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Obstructive Sleep Apnea and the Risk of Gestational Diabetes in Young Pregnant Women: A Prospective Cohort Study

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Abstract

Obstructive sleep apnea (OSA) has been associated with adverse metabolic and obstetric outcomes during pregnancy, but prospective evidence from Middle Eastern populations remains limited. This prospective cohort study investigated the association between OSA and maternal and neonatal outcomes among young pregnant women in Oman. Omani women aged ≤ 35 years with singleton low-risk pregnancies were recruited before 24 weeks' gestation from Sultan Qaboos University Hospital and Ministry of Health primary healthcare centres between January 2021 and April 2024. OSA was assessed using level III home sleep apnea testing and classified according to the apnea–hypopnea index (AHI). Daytime sleepiness was evaluated using the Epworth Sleepiness Scale, and participants were followed until delivery. Maternal and neonatal outcomes were extracted from medical records and analysed using multivariable regression models. Among 429 women who completed the study, 42.2% had OSA (AHI ≥ 5 events/hour). Gestational diabetes mellitus (GDM) occurred in 28.2% of participants and was the only pregnancy outcome significantly associated with OSA ($p = 0.031$). No significant associations were found between OSA and gestational hypertension, preterm birth, fetal growth restriction, cesarean delivery, low birth weight, Apgar score, or neonatal intensive care unit admission. Third-trimester body mass index and AHI independently predicted HbA1c levels ($F = 4.199$, $p = 0.006$; $R^2 = 0.030$). OSA was common and independently associated with GDM, supporting consideration of OSA screening during pregnancy, particularly among women at increased risk of GDM.

Introduction

Sleep is a fundamental biological process essential for metabolic, cardiovascular, neurocognitive, and endocrine homeostasis. Healthy sleep encompasses adequate duration, quality, regularity, timing, and the absence of sleep disorders. Both insufficient and excessive sleep, as well as poor sleep quality, have been associated with adverse health outcomes, including cardiometabolic disease, increased healthcare utilization, and all-cause mortality [1–5]. These relationships are particularly relevant during pregnancy, when physiological adaptations substantially alter sleep patterns and respiratory function. In Oman, changing lifestyle patterns, including polyphasic sleep and prolonged daytime napping, may further influence obesity and metabolic derangement, particularly among women balancing occupational and domestic responsibilities [6].

Pregnancy is accompanied by profound physiological, hormonal, and anatomical changes that alter sleep architecture and respiratory physiology. Although total sleep duration may increase during early pregnancy, sleep quality generally deteriorates as gestation progresses owing to increased sleep fragmentation, nocturnal awakenings, and reduced sleep efficiency [7]. Consequently, sleep disturbances are common during pregnancy, with obstructive sleep apnea (OSA) and restless legs syndrome among the most frequently reported disorders [8].

OSA is characterized by recurrent upper airway obstruction during sleep, resulting in intermittent hypoxia and sleep fragmentation [9, 10]. Once considered predominantly a disorder affecting men, OSA is now

increasingly recognized in women, particularly during pregnancy, when gestational weight gain, upper airway oedema, and hormonal changes predispose to upper airway narrowing [11–13]. Even mild sleep-disordered breathing may have clinically important consequences for maternal and fetal health [13, 14]. Although the prevalence of OSA in women of reproductive age is relatively low, pregnancy may unmask or exacerbate the condition, increasing susceptibility to adverse metabolic and cardiovascular outcomes [10].

