Sleep disordered breathing, insomnia, and excessive daytime sleepiness among Japanese pregnant women without gestational complications do not negatively impact delivery outcomes

Hideaki Kondo (kondo.hideaki.gb@u.tsukuba.ac.jp)
International Institute for Integrative Sleep Medicine, The University of Tsukuba https://orcid.org/0000-0003-0856-6650
Shiho Umeno
Karatsu Red Cross Hospital
Hiromi Eto
Nagasaki University
Chiho Kato
Japan Red Cross College of Nursing
Yuki Nagaura
Nagasaki University

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Abstract

Frequently observed sleep/wake problems among pregnant women need comprehensive evaluation. This study was conducted to clarify the sleep/wake problems among pregnant women without gestational complications at the second and third trimester and the effects of sleep/wake problems on delivery outcomes. Methods: A total of 88 Japanese pregnant women participated in this study. At the second and third trimester, subjective sleep quality, insomnia severity, excessive daytime sleepiness (EDS), and restless legs syndrome/Willis-Ekbom disease (RLS/WED) were assessed using questionnaires; also, sleep disordered breathing (SDB) was screened using a pulse oximeter. Results: From the second to third trimester, an increasing tendency of sleep/wake problems was observed. At the third trimester, the percentage of women experiencing decreased subjective sleep quality, difficulty maintaining sleep (DMS), EDS, RLS/WED, and 3% oxygen desaturation index (ODI) values ≥ 5/h were 62.5%, 45.5%, 48.9%, 9.1%, and 29.5%, respectively. In a logistic regression analysis for EDS at the third trimester, the adjusted odds ratio (95% confidence interval) of total sleep time < 6 hours, moderate to severe DMS, and 3% ODI ≥ 5/h were 3.25 (1.16–9.10), 4.74 (1.60–14.00), and 0.90 (0.28–2.89), respectively. Decreased subjective sleep quality, insomnia severity, EDS, and SDB did not affect the delivery outcome or infant's condition. Conclusions: Sleep/wake problems were frequent during pregnancy, especially at the third trimester. EDS among pregnant women was associated with shorter sleep time and DMS, rather than SDB. However, there were no significant effects of sleep/wake problems on the delivery outcomes or infant's conditions.

Background

Sleep disordered breathing (SDB), frequent among pregnant women, is associated with gestational diabetes and hypertensive disorders during pregnancy [1-3]. Also, maternal SDB affects delivery outcomes and is associated with preterm birth and admission to the neonatal intensive care unit [1,4,5]. The prevalence of SDB increases during the course of pregnancy and a meta-analysis reported a prevalence of 15% (95% confidence interval [CI]: 12–18%) [1]. In a study using polysomnography (PSG), the prevalence of an apnea-hypopnea index (AHI) value ≥ 5/h at the first and third trimester, after adjusting for the general body mass index (BMI) of pregnant women, were 8.4% and 19.7%, respectively [6]. Among high-risk pregnant women with a BMI≥ 30 kg/m^2, the prevalence of an AHI ≥ 5/h at the first and third trimester is reported as 30% and 47%, respectively [7].

In previous studies performed in Europe and the US, about half of the participants' pre-pregnancy BMI values were greater than or equal to 25 kg/m^2 [4,5,2,3,6,7]. In a study performed in Japan, the mean ± standard deviation (SD) of the participants' pre-pregnancy BMI value was 23.8 ± 6.1 kg/m^2, and the prevalence of having a 3% oxygen desaturation index (ODI) value ≥ 5/h was 12.3% after 28 weeks gestation. This group was associated with a history of spontaneous abortion, emergency cesarean birth, and vacuum extraction [8]. Among pregnant women without gestational complications, whose pre-pregnancy BMI values were 22.2 ± 2.6 kg/m^2, none had a 3% ODI ≥ 5/h at the second trimester [9]. The prevalence of SDB among Japanese pregnant women vary greatly.

During pregnancy, increased waking after sleep onset and decreased sleep efficiency are frequently observed [10,11], and complaints about insomnia symptoms are prevalent [12]. Also, a decrease in subjective sleep quality is often observed [13] and restless legs syndrome/Willis–Ekbom disease (RLS/WED), related to insomnia and decreased sleep quality, is also prevalent [14]. Moreover, complaints about excessive daytime sleepiness (EDS) are common among pregnant women [15]. Although EDS is affected by SDB, insomnia and/or sleep insufficiency also influence EDS. To clarify the cause of EDS, sleep related problems must be evaluated comprehensively. This study aims to clarify the sleep/wake problems among pregnant Japanese women without gestational complications at the second and third trimester of pregnancy and the effects of sleep/wake problems on delivery outcomes.

