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Common sleep characteristics and the risk of common perinatal complications and adverse outcomes: a multi-sample, bidirectional Mendelian randomization study

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Abstract

Background Improving maternal and child health has been a global priority since the early 2000s, with a focus on reducing perinatal complications and improving overall maternal well-being. Sleep characteristics influence various health outcomes, yet their role in perinatal complications and adverse outcomes remains poorly understood.

Methods A Mendelian randomization analysis was conducted, using seven common sleep characteristics (sleeplessness, sleep duration, getting up in the morning, daytime napping, morning/evening person, narcolepsy, snoring) as exposure factors and twelve common perinatal complications and adverse outcomes (preterm birth, polyhydramnios, slow fetal growth and fetal malnutrition, dystocia, umbilical cord-related complications, postpartum hemorrhage, fetal distress, gestational diabetes, pregnancy hypertension, eclampsia, abruptio placentae, placenta previa) as outcomes. A two-sample Mendelian randomization analysis was performed to infer causal effects.

Results The inverse variance weighted (IVW) analysis showed that sleeplessness was associated with preterm birth, sleep duration with gestational diabetes, and narcolepsy with pregnancy hypertension and eclampsia. These results were consistently supported by other methods, suggesting that sleep characteristics are causal risk factors for perinatal complications and adverse outcomes.

Conclusion This study found that sleeplessness is associated with preterm birth, sleep duration with gestational diabetes, and narcolepsy with pregnancy hypertension and eclampsia. These findings contribute to a better understanding of the impact of sleep characteristics on common perinatal complications and adverse outcomes. Targeting sleep interventions, such as improving sleep duration and addressing sleep disorders like sleeplessness and narcolepsy, may reduce the incidence of preterm birth, gestational diabetes, and pregnancy hypertension, offering effective strategies to improve maternal and infant health outcomes.

Keywords Mendelian randomization, Perinatal complications, Sleep characteristics, Gestational diabetes, Preterm birth

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In 2023, the World Health Organization (WHO) emphasized the importance of improving maternal and child health as a global priority for development. From 2000 to 2015, global maternal mortality rates decreased by one-third, from 339 deaths per 100,000 live births to 227 deaths per 100,000 live births. The United Nations' Sustainable Development Goals, established in 2015, aim to reduce the maternal mortality rate to less than 70 deaths per 100,000 live births by 2030. However, despite these efforts, the global maternal mortality rate stagnated from 2016 to 2020 [1]. While maternal deaths are primarily caused by factors such as hemorrhage, hypertension, and infections [2], improving maternal health and preventing perinatal complications remain key areas for enhancing health outcomes [3, 4].

In recent years, there has been increasing attention on improving healthcare systems to address maternal health challenges [5, 6]. However, despite advancements in healthcare standards, the issue of perinatal complications continues to be a significant concern, especially in both developed and developing countries [2]. Preterm births, for example, remain a leading cause of neonatal mortality, and complications during pregnancy can lead to long-term health consequences for both mothers and children [7].

One-third of human life is spent sleeping [8]. Good sleep is essential for overall health [9]. Different sleep characteristics have varying impacts on health. Research has shown that short sleep duration and sleep disorders are associated with adverse cardiovascular and metabolic risks, including obesity, hypertension, type 2 diabetes, and cardiovascular diseases [10]. Sleep disorders, sleep interruptions, and sleep posture during pregnancy can negatively affect fetal growth, pregnancy duration, and even lead to fetal death [11].

Previous studies examining the relationship between sleep characteristics and perinatal complications or adverse outcomes were mostly observational studies, which may have been influenced by confounding bias, selection bias, and information bias, leading to inaccurate or conflicting results [12, 13]. Even meta-analyses on specific sleep characteristics and pregnancy complications present conflicting findings [12, 14]. Mendelian randomization (MR) can evaluate and screen for potential causal associations when randomized controlled trials are unfeasible, and observational studies may provide biased associations due to confounding or reverse causality [15].

This study aims to utilize publicly available genome-wide association study (GWAS) data to conduct a multi-sample bidirectional MR analysis, exploring the potential causal relationships between common sleep characteristics and common perinatal complications and adverse outcomes, highlighting the need to identify and address modifiable risk factors from the perspective of the pregnant women themselves, and providing a basis for public health policy development.

Materials and methods

Study design

This study was conducted following the STROBE-MR guidelines [16]. Seven common sleep characteristics (Sleeplessness, Sleep duration, Getting up in the morning, Nap during the day, Morning/evening person, Narcolepsy, Snoring) were used as exposure factors, while twelve common perinatal complications and adverse outcomes (Preterm birth, Polyhydramnios, Slow fetal growth and fetal malnutrition, Dystocia, Umbilical cord-related complications, Postpartum hemorrhage, Fetal distress, Gestational diabetes, Pregnancy hypertension, Eclampsia, Abruptio placentae, Placenta previa) were used as outcomes. The study utilized a multi-sample bidirectional Mendelian Randomization (MR) analysis to infer causal effects.

This study adheres to the three basic assumptions of MR analysis [17]: Relevance: A significant association exists between the instrumental variables (IVs) and the exposure factors. Exclusivity: The effect of the IVs on the outcome is entirely mediated through the exposure factors, with no alternative pathways. Independence: Single nucleotide polymorphisms (SNPs) are independent of confounders that may affect the outcome. A diagram illustrating the three major assumptions of MR is shown in Fig. 1.