Snoring, one of the most common symptoms of obstructive sleep apnea (OSA), is reported in approximately 27–40% of adults and becomes increasingly prevalent during pregnancy [15, 16]. Maternal snoring and OSA have been associated with several adverse pregnancy outcomes, including hypertensive disorders of pregnancy, gestational diabetes mellitus (GDM), preterm birth, cesarean delivery, low birth weight, small-for-gestational-age infants, and lower Apgar scores [17–21]. These associations are biologically plausible, as intermittent hypoxia and recurrent sleep fragmentation associated with OSA may promote sympathetic activation, oxidative stress, systemic inflammation, endothelial dysfunction, and impaired placental perfusion [21–22]. Furthermore, emerging evidence suggests that OSA may contribute to impaired glucose metabolism during pregnancy. In non-pregnant populations, OSA is an established risk factor for insulin resistance, type 2 diabetes mellitus, hypertension, and cardiovascular disease through mechanisms involving intermittent hypoxia, sympathetic activation, inflammation, and hormonal dysregulation [4, 10, 23]. Similar pathways may contribute to the development of GDM, one of the most common complications of pregnancy and an important determinant of adverse maternal and offspring outcomes [24, 25]. Several prospective studies have reported associations between short sleep duration, habitual snoring, and gestational glucose intolerance [26], while meta-analyses have suggested possible associations between both short and long sleep duration and GDM [27, 28]. However, findings remain inconsistent, as many studies rely on self-reported sleep measures, lack objective assessment of sleep-disordered breathing, or inadequately adjust for important maternal confounders.

Despite increasing global interest in the relationship between sleep disordered breathing and pregnancy outcomes, evidence from Middle Eastern populations remains limited with increased prevalence of obesity. In Oman, rapid socioeconomic transition has been accompanied by increasing rates of obesity, diabetes, and pregnancy-related complications, highlighting the need for region-specific evidence [29, 30]. To date, sleep-disordered breathing among pregnant women in this region has not been systematically investigated.

Therefore, this prospective cohort study aimed to examine the association between OSA during pregnancy and adverse pregnancy outcomes The primary outcome was gestational diabetes mellitus (GDM), while secondary outcomes included preeclampsia, cesarean delivery, preterm birth, low birth weight, and Apgar scores.

By following women prospectively from early pregnancy through delivery and adjusting for key maternal confounders, this study is expected to provide region-specific evidence to inform future screening and

preventive strategies for improving maternal and neonatal outcomes.

Materials and Methods

Study design and setting

This prospective cohort study was conducted among pregnant Omani women attending antenatal clinics at Sultan Qaboos University Hospital (SQUH) and Ministry of Health (MOH) primary healthcare centres in Muscat, Oman from Jan 2021-April 2024. Participants were recruited before 24 weeks of gestation and followed until delivery.

Participants

Eligible participants were Omani pregnant women aged ≤ 35 years with singleton, low-risk pregnancies. Exclusion criteria included pre-existing diabetes, chronic hypertension, grand multiparity (> 5), and known psychiatric disorders. Written informed consent was obtained from all participants after explaining the purpose of the study and providing a patient information sheet.

Exposure assessment

Sleep parameters were assessed using a combination of subjective and objective measures at the time of recruitment which was early 2nd trimester. Daytime sleepiness was evaluated using the validated Arabic version of the Epworth Sleepiness Scale (ESS).. Obstructive sleep apnoea (OSA) was assessed using a level III home sleep apnea testing (HSAT) device (Somnotouch, Somnomedics, Germany), with diagnosis and classification based on the apnoea–hypopnoea index (AHI); mild OSA (AHI = 5–15), moderate OSA (AHI = 16–30) and severe OSA (AHI > 30). HSAT was scored based on American academy of sleep medicine (AASM) guidelines [31]. Scoring of sleep study was done according to American academy of sleep medicine guidelines (AASM)[31].

Outcomes

The primary outcome was gestational diabetes mellitus (GDM), diagnosed according to national guidelines based on fasting blood glucose and/or oral glucose tolerance testing [32]. Secondary maternal outcomes included anaemia (Hb less than 11 g/dL), pre-eclampsia (BP ≥ 140/90 with proteinuria), preterm delivery (≤ 37 weeks of gestation), and mode of delivery. Fetal outcomes included fetal growth restriction (FGR), low birth weight (LBW) ≤ 2500 grams, low Apgar scores, and neonatal intensive care unit (NICU) admission.