Methods

Participants and protocol

The participants were pregnant women who were undergoing pregnancy-related medical examinations at an obstetric medical facility in Nagasaki Prefecture from December 2017 until October 2018. Women who had pregnancy complications were excluded. A total of 143 pregnant women were asked to participate in the study and 113 women consented to participate in this research at their second trimester of pregnancy (around 24 weeks gestation). After accounting for women who dropped out due to obstetric or experienced technological issues related to data collection during the study period, effective responses were obtained from 107 women (74.8%) in the second trimester and 88 (61.5%) in the third trimester (around 37 weeks gestation). The final analysis was performed among 88 participants (Figure 1).

Participants were aged between 19 and 42 years old, with a mean age (± SD) of 30.9 ± 4.7 years. Forty women were primipara (46%). The data were collected at 24.6 ± 0.6 weeks gestation in the second trimester and 36.2 ± 0.9 weeks gestation in the third trimester. The median (interquartile range [IQR]) pre-pregnancy BMI was 20.3 (18.9–22.1) kg/m^2 and 6 women (6.9%) were obese (BMI ≥ 25 kg/m2).

All procedures performed this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This study was approved by the Ethics Committee of Nagasaki University Graduate School of Biomedical Sciences (Approval No. 1711090). Informed consent was obtained from all individual participants included in the study.

We obtained demographic and clinical characteristics of all participants including age, body weight (pre-pregnancy, second trimester, and third trimester), height, history of gravidity, history of parity. Pre-pregnancy, second trimester, and third trimester BMIs were calculated. The delivery and neonatal information were collected from midwifery records including gestational age, duration of birth, type of birth (vaginal delivery, cesarean section), labor induction, episiotomy, perineal laceration, uterus contraction, oxytocic agent use, volume of blood loss, the infant's condition, infant weight, infant height, Apgar score, umbilical pH, and umbilical partial pressure of carbon dioxide. Self-reported questionnaires

related to sleep/wake problems were administered and SDB screening was performed over 2 consecutive nights using a pulse oximeter during the second and third trimester.

Pulse oximeter

SDB was screened using a pulse oximeter (PULSOX-300i, KONICA MINOLTA Japan, Inc., Tokyo, Japan). The pulse oximeter was attached to the first joint of the second or third fingers on the non-dominant hand at bedtime and removed at the time of awakening over 2 consecutive nights. The data were downloaded to a personal computer using DS-Me version 2.1 (KONICA MINOLTA Japan, Inc.). After removing poor measurement periods, the 3% ODI was calculated, defined as the number of times per hour in which the oxygen saturation decreased by 3% or more from the baseline. Patients who had a 3% ODI ≥ 5 were defined as having suspected SDB [8].

Questionnaires

Pittsburgh Sleep Quality Index

Subjective sleep quality was assessed using the Japanese version of the Pittsburgh Sleep Quality Index (PSQI). This questionnaire consists of 7 components including sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, hypnotic use, and daytime dysfunction. The score of each component ranges from 0 to 3, with global scores ranging from 0 to 21. Higher scores indicate inadequate sleep quality with scores ≥ 6 indicating poor sleep quality [16,17]. ; therefore, women with global scores ≥ 6 were categorized into a “poor sleeper” group. According to a meta-analysis, the sensitivity and specificity (95% CI) for insomnia are 0.94 (0.86–0.98) and 0.76 (0.64–0.85), respectively [18].

Insomnia Severity Index

Insomnia severity was assessed using the Japanese version of the Insomnia Severity Index (ISI). The severity of difficulty initiating sleep (DIS) and difficulty maintaining sleep (DMS) are answered as “none”, “mild”, “moderate”, “severe”, or “very severe”. Responders who had “mild” to “very severe” symptoms were defined as having DIS and DMS. Responders who had “moderate” to “very severe” symptoms were defined as having moderate to severe DIS and DMS. The global score of this index ranges from 0 to 28, with higher scores indicating greater insomnia severity, and the cut off score for insomnia is 10 points [19]. According to a meta-analysis, the sensitivity and specificity (95% CI) for insomnia is 0.88 (0.79–0.93) and 0.85 (0.68–0.94), respectively [18].

Epworth Sleepiness Scale

Daytime sleepiness was assessed using the Japanese version of the Epworth Sleepiness Scale (ESS). The global score on this scale ranges from 0 to 24, with higher scores indicating greater subjective daytime sleepiness and the cut off score for EDS is 10 points [20,21]. In this study, we categorized participants with an ESS score ≥ 11 as the EDS group, because a daytime dysfunction score ≥ 2 on the PSQI, which reflects daytime sleepiness, was associated with an ESS score ≥ 11, not an ESS score ≥ 10.

Cambridge-Hopkins Questionnaire Short Form13

Symptoms related to RLS/WED were assessed using the Japanese version of the Cambridge-Hopkins questionnaire short form 13 (CH-RLSq13). The CH-RLSq13 is a self-reported questionnaire containing 13 items, 10 of which are related to characteristic symptoms and the exclusion of other conditions (e.g., leg cramping and positional discomfort); the remaining 3 items are related symptom severity and onset. The sensitivity and specificity of the original CH-RLSq13 for an RLS/WED diagnosis have been reported as 87.2% and 94.4%, respectively, and those of the Japanese version are 88.9% and 100.0%, respectively [22].