Data sources

The data used in this study were obtained from publicly available Genome-Wide Association Studies (GWAS) databases. GWAS data for the seven common sleep characteristics were obtained through the IEU OpenGWAS project website (https://gwas.mrcieu.ac.uk/). The GWAS data for the twelve common perinatal complications and adverse outcomes were sourced from the FinnGen Biobank database (https://www.finngen.fi/en). All GWAS data used in this study were publicly reported, and the original studies adhered to the Declaration of Helsinki and were approved by the relevant ethics committees. Furthermore, there was no sample overlap between the exposure and outcome data, and the study population was of European ancestry, minimizing potential bias due to racial confounding factors. Detailed information on the GWAS data used in this study is shown in Table 1.

Instrumental variable selection

The criteria for selecting SNPs as IVs in MR analysis are as follows:

Selection of SNPs Strongly Associated with Sleep Characteristics: SNPs strongly associated with sleep characteristics were selected with a significance threshold of

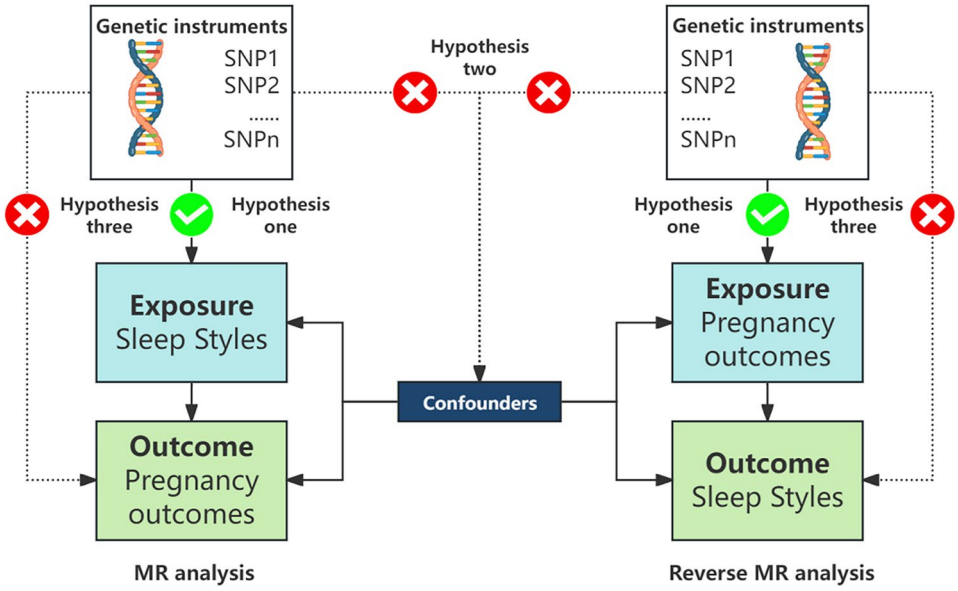

Fig. 1 Schematic diagram of two-sample MR analysis

$P < 5 \times 10$^-8 [18], and SNPs with $F > 10$ were chosen to exclude weak instruments. The F-statistic is calculated as $F = [(n - k - 1) / k] * [R^2 / (1 - R^2)]$ [19], where $R^2 = 2 * (1 - MAF) * MAF * (\beta / SD)^2$. Here, n represents the sample size of the selected dataset, k is the total number of SNPs used for MR analysis, β is the effect estimate of the SNP on the phenotype, SD is the standard deviation of β, and MAF is the minor allele frequency.

Ensuring Independence of SNPs: SNPs were selected to be independent, with an r^2 threshold of 0.001 and a distance of 10,000 kb to remove SNPs in linkage disequilibrium [18].

Exclusion of Confounding SNPs: Confounding SNPs were identified and excluded using the PhenoScanner database (http://www.phenoscanner.medschl.cam.ac.uk/). When a SNP is associated with a phenotype that may confound either the exposure or the outcome, it is considered a confounding SNP [20, 21].

Multi-sample, bidirectional MR analysis

The inverse variance weighted (IVW) method was used as the primary analysis to assess the causal relationship between sleep characteristics and the risk of common perinatal complications and adverse outcomes [22]. MR-Egger regression, weighted median (WME) method, simple model, and weighted model analysis results were used as supplementary methods [23]. IVW assumes that all SNPs satisfy the three core assumptions of MR, and combines the SNP Wald ratios to estimate causal relationships. The IVW method provides accurate estimates and is more efficient than the other four methods, making it the primary method for MR analysis. In the reverse MR analysis, since the number of SNPs for the outcome data is moderate, a significance threshold of $P < 5 \times 10$^-6 was used [24], with the linkage disequilibrium threshold set to $r^2 = 0.01$, $kb = 10{,}000$, while other parameters remained unchanged.

Sensitivity analysis

Sensitivity analyses included pleiotropy testing, heterogeneity testing, and leave-one-out testing, conducted using MR-Egger, Cochran's Q test, and leave-one-out methods, respectively. MR-Egger Regression: If the intercept is close to zero and $P > 0.05$, the study results are similar to IVW, indicating no horizontal pleiotropy [25]. MR-PRESSO Global Test and Outlier Test: MR-PRESSO was used to detect pleiotropy in the overall model and identify outlier SNPs [26]. Cochran's Q Test: Cochran's Q test was used to assess heterogeneity among SNPs. When $P > 0.05$, there is no significant heterogeneity among SNPs [27]. A funnel plot was drawn to assess potential bias.

Leave-One-Out Sensitivity Analysis: This method was used to assess the influence of individual SNPs on the total effect [28].

Statistical methods

All statistical analyses were performed using R software version 4.3.3, and the Two Sample MR package (version 0.6.8) was used for MR analysis. The results were reported using odds ratios (OR) and 95% confidence intervals (CI). The significance level was set at $\alpha = 0.05$, with $P < 0.05$ considered statistically significant.