Data collection

Baseline demographic, obstetric, and anthropometric data were collected at recruitment. Maternal weight, height, and blood pressure were measured using standardised procedures, and body mass index (BMI) was calculated.

Participants were followed through routine antenatal visits, and pregnancy outcomes were obtained from medical records at delivery.

Sample size

Sample size was calculated using nMaster 2.0 software based on expected prevalence of key outcomes and an assumed relative risk of 2.5 among women with sleep disturbances. For 80% power and 5% significance level, the required sample size required was 430. A total of 600 women were recruited, of whom 429 completed the full study protocol.

Statistical analysis

Data were analysed using SPSS version 26. Continuous variables were summarised as mean (SD) or median (IQR), and categorical variables as frequencies and percentages. Group comparisons were performed using t-tests or non-parametric equivalents for continuous variables and χ^2 tests for categorical variables. Logistic regression analysis was used to assess associations between sleep parameters and pregnancy outcomes, adjusting for potential confounders including maternal age, BMI, gravidity, and prior obstetric history. Results were reported as odds ratios (ORs) with 95% confidence intervals (CIs). A p-value < 0.05 was considered statistically significant.

Ethical approval

The study was approved by the College of Medicine and Health Sciences Medical Research and Ethics Committee of Sultan Qaboos University (MREC-2040) and the Ministry of Health Research and Ethics Review Committee (MoH/CSR/20/24144). All research was performed in accordance with relevant guidelines/regulations.

Results

Study population

A total of 500 pregnant women were recruited into the study, of whom 429 (71.5%) completed the study protocol and were included in the final analysis. All participants were Omani women aged ≤35 years with singleton, low-risk pregnancies who were enrolled before 24 weeks of gestation and followed prospectively until delivery.

The mean (SD) maternal age was 31.96 (3.77) years, and the mean baseline body mass index (BMI) was 25.46 (1.43) kg/m². Approximately one-third of participants were primigravida (34.5%) and 36.1% were nulliparous. Baseline demographic and obstetric characteristics are presented in **Table 1**.

Maternal and neonatal outcomes

Gestational diabetes mellitus (GDM) was diagnosed in 121 women (28.2%), making it the most frequent pregnancy complication observed. Anemia occurred in 49 participants (11.4%), whereas gestational hypertension was identified in only one participant (0.2%). No cases of pre-eclampsia were recorded during the study period.

Preterm delivery (<37 weeks of gestation) occurred in 25 women (5.8%), and 61 participants (14.2%) underwent emergency cesarean section. Fetal growth restriction (FGR) was documented in 27 pregnancies (6.3%), while postpartum hemorrhage occurred in 22 women (5.1%). The mean (SD) gestational weight gain was 6.96 (4.34) kg, and the average estimated blood loss at delivery was 272.49 (202.24) mL. Maternal pregnancy outcomes are summarized in **Table 2**.

The mean (SD) neonatal birth weight was 2,972 (468) g, with 51 neonates (11.9%) classified as having low birth weight. Mean Apgar scores at one and five minutes were 8.70 (0.99) and 9.75 (0.85), respectively. Four perinatal deaths (0.9%) occurred, resulting in an overall live birth rate of 99.1%. Twenty-one neonates (4.9%) required admission to the neonatal intensive care unit (NICU). Detailed neonatal outcomes are presented in **Table 3**.

Sleep characteristics

Obstructive sleep apnea (OSA), defined as an apnea–hypopnoea index (AHI) >5 events/hour, was identified in 181 participants, corresponding to a prevalence of 42.2%. Based on the Epworth Sleepiness Scale, 253 women (59.0%) had excessive daytime sleepiness (ESS >10), whereas 176 (41.0%) had ESS scores ≤10. The distribution of sleep-related characteristics is shown in **Table 2**.