Statistical analysis

R version 3.5.2 and EZR version 1.40 (http://www.jichi.ac.jp/saitama-sct/SaitamaHP.files/statmed.html) [23] were used for statistical analysis. Categorical variables were presented as counts and percentages. Continuous variables were presented as the mean and SD when normally distributed and as medians and IQRs when non-normally distributed. Comparisons were made using t-tests for normally distributed data and Mann–Whitney U tests for non-normally distributed data. Comparisons of continuous variables between the second and third trimester were performed using the Wilcoxon signed-rank test. Frequency analyses for categorical data were performed using a Fisher's exact test. Frequency analyses between the second and third trimester were performed using a McNemar's test. The 2-sided alpha level was set at 0.05.

The odds ratios for EDS were calculated using logistic regression analysis to assess the association with total sleep time, DMS, and SDB. After a univariate analysis, adjustments for age and BMI were made. Age and BMI were categorized into 2 groups each: age < 30 years (reference) or ≥ 30 years and BMI < 25 kg/m2 (reference) or ≥ 25 kg/m2. Total sleep time obtained from the PSQI was categorized into 2 groups: < 6 hours and ≥ 6 hours (reference). DMS was categorized into 2 groups: none-mild (reference) and moderate-severe. Also, 3% ODI values were categorized into 2 groups: < 5/h (reference) and ≥ 5/h.

Results

The percentage of women in the poor sleeper group increased from 34.1% in the second trimester to 62.5% in the third trimester ($p < 0.001$). More than 90% of women had DIS and DMS at the third trimester and the percentage of women having moderate to severe DIS and DMS increased from 31.8% in the second trimester to 55.7% in the third trimester ($p < 0.001$). Although the percentage of women having EDS (ESS ≥ 11) did not show significant changes from the second to third trimester, almost half of the participants were aware of EDS during their pregnancy. The percentage of women having RLS/WED increased from 2.3% to 9.1% ($p = 0.04$, Table 1).

Although, the percentage of women in the SDB group, which were those with a 3% ODI ≥ 5/h, showed an increasing tendency with values of 18.2% in the second trimester to 29.5% in the third trimester; there was no statistically significant increase ($p = 0.08$). There was no suspected moderate to severe SDB, defined with a 3% ODI ≥ 15/h, at the second trimester, and only 1 participant had a 3% ODI ≥ 15/h at the third trimester (Table 1). The median BMIs of the 3% ODI ≥ 5/h group at the third trimester were higher than those in the 3% ODI < 5/h group from pre-pregnancy to the third trimester (Table 2). DMS was frequent in the 3% ODI < 5/h group at the third trimester. However, an association with SDB and EDS was not found (Table 3).

In the ESS ≥ 11 group at the third trimester, decreased subjective sleep quality, shorter sleep time, and moderate to severe DMS was found; also, ISI global scores in this group were ≥ 10 (Table 4). In a logistic regression analysis for EDS at the third trimester, the adjusted odds ratio (95% CI) of total sleep time < 6 hours, moderate to severe DMS, and 3% ODI ≥ 5/h were 3.25 (1.16–9.10), 4.74 (1.60–14.00), and 0.90 (0.28–2.89), respectively (Table 5). There was no collinearity between total sleep time and DMS. The median (IQR) total sleep time among participants with ISI values ≥ 10 was significantly shorter than those with ISI values < 10: 6.50 (6.00–7.75) hours vs. 7.00 (7.00–8.00) hours ($p = 0.02$).

Compared to the 3% ODI < 5/h group, there was no significant effect on delivery outcomes or infant conditions in the 3% ODI ≥ 5/h group (Table 6). Similarly, decreased subjective sleep quality, insomnia severity, and EDS did not affect delivery outcomes or the infant's condition (Supplementary Tables 1–3).

Discussion

Excessive daytime sleepiness among pregnant women

In this study, SDB was not a significant factor for EDS among pregnant women. It has been reported that ESS global scores at pre-pregnancy and the third trimester among pregnant women who are obese are higher than those without are not obese [24]. Moreover, snoring during the first trimester is associated with not only continuous EDS throughout pregnancy, but also with EDS onset during pregnancy [15]. In the present study, there were only 6 pre-pregnancy obese participants and almost all suspected SDB participants were thought to be mild cases. These factors might influence the relationship between SDB and EDS.

Although, DIS and DMS at the third trimester were frequently observed in the present study, moderate to severe DMS, rather than moderate to severe DIS, affected EDS. In some previous studies, DMS was more frequent than DIS. In objective findings using PSG during pregnancy, significant prolongation of sleep latency was been observed and increased wake time after sleep onset and decreased sleep efficiency was reported [10,11]. Furthermore, while the percentage of DIS was only 14%, the percentage of DMS was as high as 70% in the subjective findings using a Basic Nordic Sleep Questionnaire at the third trimester [25]. The discrepancy in insomnia symptom frequency might be caused by the differences between questionnaires or the severity of insomnia symptoms. Also, the study using PSG has had a small sample size, so this approach needs to be evaluated on a larger scale.