Table 1 Phenotype-related information for exposure and outcome data

Exposure or Outcome	Data Source URL	Data ID or GWAS Number	Sample Ethnicity	Number of Single Nucleotide Polymorphisms	Sample Size
Sleeplessness	https://gwas.mrcieu.ac.uk/datasets/	ukb-b-3957	European	9,851,867	462,341
Sleep duration	https://gwas.mrcieu.ac.uk/datasets/	ukb-b-4424	European	9,851,867	460,099
Getting up in morning	https://gwas.mrcieu.ac.uk/datasets/	ukb-b-2772	European	9,851,867	461,658
Nap during day	https://gwas.mrcieu.ac.uk/datasets/	ukb-b-4616	European	9,851,867	462,400
Morning/evening person	https://gwas.mrcieu.ac.uk/datasets/	ukb-b-4956	European	9,851,867	413,343
Daytime dozing / sleeping (narcolepsy)	https://gwas.mrcieu.ac.uk/datasets/	ukb-b-5776	European	9,851,867	460,913
Snoring	https://gwas.mrcieu.ac.uk/datasets/	ukb-b-17,400	European	9,851,867	430,438
Preterm labour and delivery (Preterm birth)	https://r12.finngen.fi/	O15_PRETERM	European	21,317,595	226,330
Polyhydramnios	https://r12.finngen.fi/	O15_POLYHYDR	European	21,317,399	222,997
Slow fetal growth and fetal malnutrition	https://r12.finngen.fi/	P16_Slow_Fetal_Growth_Fetal_Malnutrition	European	21,327,029	499,624
Obstructed labour due to malposition and malpresentation of fetus (Dystocia)	https://r12.finngen.fi/	O15_LABOUR_MALPOS	European	21,317,491	225,409
Labour and delivery complicated by umbilical cord complications (Umbilical cord-related complications)	https://r12.finngen.fi/	O15_LABOUR_UMBILICAL	European	21,316,659	216,900
Postpartum haemorrhage	https://r12.finngen.fi/	O15_Postpart_Heamorrh_Allw	European	21,315,483	282,064
Labour and delivery complicated by fetal stress [distress] (fetal distress)	https://r12.finngen.fi/	O15_LABOUR_FETAL_STRESS	European	21,317,853	207,093
Pregnancy hypertension	https://r12.finngen.fi/	O15_HYPTENSPREG	European	21,320,948	282,064
Gestational diabetes	https://r12.finngen.fi/	Gest_Diabetes	European	21,321,577	282,064
Eclampsia	https://r12.finngen.fi/	O15_ECLAMPSIA	European	21,320,797	259,401
Abruptio placentae	https://r12.finngen.fi/	O15_Plac_premat_separ	European	21,317,290	222,061
Placenta praevia	https://r12.finngen.fi/	O15_Plac_Praevia	European	21,317,385	223,001

Results

Instrumental variable selection results

After removing weak IVs, addressing linkage disequilibrium, excluding confounding factors (The confounding SNP phenotypes include: height, BMI, Type 2 diabetes, smoking initiation, and others.), and eliminating palindrome structures, the number of SNPs included for the seven sleep characteristics as exposure factors were as follows: ukb-b-2772 had 56 SNPs, ukb-b-3957 had 30 SNPs, ukb-b-4424 had 45 SNPs, ukb-b-4616 had 68 SNPs, ukb-b-4956 had 106 SNPs, ukb-b-5776 had 23 SNPs, and ukb-b-17,400 had 30 SNPs. After coordinating the exposure and outcome, the final number of SNPs included in the analysis for each sleep characteristic, along with the screening process, can be found in Supplement 1 - Table 1. The *F*-values for all IVs were greater than 10, indicating that the selected IVs had high strength and significantly reduced the risk of bias associated with the IVs, the *F*-values for all IVs can be found in Supplement 2.

MR analysis results

A two-sample MR analysis was conducted to examine the relationship between common sleep characteristics and common adverse pregnancy and delivery outcomes. The IVW analysis results (Fig. 2) showed that three sleep characteristics were associated with four perinatal complications and adverse outcomes ($P < 0.05$): Sleeplessness was associated with Preterm birth [$OR = 1.996$, *95%CI*: 1.227–3.246, $P = 0.005$] (Fig. 3-A), Sleep duration was associated with Gestational diabetes [$OR = 1.498$, *95%CI*: 1.051–2.136, $P = 0.025$] (Fig. 3-B), and Narcolepsy was associated with Pregnancy hypertension [$OR = 3.335$, *95%CI*: 1.129–9.852, $P = 0.029$] (Fig. 3-C) and Eclampsia