Association between obstructive sleep apnea and pregnancy outcomes

The association between OSA severity and maternal and neonatal outcomes is presented in **Table 4**. Among all pregnancy outcomes evaluated, only gestational diabetes mellitus demonstrated a statistically significant association with OSA severity ($p = 0.031$). Approximately half of the women diagnosed with GDM had OSA, whereas women without GDM were significantly more likely to have no evidence of OSA.

No statistically significant associations were observed between OSA and gestational hypertension, anemia, preterm birth, mode of delivery, fetal growth restriction, postpartum hemorrhage, neonatal birth weight, Apgar scores, or NICU admission.

Predictors of glycemic status

Multiple linear regression analysis was performed to evaluate whether third-trimester BMI, Epworth Sleepiness Scale score, and AHI independently predicted maternal HbA1c levels. The overall regression

model was statistically significant ($F(3,413)=4.199$, $p=0.006$), explaining 3.0% of the variance in HbA1c ($R^2=0.030$).

Within the model, both AHI and third-trimester BMI were independent predictors of HbA1c ($p<0.05$), whereas Epworth Sleepiness Scale score was not significantly associated with HbA1c. The resulting regression equation was:Predicted HbA1c = 4.612 − (0.012 × AHI) + (0.020 × third-trimester BMIThe regression coefficients are presented in **Table 5**.

Discussion

The main finding of the present study is that OSA is associated with GDM but does not affect other maternal or fetal outcomes. The mechanisms that link OSA to GDM are not yet clear. OSA is associated with autonomic imbalance, increase in inflammatory process and endothelial dysfunction, which have been implicated in the development of gestational diabetes and gestational hypertension [33]. Some studies proposed that OSA impairs glucose-induced insulin secretion from pancreatic β cells and causes the aggregation of inflammatory factors in adipose tissue, leading to the occurrence of diabetes or insulin resistance [34].

The study did not support the evidence associating OSA with various maternal hypertensive disorders, including gestational hypertension, preeclampsia, and eclampsia. Oxidative stress is proposed to be one of the main intermediate mechanisms. However, the effects of OSA on systemic oxidative stress are unknown in pregnancy [35].

During pregnancy, weight gain, hormones, and upper airway edema can trigger or worsen OSA. This breathing disruption causes sleep fragmentation and nocturnal desaturation, leading to inflammation and insulin resistance, which increase the risk of gestational diabetes [36]. The studies evaluating the association between OSA and GDM are mostly retrospective with small numbers and conflicting results.

Two small case-control studies found a higher prevalence of obstructive sleep apnea (OSA) in women with gestational diabetes mellitus (GDM) compared with controls, suggesting a significant association between OSA and GDM. However, both studies were limited by small sample sizes and study populations consisting largely of women with obesity and predominantly non-Caucasian ethnic groups. Because obesity and ethnicity are independent risk factors for both OSA and GDM, these findings may not be generalized to the broader pregnant population [37,38].

The largest prospective pregnancy study (2,474 women) found that obstructive sleep apnea (OSA) diagnosed by sleep study in mid-pregnancy was independently associated with an increased risk of gestational diabetes mellitus (GDM) (OR 2.79, 95% CI 1.63–4.77). However, the study was primarily designed to assess pre-eclampsia [39]. A questionnaire-based study concluded that Poor sleep conditions and specific sleep hygiene behaviors in early pregnancy may be independent risk factors for GDM [40].

In contrast, a study by Bublitz et al. revealed a lower OSA prevalence of 17% among women with GDM, potentially due to the use of polysomnography, which applies more stringent diagnostic criteria [41]. Moreover, a multicenter study in Spain including 177 women didn't find an association between OSA and GDM [42].