RLS/WED is prevalent among pregnant women and it affect DIS, DMS, and EDS [14,26,27]. In the present study, the prevalence of suspected RLS/WED was increased at the third trimester. However, the presence of RLS/WED did not affect EDS, insomnia symptoms, or subjective sleep quality. In Japanese pregnant women without gestational complications, few severe cases of RLS/WED were reported, and almost all RLS/WED patients reported mild to moderate issues [28]. Among 8 suspected RLS/WED patients at the third trimester of pregnancy in this study, 7 indicated they had moderate to severe symptoms. However, only 3 patients experienced these symptoms twice a week or more. The lower symptom occurrence frequency and the small sample size might influence the relationship between RLS/WED and EDS.

In the present study, a short sleep time of < 6 hours was associated with EDS. Total sleep time among participants with insomnia was shorter than those without insomnia. Although there was no collinearity between total sleep time and DMS in a logistic regression analysis, a shorter sleep time induced by DMS, but might affect EDS.

Sleep disordered breathing among pregnant women

In the present study, BMI values among pregnant women with a 3% ODI ≥ 5/h were higher than those with a 3% ODI < 5/h from pre-pregnancy to the third trimester; the tendency was clearly noticeable in the later period of pregnancy. However, there were few participants with obesity in this study. Also, a lower BMI is thought to be associated with a lower desaturation index obtained from the pulse oximeter.

SDB is associated with gestational complications, delivery outcomes, and neonatal conditions [1,4,5,2,3]. However, there was no significant effect on delivery outcomes and infant conditions in the 3% ODI ≥ 5/h group. Overall, SDB severity was relatively mild in the study participants; this is thought to contribute to the good outcomes along with the fact that the participants had no gestational complications.

Limitations

The present study possesses some limitations of note. First, the results did not reflect the conditions of all pregnant women since they were obtained from Japanese women without gestational complications. Hence, we could not assess the sleep/wake problems among high risk pregnant women also suffering from obesity. Second, SDB was evaluated using only a pulse oximeter; therefore, the information on sleep stages, respiration itself, and position were lacking in this study. Third, symptoms of RLS/WED were examined using a self-reported questionnaire; thus a diagnosis of RLS/WED was not confirmed by sleep medicine specialists.

Conclusions

From the second to third trimester, an increasing tendency of sleep/wake problems was observed. However, there were few pregnant women with moderate to severe SDB and there were no significant effects of SDB on the delivery outcome and infant's condition. Also, EDS among pregnant women was associated with a shorter sleep time and DMS, rather than SDB. Consequently, sleep hygiene awareness including sleep duration and insomnia among Japanese pregnant women without gestational complications is needed. To further evaluate the effects of sleep/wake disorders on gestational complications and delivery outcomes, additional research is needed, beginning from pre-pregnancy, on a large scale including high-risk pregnant women.

Abbreviations

AHI: apnea-hypopnea index

BMI: body mass index

CI: confidence interval

CH-RLSq13: Cambridge-Hopkins questionnaire short form 13

DIS: difficulty initiating sleep

DMS: difficulty maintaining sleep

EDS: excessive daytime sleepiness

ESS: Epworth Sleepiness Scale

IQR: interquartile range

ISI: Insomnia Severity Index

ODI: oxygen desaturation index

PSQI: Pittsburgh Sleep Quality Index

RLS/WED: restless legs syndrome/Willis–Ekbom disease

SD: standard deviation

SDB: sleep disordered breathing

Declarations

Ethics approval and consent to participate: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This study was approved by the Ethics Committee of Nagasaki University Graduate School of Biomedical Sciences (Approval No. 1711090). Informed consent was obtained from all individual participants included in the study.

Consent for publication: Not applicable.

Availability of data and materials: All data generated or analysed during this study are included in this published article and its supplementary information files.

Competing interests: The authors declare that they have no competing interest.

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Authors' contributions: CK, HE, YN, and HK designed the data collection. SU interviewed and enrolled eligible participants and completed all study procedures. EH drafted the initial manuscript. All authors read and approved the final manuscript.

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References

1. Liu L, Su G, Wang S, Zhu B (2019) The prevalence of obstructive sleep apnea and its association with pregnancy-related health outcomes: a systematic review and meta-analysis. Sleep Breath 23 (2):399-412. doi:10.1007/s11325-018-1714-7
2. Dominguez JE, Habib AS, Krystal AD (2018) A review of the associations between obstructive sleep apnea and hypertensive disorders of pregnancy and possible mechanisms of disease. Sleep medicine reviews 42:37-46. doi:10.1016/j.smrv.2018.05.004
3. Facco FL, Parker CB, Reddy UM, Silver RM, Koch MA, Louis JM, Basner RC, Chung JH, Nhan-Chang CL, Pien GW, Redline S, Grobman WA, Wing DA, Simhan HN, Haas DM, Mercer BM, Parry S, Mobley D, Hunter S, Saade GR, Schubert FP, Zee PC (2017) Association Between Sleep-Disordered Breathing and Hypertensive Disorders of Pregnancy and Gestational Diabetes Mellitus. Obstetrics and gynecology 129 (1):31-41. doi:10.1097/aog.0000000000001805