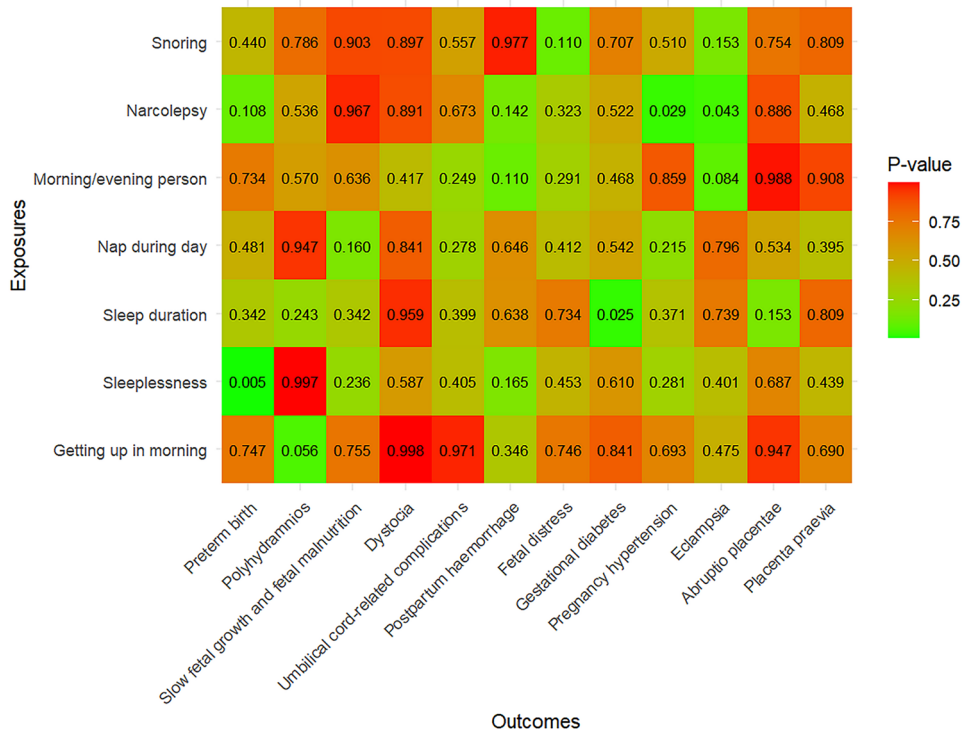

Fig. 2 IVW Method Results for the Forward MR Analysis of Common Sleep Characteristics and Common Adverse Pregnancy and Delivery Outcomes

[*OR* = 3.073, *95%CI*: 1.040–9.080, *P* = 0.042] (Fig. 3-D). The IVW analysis results for these four sleep characteristics, along with MR-Egger regression, WME, simple model, and weighted model analysis results, were consistent in direction (Fig. 3), suggesting that the exposure is a risk factor for the outcomes. Additionally, the effect sizes for these four associations were presented using the IVW method, WME method, and forest plots (Fig. 4).

Sensitivity analysis

Horizontal Pleiotropy test

The intercept analysis from MR-Egger regression did not observe any horizontal pleiotropy (Sleeplessness: *P* = 0.807, Sleep duration: *P* = 0.833, Narcolepsy: *P* = 0.616). The MR-PRESSO global test analysis showed that the residual sum of squares (RSSobs) values were small (32.297 ~ 52.963), and no evidence of horizontal pleiotropy was observed in the overall model (Sleeplessness: *P* = 0.404; Sleep duration: *P* = 0.216; Narcolepsy: *P* = 0.094). The MR-PRESSO outlier test analysis did not identify any outlier SNPs in any of the exposure factors, as shown in Table 2.

Heterogeneity test

The results of Cochran's Q test analysis showed that there was no significant heterogeneity between the SNPs strongly associated with the three sleep characteristics. [Sleeplessness (IVW: *Q* = 30.036, *P* = 0.412; MR-Egger regression: *Q* = 29.97, *P* = 0.364), Sleep duration (IVW: *Q* = 50.615, *P* = 0.198; MR-Egger regression: *Q* = 50.56, *P* = 0.171), Narcolepsy (IVW: *Q* = 29.731, *P* = 0.097; MR-Egger regression: *Q* = 29.351, *P* = 0.080)] as shown in Table 2.

The forward MR analysis reported no bias: The funnel plot (Fig. 5) shows that the SNPs are symmetrically distributed, with no potential bias.

Leave-one-out sensitivity analysis

The leave-one-out analysis (Fig. 6) was performed on the MR study results, where each SNP was progressively removed to observe the effect on the estimated effect size. The IVW analysis results for all SNPs were consistent, with all values falling to the right of the null line, indicating no significant influential SNP loci. This suggests the stability of the MR analysis results.

Reverse MR analysis

The exposures and outcomes were swapped, and a reverse MR analysis was conducted. The IVW analysis showed no significant associations: Preterm birth and Sleeplessness (*OR* = 1.007, *95%CI*: 0.989–1.025, *P* = 0.412); Gestational diabetes and Sleep duration (*OR* = 0.995, *95%CI*: 0.984–1.005, *P* = 0.354); Pregnancy hypertension and Narcolepsy (*OR* = 1.000, *95%CI*: 0.994–1.025, *P* = 1.006); Eclampsia and Narcolepsy (*OR* = 0.998, *95%CI*: 0.993–1.003, *P* = 0.533). The details of the four reverse MR analysis results can be found in Supplement 1 - Table 2.

