibilities. The entry of Yi themes into the field of ink painting creation has not only injected fresh national vitality into traditional ink painting, but also raised aesthetic issues worthy of in-depth discussion at the level of composition. Based on the contemporary transformation background of ink art, this study attempts to analyze how Yi cultural elements can be sublimated from national symbols to artistic language through

the creative transformation of composition. Today, when the dual forces of globalization and localization are intertwined, the study of Yi themes in ink painting is not only about the exploration of an artistic expression technique, but also involves the visual construction of national cultural identity, and implies a profound reflection on how traditional art forms respond to the propositions of the times. By analyzing the spatial layout, visual rhythm and image combination of typical works, this study aims to reveal the dialogue mechanism between the Yi cultural spirit and the ink art language, and provide theoretical references and practical inspirations for the innovative development of contemporary Chinese painting.

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