4. Warland J, Dorrian J, Morrison JL, O'Brien LM (2018) Maternal sleep during pregnancy and poor fetal outcomes: A scoping review of the literature with meta-analysis. Sleep medicine reviews 41:197-219. doi:10.1016/j.smrv.2018.03.004
5. Li L, Zhao K, Hua J, Li S (2018) Association between Sleep-Disordered Breathing during Pregnancy and Maternal and Fetal Outcomes: An Updated Systematic Review and Meta-Analysis. Frontiers in neurology 9:91. doi:10.3389/fneur.2018.00091
6. Pien GW, Pack AI, Jackson N, Maislin G, Macones GA, Schwab RJ (2014) Risk factors for sleep-disordered breathing in pregnancy. Thorax 69 (4):371-377. doi:10.1136/thoraxjnl-2012-202718
7. Facco FL, Ouyang DW, Zee PC, Grobman WA (2014) Sleep disordered breathing in a high-risk cohort prevalence and severity across pregnancy. American journal of perinatology 31 (10):899-904. doi:10.1055/s-0033-1363768
8. Miyagawa S, Emori Y, Kawano A, Sakurai S, Tanigawa T (2011) Relationship between sleep-disordered breathing and perinatal outcome in pregnant women. J Jpn Acad Midwif 25 (1):5-12
9. Watanabe M, Shinohara H, Kodama H (2015) Impact of overnight oximetry findings on cardiac autonomic modulation in women during second trimester of uncomplicated pregnancy. J Obstet Gynaecol Res 41 (5):689-696. doi:10.1111/jog.12634
10. Wilson DL, Barnes M, Ellett L, Permezel M, Jackson M, Crowe SF (2011) Decreased sleep efficiency, increased wake after sleep onset and increased cortical arousals in late pregnancy. The Australian & New Zealand journal of obstetrics & gynaecology 51 (1):38-46. doi:10.1111/j.1479-828X.2010.01252.x
11. Hertz G, Fast A, Feinsilver SH, Albertario CL, Schulman H, Fein AM (1992) Sleep in normal late pregnancy. Sleep 15 (3):246-251. doi:10.1093/sleep/15.3.246
12. Hashmi AM, Bhatia SK, Bhatia SK, Khawaja IS (2016) Insomnia during pregnancy: Diagnosis and Rational Interventions. Pak J Med Sci 32 (4):1030-1037. doi:10.12669/pjms.324.10421
13. Sharma SK, Nehra A, Sinha S, Soneja M, Sunesh K, Sreenivas V, Vedita D (2016) Sleep disorders in pregnancy and their association with pregnancy outcomes: a prospective observational study. Sleep Breath 20 (1):87-93. doi:10.1007/s11325-015-1188-9
14. Chen SJ, Shi L, Bao YP, Sun YK, Lin X, Que JY, Vitiello MV, Zhou YX, Wang YQ, Lu L (2018) Prevalence of restless legs syndrome during pregnancy: A systematic review and meta-analysis. Sleep medicine reviews 40:43-54. doi:10.1016/j.smrv.2017.10.003
15. Tsai SY, Lee PL, Lin JW, Lee CN (2017) Persistent and new-onset daytime sleepiness in pregnant women: A prospective observational cohort study. Int J Nurs Stud 66:1-6. doi:10.1016/j.ijnurstu.2016.11.003
16. Doi Y, Minowa M, Uchiyama M, Okawa M, Kim K, Shibui K, Kamei Y (2000) Psychometric assessment of subjective sleep quality using the Japanese version of the Pittsburgh Sleep Quality Index (PSQI-J) in psychiatric disordered and control subjects. Psychiatry Res 97 (2-3):165-172
17. Buysse DJ, Reynolds CF, 3rd, Monk TH, Berman SR, Kupfer DJ (1989) The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res 28 (2):193-213.

doi:0165-1781(89)90047-4 [pii]