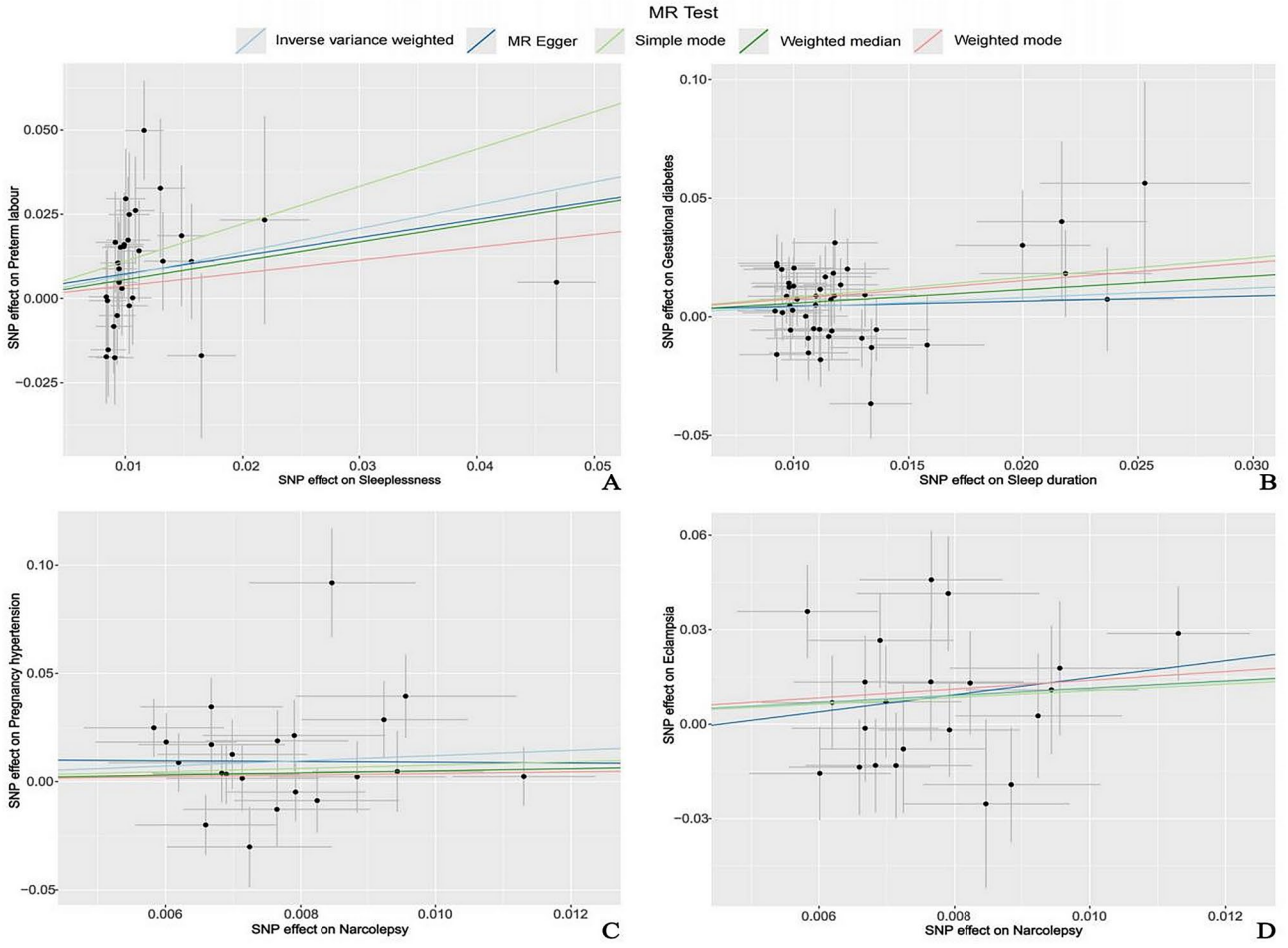

Fig. 3 Scatter Plots for Positive Results in the Forward MR Analysis of Common Sleep Characteristics and Common Adverse Pregnancy and Delivery Outcomes

Exposure Factor	Outcome Factor	SNP (Count)	MR Method	OR (95%CI)	*P*-value
Narcolepsy	Eclampsia	22	WME	3.126(0.847-11.528)	0.086
			IVW	3.073(1.040-9.080)	0.042
Narcolepsy	Pregnancy hypertension	22	WME	1.651(0.486-5.600)	0.420
			IVW	3.335(1.129-9.852)	0.029
Sleep duration	Gestational diabetes	44	WME	1.772(1.094-2.869)	0.019
			IVW	1.498(1.051-2.136)	0.025
Sleeplessness	Preterm labour and delivery	30	WME	1.748(0.847-3.303)	0.130
			IVW	1.996(1.227-3.246)	0.005

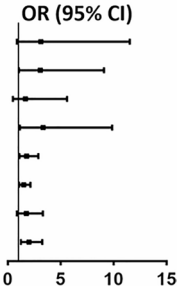

Fig. 4 Forest Plot of Positive Results in the Forward MR Analysis of Common Sleep Characteristics and Common Adverse Pregnancy and DeliveryOutcomes Note: MR: Mendelian Randomization; SNP: Single Nucleotide Polymorphism; IVW: Inverse Variance Weighted; WME: Weighted Median Estimator

Table 2 Sensitivity analysis results for positive results in the forward MR analysis of common sleep characteristics and common adverse pregnancy and delivery outcomes

Exposure	Horizontal Pleiotropy Test		Heterogeneity Test			
	Intercept	*P*-value	MR-Egger		IVW	
			Q-value	*P*-value	Q-value	*P*-value
Sleeplessness	0.001	0.807	29.97	0.364	30.036	0.412
Sleep duration	0.002	0.833	50.56	0.171	50.615	0.198
Narcolepsy	−0.012	0.616	29.351	0.080	29.731	0.097