This study has several important strengths. To our knowledge, it is among the first prospective cohort studies from the Middle East to objectively evaluate obstructive sleep apnea (OSA) during pregnancy and its association with maternal and neonatal outcomes. Participants were enrolled early in pregnancy and followed until delivery, minimizing recall bias and establishing the temporal relationship between OSA and pregnancy outcomes. OSA was assessed using validated objective methods, including home sleep apnea testing and the Epworth Sleepiness Scale. Additionally, the relatively homogeneous cohort of young women with singleton, low-risk pregnancies reduced potential confounding from pre-existing maternal comorbidities.

This study has several limitations. Although the overall sample size was adequate, the low frequency of some maternal and neonatal outcomes may have limited the power to detect significant associations. The inclusion of only young Omani women with low-risk singleton pregnancies may also limit the generalizability of the findings. In addition, OSA was assessed using level III home sleep apnea testing rather than gold-standard polysomnography, which may underestimate disease severity. Finally, residual confounding cannot be excluded, as lifestyle factors such as diet and physical activity were not assessed.

Conclusion

This prospective cohort study demonstrated that obstructive sleep apnea is common among young pregnant Omani women and is associated with an increased risk of gestational diabetes mellitus, while no significant associations were observed with other maternal or neonatal outcomes. These findings support greater awareness of sleep-disordered breathing during pregnancy and suggest that screening women at high metabolic risk may facilitate earlier identification of gestational diabetes. Further multicenter studies with larger populations are warranted to determine whether early diagnosis and treatment of OSA can improve pregnancy outcomes.

Declarations

Author contributions

N.R.: wrote the main manuscript, J.A.: recruited participants and collected the data, S.J.: performed data management and statistical analyses, A.A.: recruited participants, M.A.: recruited participants, S.S.: designed the study, K.A.: interpreted the results, M.A.: conceived, designed the study, and interpreted the results. All authors reviewed and approved the final manuscript.

Data availability

The datasets generated and/or analyzed during the current study are not publicly available due to ethical and privacy restrictions related to the inclusion of individual-level clinical data but are available from the corresponding author on reasonable request and subject to approval by the relevant ethics committee.

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References

1. National Sleep Foundation. National Sleep Foundation Recommends New Sleep Times. Available at: http://sleepfoundation.org/press-release/nationalsleep-foundation-recommends-new-sleep-times/page/0/1
2. CDC. Are you getting enough sleep? Available at: http://www.cdc.gov/features/sleep/index.html
3. Kwok, C. S. et al. Self-Reported Sleep Duration and Quality and Cardiovascular Disease and Mortality: A Dose-Response Meta-Analysis. *J. Am. Heart Assoc.* ;**7**(15). (2018).
4. Cappuccio, F. P., D'Elia, L., Strazzullo, P. & Miller, M. A. Sleep duration and all-cause mortality: a systematic review and meta-analysis of prospective studies. *Sleep* **33**, 585–592 (2010).
5. Al Lawati, N. M., Patel, S. R. & Ayas, N. T. Epidemiology, risk factors, and consequences of obstructive sleep apnea and short sleep duration. *Prog Cardiovasc. Dis.* **51**, 285–293 (2009).
6. Al-Abri, M., Al-Lawati, I. & Al-Zedjali, F. Sleep pattern among young and middle aged Omani adults using actigraphy. *Sleep. Med.* **40**, e3–e185 (2017).
7. Lee, K. A., Zaffke, M. E. & McEnany, G. Parity and sleep patterns during and after pregnancy. *Obstet. Gynecol.* **95** (1), 14–18 (2000).
8. Warland, J., Dorrian, J., Morrison, J. L. & O'Brien, L. M. Maternal sleep during pregnancy and poor fetal outcomes: A scoping review of the literature with meta-analysis. *Sleep. Med. Rev.* **41**, 197–219 (2018).
9. Jordan, A. S., McSharry, D. G. & Malhotra, A. Adult obstructive sleep apnoea. *Lancet* **383**, 736–747 (2014).
10. Young, T. et al. The occurrence of sleep disordered breathing among middle-aged adults. *N Engl. J. Med.* **328**, 1230–1235 (1993).
11. Louis, J. M., Auckley, D., Sokol, R. J. & Mercer, B. M. Maternal and neonatal morbidities associated with obstructive sleep apnea complicating pregnancy. *Am. J. Obstet. Gynecol.* **202**, 261e1–261e5 (2010).
12. Dhamelia, P., Gupta, V., Agarwal, S., Singh, B. & Jain, R. Obstructive Sleep Apnea in Pregnancy and its Impact on Maternal-Fetal Health: A Hidden Threat Narrative Review. The Open Respiratory Medicine Journal. (2025). 10.2174/0118743064411633250826105304, **19**, e18743064411633 .
13. Pien, G. W. & Schwab, R. J. Sleep disorders during pregnancy. *Sleep* **27**, 1405–1417 (2004).