18. Chiu HY, Chang LY, Hsieh YJ, Tsai PS (2016) A meta-analysis of diagnostic accuracy of three screening tools for insomnia. J Psychosom Res 87:85-92. doi:10.1016/j.jpsychores.2016.06.010
19. Bastien CH, Vallieres A, Morin CM (2001) Validation of the Insomnia Severity Index as an outcome measure for insomnia research. Sleep Med 2 (4):297-307
20. Takegami M, Suzukamo Y, Wakita T, Noguchi H, Chin K, Kadotani H, Inoue Y, Oka Y, Nakamura T, Green J, Johns MW, Fukuhara S (2009) Development of a Japanese version of the Epworth Sleepiness Scale (JESS) based on item response theory. Sleep Med 10 (5):556-565. doi:S1389-9457(08)00184-6 [pii]10.1016/j.sleep.2008.04.015
21. Johns M, Hocking B (1997) Daytime sleepiness and sleep habits of Australian workers. Sleep 20 (10):844-849. doi:10.1093/sleep/20.10.844
22. Allen RP, Burchell BJ, MacDonald B, Hening WA, Earley CJ (2009) Validation of the self-completed Cambridge-Hopkins questionnaire (CH-RLSq) for ascertainment of restless legs syndrome (RLS) in a population survey. Sleep Med 10 (10):1097-1100. doi:10.1016/j.sleep.2008.10.007
23. Kanda Y (2013) Investigation of the freely available easy-to-use software 'EZR' for medical statistics. Bone marrow transplantation 48 (3):452-458. doi:10.1038/bmt.2012.244
24. Amador-Licona N, Guizar-Mendoza JM (2012) Daytime sleepiness and quality of life: are they associated in obese pregnant women? Archives of gynecology and obstetrics 285 (1):105-109. doi:10.1007/s00404-011-1879-9
25. Polo-Kantola P, Aukia L, Karlsson H, Karlsson L, Paavonen EJ (2017) Sleep quality during pregnancy: associations with depressive and anxiety symptoms. Acta Obstet Gynecol Scand 96 (2):198-206. doi:10.1111/aogs.13056
26. Dunietz GL, Lisabeth LD, Shedden K, Shamim-Uzzaman QA, Bullough AS, Chames MC, Bowden MF, O'Brien LM (2017) Restless Legs Syndrome and Sleep-Wake Disturbances in Pregnancy. Journal of clinical sleep medicine : JCSM : official publication of the American Academy of Sleep Medicine 13 (7):863-870. doi:10.5664/jcsm.6654
27. Picchietti DL, Hensley JG, Bainbridge JL, Lee KA, Manconi M, McGregor JA, Silver RM, Trenkwalder C, Walters AS (2015) Consensus clinical practice guidelines for the diagnosis and treatment of restless legs syndrome/Willis-Ekbom disease during pregnancy and lactation. Sleep medicine reviews 22:64-77. doi:10.1016/j.smrv.2014.10.009
28. Hatanaka A, Eto H, Kato C, Yamaguchi Y, Sakamoto H, Kondo H (2017) Prevalence and clinical features of restless legs syndrome among Japanese pregnant women without gestational complications. Sleep and Biological Rhythms 15 (2):183-186. doi:10.1007/s41105-016-0086-2

Tables

Table 1. Comparison of body weight and sleep problems during the second and third trimester of pregnancy (N = 88)

	Second trimester	Third trimester	p value
Body mass index kg/m2, median (IQR)	22.6 (21.3–24.3)	24.2 (22.5–26.3)	< 0.001
Weight gain[1)] kg, median (IQR	6.4 (4.8–8.1)	10.2 (8.5–13.3)	< 0.001
Rate of weight gain* %, median (IQR)	11.5 (7.7–13.9)	19.0 (14.9–22.6)	< 0.001
PSQI			
C1 sleep quality ≥ 2, n (%)	25 (28.4)	51 (58.0)	< 0.001
C2 sleep latency ≥ 2[2)], n (%)	26 (29.5)	43 (48.9)	0.003
C3 sleep duration ≥ 2[3)], n (%)	23 (26.1)	30 (34.1)	< 0.001
C4 sleep efficiency ≥ 2[4)], n (%)	5 (5.7)	12 (13.6)	0.10
C5 sleep disturbance ≥ 2, n (%)	23 (26.1)	49 (55.7)	< 0.001
C6 hypnotic use ≥ 2[5)], n (%)	0 (0.0)	1 (1.1)	< 0.001
C7 daytime dysfunction ≥ 2, n (%)	8 (9.1)	8 (9.1)	0.64
Global score ≥ 6, n (%)	30 (34.1)	55 (62.5)	< 0.001
ISI			
Mild to severe DIS, n (%)	36 (40.9)	71 (80.7)	< 0.001
Moderate to severe DIS, n (%)	16 (18.2)	37 (42.0)	< 0.001
Mild to severe DMS, n (%)	52 (59.1)	67 (76.1)	0.007
Moderate to severe DMS, n (%)	23 (26.1)	40 (45.5)	0.005
Mild to severe DIMS, n (%)	57 (64.8)	80 (90.9)	< 0.001
Moderate to severe DIMS, n (%)	28 (31.8)	49 (55.7)	< 0.001
Global score ≥ 10, n (%)	18 (20.5)	47 (53.4)	<0.001
ESS ≥ 10, n (%)	46 (52.3)	47 (53.4)	1
ESS ≥ 11, n (%)	39 (44.3)	43 (48.9)	0.48
RLS/WED, n (%)	2 (2.3)	8 (9.1)	0.04
3% ODI ≥ 5/h, n (%)	16 (18.2)	26 (29.5)	0.08
5 ≤ 3% ODI < 15/h, n (%)	16 (18.2)	25 (28.4)	
3% ODI ≥ 15/h, n (%)	0 (0.0)	1 (1.1)	

1) From pre-pregnancy. 2) Sleep latency ≥31 min and the presence of difficulty initiating sleep. 3) Total sleep time <6 hours. 4) Sleep Efficiency <85%. 5) More than one time. DIS, difficulty initiating sleep; DISM, difficulty initiating and/or maintaining sleep; DMS, difficulty maintaining sleep; ESS, Epworth Sleepiness Scale; ISI, Insomnia Severity Index; IQR, interquartile range; ODI, oxygen desaturation index; PSQI, Pittsburgh Sleep Quality Index global score; RLS/WED, restless legs syndrome/Willis–Ekbom disease.