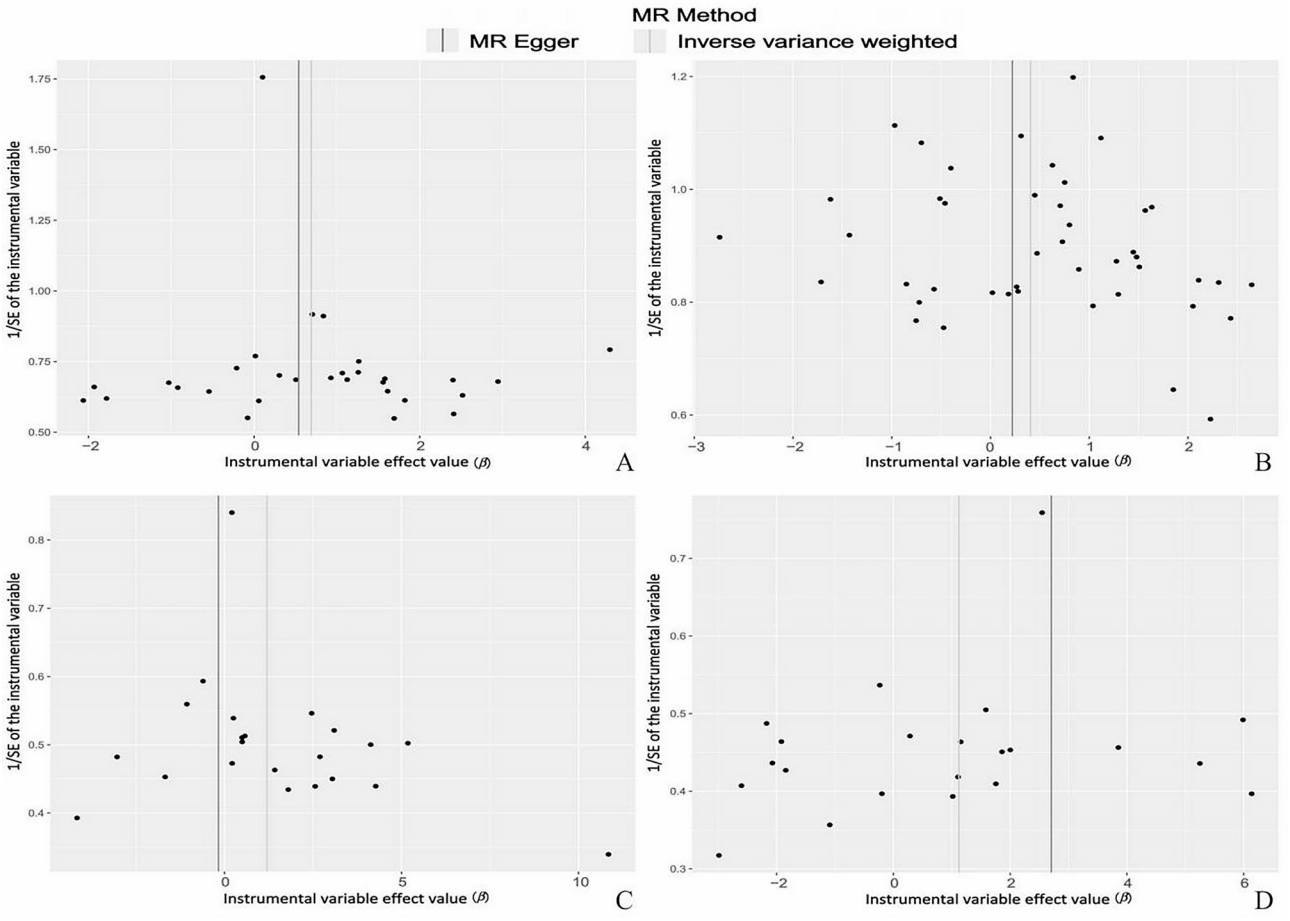

Fig. 5 Funnel Plot of Positive Results in the Forward MR Analysis of Common Sleep Characteristics and Common Adverse Pregnancy and Delivery Outcomes

Discussion

This study used large-scale GWAS data and performed multi-sample bidirectional MR analysis. It found that Sleeplessness was associated with Preterm birth, Sleep duration was associated with Gestational diabetes, and Narcolepsy was associated with Pregnancy hypertension and Eclampsia. No significant associations were found between other common sleep characteristics and the risk of common perinatal complications and adverse outcomes. After adjusting for confounding factors, the above causal associations remained statistically significant.

Research suggests that long-term sleeplessness may lead to chronic low-grade inflammation [29], especially under stressful conditions, where sleeplessness activates the immune system [30], resulting in elevated levels of C-reactive protein (CRP) [31], interleukin-6 (IL-6) [32], and an enhanced inflammatory response [33]. An increase in CRP concentration typically indicates the presence of systemic inflammation, particularly in cases of infection or other pathological conditions. A study by GHEZZI F and colleagues highlighted that elevated CRP levels in pregnant women and amniotic fluid might be associated with preterm birth [34]. Populations with sleeplessness and poor sleep quality exhibit significantly higher levels of IL-6 compared to those with normal sleep [35]. sleeplessness raises IL-6 levels, which may be related to immune system activation and a strengthened inflammatory response in the body. IL-6 is considered a key factor in initiating preterm birth mechanisms, especially in preterm birth cases associated with intrauterine infections, where IL-6 levels are often significantly elevated [36]. P. Polo-Kantola and colleagues' research also confirmed that primary sleeplessness may increase the risk of complications such as preterm birth [37], a finding consistent with the results of this study. A meta-analysis showed a high incidence of sleeplessness during pregnancy [38]. Pregnancy-related sleeplessness is associated with both physical and psychological causes, including vomiting, nocturia, joint and back pain, heartburn, nasal congestion, temperature regulation issues, uterine contractions, fetal movement, uncomfortable sleeping positions, depression, and anxiety [37].