14. Herrera Morales, A., Choh, A. C., Bauer, C. X., Czerwinski, S. A. & Lee, M. Maternal Sleep Disorders and Maternal and Birth Outcomes: A Retrospective US Claims-Based Study. *Brain Behav.* **15** (9), e70908. 10.1002/brb3.70908 (2025).
15. Sarberg, M., Svanborg, E., Wiréhn, A. B. & Josefsson, A. Snoring during pregnancy and its relation to sleepiness and pregnancy outcome - a prospective study. *BMC Pregnancy Childbirth*. **14** (1), 15. 10.1186/1471-2393-14-15 (2014).
16. Udwadia, Z. F., Doshi, A. V., Lonkar, S. G. & Singh, C. I. Prevalence of sleep-disordered breathing and sleep apnea in middle-aged urban Indian men. *Am. J. Respir Crit. Care Med.* **169**, 168–173 (2004).
17. Champagne, K. A., Kimoff, R. J., Barriga, P. C., Schwartzman, K. & Sleep disordered breathing in women of childbearing age and during pregnancy. *Indian J. Med. Res.* **131**, 285–301 (2010).
18. Sahin, F. K. et al. Obstructive sleep apnea in pregnancy and fetal outcome. *Int. J. Gynaecol. Obstet.* **100**, 141–146 (2008).
19. Kapsimalis, F. & Kryger, M. Sleep breathing disorders in the U.S. female population. *J. Womens Health (Larchmt)*. **18**, 1211–1219 (2009).
20. Roush, S. F. & Bell, L. Obstructive sleep apnea in pregnancy. *J. Am. Board. Fam Pract.* **17**, 292–294 (2004).
21. Chen, Y. H. et al. Obstructive sleep apnea and the risk of adverse pregnancy outcomes. *Am. J. Obstet. Gynecol.* **206**, 136e1–136e5 (2012).
22. Olivarez, S. A. et al. Prospective trial on obstructive sleep apnea in pregnancy and fetal heart rate monitoring. *Am. J. Obstet. Gynecol.* **202**, 552e1–552e7 (2010).
23. Foley, D., Ancoli-Israel, S., Britz, P. & Walsh, J. Sleep disturbances and chronic disease in older adults: results of the 2003 National Sleep Foundation Sleep in America survey. *J. Psychosom. Res.* **56**, 497–502 (2004).
24. Hedman, C., Pohjasvaara, T., Tolonen, U., Suhonen-Malm, A. S. & Myllylä, V. V. Effects of pregnancy on mothers' sleep. *Sleep. Med.* **3**, 37–42 (2002).
25. Mindell, J. A. & Jacobson, B. J. Sleep disturbances during pregnancy. *J. Obstet. Gynecol. Neonatal Nurs.* **29**, 590–597 (2000).
26. Pien, G. W. & Schwab, R. J. Sleep disorders during pregnancy. *Sleep* **27**, 1405–1417 (2004).
27. Sedov, I. D., Cameron, E. E., Madigan, S. & Tomfohr-Madsen, L. M. Sleep quality during pregnancy: a meta-analysis. *Sleep. Med. Rev.* **38**, 168–176 (2018).
28. Xu, Y. H. et al. Association between sleep duration during pregnancy and gestational diabetes mellitus: a meta-analysis. *Sleep. Med.* **52**, 67–74 (2018).
29. Subki, A. H. et al. Prevalence, risk factors, and fetal and maternal outcomes of hypertensive disorders of pregnancy: a retrospective study in Western Saudi Arabia. *Oman Med. J.* **33**, 409–415 (2018).
30. Al-Abri, M. et al. Gender difference in relationship of apnoea/hypopnoea index with body mass index and age in the Omani population. *Sultan Qaboos Univ. Med. J.* **11**, 363–368 (2011).