Table 2. Comparison of clinical characteristics between 3% ODI < 5/h group and 3% ODI ≥ 5/h group at the third trimester of pregnancy

	3% ODI < 5/h	3% ODI ≥ 5/h	p value
N	62	26	
Age years, mean ± SD	31.4 ± 4.6	29.7 ± 4.8	0.11
Primipara, n (%)	28 (45.9)	12 (46.2)	1
Body mass index			
Pre-pregnancy kg/m^2, median (IQR)	20.0 (18.6–21.6)	21.5 (20.2–22.8)	0.03
Second trimester kg/m^2, median (IQR)	22.2 (20.9–23.9)	23.8 (22.7–25.3)	0.01
Third trimester kg/m^2, median (IQR)	23.6 (22.4–25.5)	26.3 (24.2–27.4)	0.004
Weight gain			
From pre-pregnancy kg, median (IQR)	10.0 (8.0–13.1)	10.8 (9.5–13.6)	0.22
From second trimester kg, median (IQR)	3.9 (2.5–4.4)	4.1 (3.1–5.0)	0.08
Rate of weight gain			
From pre-pregnancy %, median (IQR)	18.1 (13.8–23.4)	20.1 (18.5–21.7)	0.12
From second trimester %, median (IQR)	6.6 (4.5–8.5)	6.8(5.8–7.9)	0.27

IQR, interquartile range; ODI, oxygen desaturation index; SD, standard deviation.

Table 3. Comparison of sleep problems between 3% ODI < 5/h group and 3% ODI ≥ 5/h group at the third trimester of pregnancy

	3% ODI < 5/h	3% ODI ≥ 5/h	p value
N	62	26	
PSQI			
C1 sleep quality ≥ 2, n (%)	31 (50.0)	20 (76.9)	0.03
C2 sleep latency ≥ 2[1], n (%)	28 (45.2)	15 (57.7)	0.35
C3 sleep duration ≥ 2[2], n (%)	19 (30.6)	11 (42.3)	0.33
C4 sleep efficiency ≥ 2[3], n (%)	6 (9.7)	6 (23.1)	0.17
C5 sleep disturbance ≥ 2, n (%)	29 (46.8)	20 (76.9)	0.01
C6 hypnotic use ≥ 2[4], n (%)	0 (0.0)	1 (3.8)	0.30
C7 daytime dysfunction ≥ 2, n (%)	6 (9.7)	2 (7.7)	1
Global score, n (%)	35 (56.5)	20 (76.9)	0.09
ISI			
Mild to severe DIS, n (%)	48 (77.4)	23 (88.5)	0.38
Moderate to severe DIS, n (%)	23 (37.1)	14 (53.8)	0.16
Mild to severe DMS, n (%)	46 (74.2)	21 (80.8)	0.59
Moderate to severe DMS, n (%)	21 (33.9)	19 (73.1)	0.001
Mild to severe DIMS, n (%)	56 (90.3)	24 (92.3)	1
Moderate to severe DIMS, n (%)	29 (46.8)	20 (76.9)	0.01
Global score ≥ 10, n (%)	32 (51.6)	15 (57.7)	0.65
ESS ≥ 11, n (%)	28 (45.2)	15 (57.7)	0.35
RLS/WED, n (%)	6 (9.7)	2 (7.7)	1

1) Sleep latency ≥31 min and the presence of difficulty initiating sleep. 2) Total sleep time <6 hours. 3) Sleep Efficiency <85%. 4) More than one time. DIS, difficulty initiating sleep; DISM, difficulty initiating and/or maintaining sleep; DMS, difficulty maintaining sleep; ESS, Epworth Sleepiness Scale; ISI, Insomnia Severity Index; ODI, oxygen desaturation index; PSQI, Pittsburgh Sleep Quality Index global score; RLS/WED, restless legs syndrome/Willis–Ekbom disease.