Sleep duration is associated with insulin sensitivity [39], with both excessive sleep and insufficient sleep

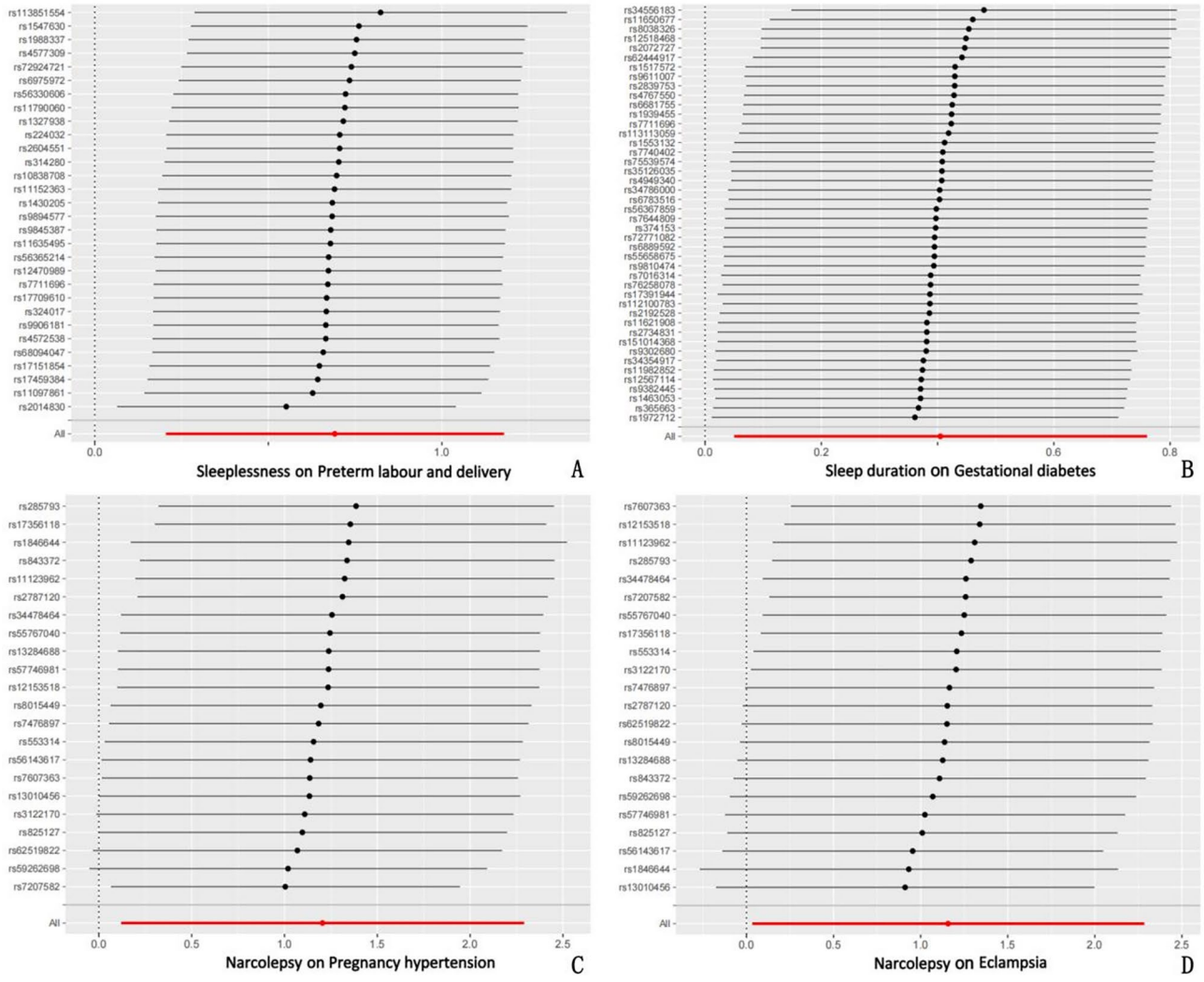

Fig. 6 Forest plot of the "Leave-One-Out" analysis results

potentially reducing insulin sensitivity [40], thereby affecting the risk of gestational diabetes. Insulin resistance is a key mechanism in the development of gestational diabetes [40]. Long sleep duration may lead to hormonal imbalances in the body, particularly affecting insulin secretion and action, resulting in insulin resistance. Extended sleep duration may also be associated with endocrine disorders and lifestyle factors such as lack of physical activity [41], which can contribute to weight gain and insulin resistance. Furthermore, some studies suggest that inflammation is an important mechanism in the development of gestational diabetes [42, 43]. Research by XU Y-H et al. [13] also indicates that changes in sleep duration may affect the risk of gestational diabetes by altering inflammation levels in the body. Additionally, prolonged sleep duration may be linked to mental health issues such as depression and anxiety, which themselves may increase the risk of gestational diabetes by altering metabolic processes. A meta-analysis by Ya-Hui Xu et al. [42, 43] also demonstrated a close association between long sleep duration and the occurrence of gestational diabetes. This result is consistent with the findings of this study.

Narcolepsy is a neurological disorder that affects the sleep-wake cycle, typically characterized by excessive daytime sleepiness, sudden sleep attacks, and sleep paralysis [44]. Its pathological mechanisms primarily involve a deficiency or dysfunction of neurotransmitters in the brain that regulate wakefulness and sleep, such as the sleep hormone orexin [44]. Orexin-A, in particular, is associated with dysregulation of sympathetic nervous activity, which may lead to increased vascular resistance and restricted placental blood flow [45]. This dysregulation of vascular tone and placental perfusion is one of the pathophysiological mechanisms leading to hypertensive disorders such as eclampsia and gestational hypertension [46]. Additionally, individuals with narcolepsy often experience higher levels of inflammation [47], and

chronic low-grade inflammation can lead to endothelial dysfunction, causing reduced vascular reactivity [48], which exacerbates vasoconstriction and impaired blood flow [49], ultimately raising blood pressure and potentially contributing to the development of hypertensive disorders in pregnancy. Moreover, narcolepsy may lead to increased levels of vascular constrictors [50] and cortisol [51], as well as activation of the sympathetic nervous system. These factors can further intensify the pathophysiological processes of hypertensive disorders in pregnancy. Cortisol, as a stress hormone, when elevated, may induce vasoconstriction and insulin resistance, thereby increasing the risk of hypertensive disorders and metabolic disturbances during pregnancy [52]. Hypertension and preeclampsia during pregnancy are both part of hypertensive disorders of pregnancy.