31. Kapur, V. K. et al. Clinical practice guideline for diagnostic testing for adult obstructive sleep apnea: an American Academy of Sleep Medicine clinical practice guideline. *J. Clin. Sleep. Med.* **13**, 479–504. 10.5664/jcsm.6506 (2017).
32. Oman Ministry of Health. *Pregnancy and Childbirth Management Guidelines. Level 1: A Guide for Nurses, Midwives and Doctors* 2nd edn (Department of Women and Child Health Care, Directorate General of Primary Health Care, Muscat, Oman Ministry of Health, 2022).
33. Tayade, S. & Toshniwal, S. Obstructive sleep apnea in pregnancy: a narrative review. *Cureus* **14** 10.7759/cureus.30387 (2022).
34. Tong, X. et al. A review of the associations between obstructive sleep apnea and gestational diabetes mellitus and possible mechanisms of disease. *Reprod. Sci.* **30**, 81–92. 10.1007/s43032-022-00904-3 (2023).
35. Liu, L., Su, G., Wang, S. & Zhu, B. The prevalence of obstructive sleep apnea and its association with pregnancy-related health outcomes: A systematic review and meta-analysis. *Sleep. Breath.* **PMID**, 30255484 (2018).
36. Reutrakul, S. et al. Interactions between pregnancy, obstructive sleep apnea, and gestational diabetes mellitus. J Clin Endocrinol Metab. ; 98(10): 4195 – 202. (2013). http://dx.doi.org/10.1210/jc.2013-2348 PMID: 23966237.
37. Reutrakul, S. et al. Interactions between pregnancy, obstructive sleep apnea, and gestational diabetes mellitus. *J. Clin. Endocrinol. Metab.* **98**, 4195–4202. http://dx.doi.org/10.1210/jc.2013-2348 (2013).
38. Izci Balserak, B. et al. Obstructive sleep apnea is associated with newly-diagnosed gestational diabetes mellitus. *Ann. Am. Thorac. Soc.* **17**, 754–761. http://dx.doi.org/10.1513/AnnalsATS.2019.06-473OC (2020).
39. Facco, F. L. et al. Association between sleep-disordered breathing and hypertensive disorders of pregnancy and gestational diabetes mellitus. *Obstet. Gynecol.* **129**, 31–41. http://dx.doi.org/10.1097/AOG. 0000000000001805 (2017).
40. Guojun, M., Yanqing, C., Yong, Z. & Jianxia, F. Sleep conditions and sleep hygiene behaviors in early pregnancy are associated with gestational diabetes mellitus: A propensity-score matched study. *Sleep. Breath.* **28**, 2421–2430. https://doi.org/10.1007/s11325-024-03071-8) (2024).
41. Bublitz, M. H. et al. Obstructive sleep apnea in gestational diabetes: A pilot study of the role of the hypothalamic-pituitary-adrenal axis. J Clin Sleep Med. ; 14(1): 87–93. (2018). http://dx.doi.org/10.5664/jcsm.6888 PMID: 29198302.
42. Alonso-Fernández, A. et al. Impact of Obstructive Sleep Apnea on Gestational Diabetes Mellitus. Archivos de Bronconeumología 58 219–227. (2022). https://doi.org/10.1016/j.arbres.2021.05.005

Tables

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