In the reverse MR analysis, the causal relationships mentioned above were not validated in the reverse direction, which may be influenced by sample size and the selected instrumental variables (SNPs). The reverse MR analysis failed to detect significant results effectively. Moreover, the lack of significant findings in the reverse MR may also suggest that the outcome variables have a weaker reverse influence on sleep characteristics. In our forward MR analysis, significant associations between sleep characteristics and pregnancy outcomes were observed, supporting the hypothesis of a unidirectional causal relationship. Therefore, the lack of significant results in the reverse MR analysis may be due to these effects being more likely to be unidirectional rather than a complex, bidirectional causal chain.

Maternal sleep disturbances during pregnancy are significantly associated with complications in multiparous women and adverse fetal outcomes [53]. To address sleep disorders and improve sleep quality in pregnant women, it is essential to implement a series of intervention measures.

Firstly, improving the sleep environment is fundamental to enhancing sleep quality [54]. Studies have shown that environmental noise and uncomfortable temperatures are key factors contributing to sleep disturbances in pregnant women [55]. Therefore, ensuring a quiet and comfortable bedroom with an appropriate temperature is crucial. Additionally, selecting a mattress and pillows that meet the needs of pregnant women, as well as ensuring overall comfort in the bed, can help improve sleep quality.

Secondly, modifying pre-sleep behaviors has a positive effect on improving sleep quality. Research indicates that exposure to artificial light and late-night eating are strongly associated with reduced sleep quality [56, 57]. Pregnant women are therefore advised to avoid using electronic devices in the evening, minimize exposure to light at night, and refrain from eating before bedtime. Furthermore, avoiding activities such as watching television in bed, which can interfere with sleep, is helpful in increasing sleep duration and quality [55].

In terms of mental health, stress and depressive symptoms are significant factors that contribute to poor sleep quality in pregnant women [58, 59]. Therefore, enhancing psychological health interventions, providing professional counseling, and offering emotional regulation support are crucial. Techniques such as relaxation training, meditation, and deep breathing can effectively reduce anxiety and stress, thereby improving sleep quality.

Moreover, hormonal and physiological changes during pregnancy also affect sleep quality, especially in the later stages of pregnancy [60]. To alleviate this issue, pregnant women are advised to adopt appropriate positions and sleeping postures that avoid pressure on the abdomen and interference with respiratory function. Selecting a suitable sleep posture can significantly reduce discomfort and improve sleep quality.

To comprehensively address maternal sleep issues, regular screening for sleep disorders and personalized interventions are vital. Pregnant women should undergo periodic sleep quality assessments, particularly those showing signs of sleeplessness or excessive daytime sleepiness, to ensure timely intervention and prevent sleep problems from negatively impacting maternal and fetal health.

Strengths and limitations of the study

The strengths of this study include: (1) the use of MR principles to control for confounding factors; (2) reverse MR analysis that eliminates reverse causality; (3) the application of multiple methods, such as MR-Egger regression and MR-PRESSO global test, to examine bias caused by pleiotropy.

However, the study has several limitations: (1) potential residual bias in MR analysis cannot be eliminated [61]; (2) the SNPs used in this study are derived from a GWAS of European populations, the generalizability of the research findings to other racial populations remains to be validated; (3) although the study did not observe any relationship between other sleep characteristics and common perinatal complications or adverse outcomes, we cannot completely rule out the possibility that weak associations may not have been detected due to insufficient statistical power in this study. (4) the sample size limited the statistical power of some analyses. Future studies could increase the sample size to reduce the occurrence of type II errors. (5) the GWAS data used in this study did not account for the temporal changes during pregnancy. To better understand the genetic basis of sleep during pregnancy, future research should explore this further through more detailed temporal data

collection or by integrating clinical and behavioral data throughout pregnancy.

Conclusion

This study assessed the potential causal relationships between common sleep characteristics and common perinatal complications or adverse outcomes. It found that sleeplessness is associated with preterm birth, sleep duration is associated with gestational diabetes, and narcolepsy is associated with pregnancy hypertension and eclampsia. The findings of this study may help further our understanding of the impact of sleep characteristics on common perinatal complications and adverse outcomes, offering effective strategies to improve maternal and infant health outcomes.

Abbreviations

MR	Mendelian Randomization
IVW	Inverse Variance Weighting
WME	Weighted Median Estimator
GWAS	Genome-Wide Association Study
SNP	Single Nucleotide Polymorphism
OR	Odds Ratio
CI	Confidence Interval
CONSORT	Consolidated Standards of Reporting Trials
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology
CRP	C-Reactive Protein
IL-6	Interleukin-6

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12884-025-07754-2.

Supplementary Material 1

Supplementary Material 2

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Author contributions

WN designed the study, performed data analysis, and drafted the manuscript. WT contributed to data collection and drafted the manuscript. TML assisted with the literature review and manuscript preparation. ZBQ and WT contributed to data interpretation and preparation of visualizations. CJM acted as the corresponding author, drafted the manuscript, and ensured the overall quality of the study. All authors reviewed the manuscript.

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Data availability

The exposure data used in this study can be retrieved and accessed from the website https://gwas.mrcieu.ac.uk/datasets/, and the outcome data can be retrieved and accessed from the website https://r12.finngen.fi/

Declarations

Ethics approval and consent to participate

The GWAS data used in this study were obtained from original research that had received ethical approval and informed consent from the participants.

Consent for publication

Consent for publication was obtained from all participants included in the study.

Competing interests

The authors declare no competing interests.

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