Table 4 Comparison of sleep problems between ESS < 11 group and ESS ≥ 11 group at the third trimester of pregnancy

	ESS < 11	ESS ≥ 11	p value
N	45	43	
PSQI			
C1 sleep quality ≥ 2, n (%)	21 (46.7)	30 (69.8)	0.03
C2 sleep latency ≥ 2[1)], n (%)	17 (37.8)	26 (60.5)	0.05
C3 sleep duration ≥ 2[2)], n (%)	9 (20.0)	21 (48.8)	0.007
C4 sleep efficiency ≥ 2[3)], n (%)	4 (8.9)	8 (18.6)	0.22
C5 sleep disturbance ≥ 2, n (%)	18 (40.0)	31 (72.1)	0.003
C6 hypnotic use ≥ 2[4)], n (%)	0 (0.0)	1 (2.3)	0.49
C7 daytime dysfunction ≥ 2, n (%)	1 (2.2)	7 (16.3)	0.03
Global score, n (%)	21 (46.7)	34 (79.1)	0.002
ISI			
Mild to severe DIS, n (%)	32 (71.1)	39 (90.7)	0.03
Moderate to severe DIS, n (%)	13 (28.9)	24 (55.8)	0.02
Mild to severe DMS, n (%)	29 (64.4)	38 (88.4)	0.01
Moderate to severe DMS, n (%)	13 (28.9)	27 (62.8)	0.003
Mild to severe DIMS, n (%)	39 (86.7)	41 (95.3)	0.27
Moderate to severe DIMS, n (%)	16 (35.6)	33 (76.7)	<0.001
Global score ≥ 10, n (%)	4 (8.9)	43 (100.0)	<0.001
RLS/WED, n (%)	2 (4.4)	6 (14.0)	0.15
3% ODI ≥ 5, n (%)	11 (24.4)	15 (34.9)	0.35

[1)] Sleep latency ≥31 min and the presence of difficulty initiating sleep. [2)] Total sleep time <6 hours. [3)] Sleep Efficiency <85%. [4)] More than one time. DIS, difficulty initiating sleep; DISM, difficulty initiating and/or maintaining sleep; DMS, difficulty maintaining sleep; ESS, Epworth Sleepiness Scale; ISI, Insomnia Severity Index; ODI, oxygen desaturation index; PSQI, Pittsburgh Sleep Quality Index global score; RLS/WED, restless legs syndrome/Willis–Ekbom disease.

Table 5. Logistic regression analysis for daytime sleepiness at the third trimester of pregnancy

	Unadjusted odds ratio (95% confidence interval)	Adjusted odds ratio† (95% confidence interval)
Total sleep time		
≥ 6 hours (reference)	1	1
< 6 hours	3.82 (1.49–9.81)	3.25 (1.16–9.10)
Difficulty maintain sleep		
None to mild (reference)	1	1
Moderate to severe	4.15 (1.70–10.10)	4.74 (1.60–14.00)
3% Oxygen desaturation index		
< 5/h (reference)	1	1
≥ 5/h	1.66 (0.66–4.18)	0.90 (0.28–2.89)

†Adjusted for age and body mass index.

Table 6. Sleep disordered breathing at the third trimester of pregnancy and delivery outcomes

	3% ODI < 5/h	3% ODI ≥ 5/h	p value
N	61*	26	
Gestational age months, median (IQR)	40.0 (39.6–40.3)	39.7 (39.2–40.2)	0.48
Duration of birth hours, median (IQR)	5.9 (4.0–10.3)	6.1 (4.0–9.1)	0.93
Type of birth			
Vaginal delivery, n (%)	57 (93.4)	22 (84.6)	0.35
Cesarean section, n (%)	4 (6.6)	4 (15.4)	
Labor induction, n (%)	8 (13.1)	3 (11.5)	0.84
Episiotomy, n (%)	0	1 (3.8)	0.13
Perineal laceration, n (%)	40 (65.6)	14 (53.8)	0.31
Volume of blood loss ml, median (IQR)	580 (370–800)	735 (460–910)	0.27
Use of oxytocic, n (%)	37 (60.7)	16 (61.5)	0.94
Infant’s condition			
Alive, n (%)	60 (96.8)	26 (100.0)	1
Stillbirth, n (%)	1 (1.6)	0	
Weight of infant g, median (IQR)	3176 (2922–3404)	3145 (2914–3445)	0.51
Height of infant cm, median (IQR)	49.0 (48.0–50.2)	49.0 (47.5–49.5)	0.51
Apgar score			
1 min ≤ 6, n (%)	1(1.6)	2 (7.7)	0.15
5 min ≤ 6, n (%)	1(1.6)	1 (3.8)	0.52
Umbilical cord blood			

pH, median (IQR)	7.32 (7.28–7.37)	7.36 (7.32–7.41)	0.06
< 7.2, n (%)	3 (5.0)	1 (3.8)	1
≥ 7.2, n (%)	57 (95.0)	25 (96.2)	
$PaCO_2$ mmHg, median (IQR)	34.8 (26.8–41.3)	29.5 (22.8–32.8)	0.15
< 32 mmHg, n (%)	24 (40.0)	16 (61.5)	0.14
32-68 mmHg, n (%)	35 (58.3)	10 (38.5)	
> 68 mmHg, n (%)	1 (1.7)	0	

*Uncertain one woman. IQR, interquartile range; ODI, oxygen desaturation index.

Figures

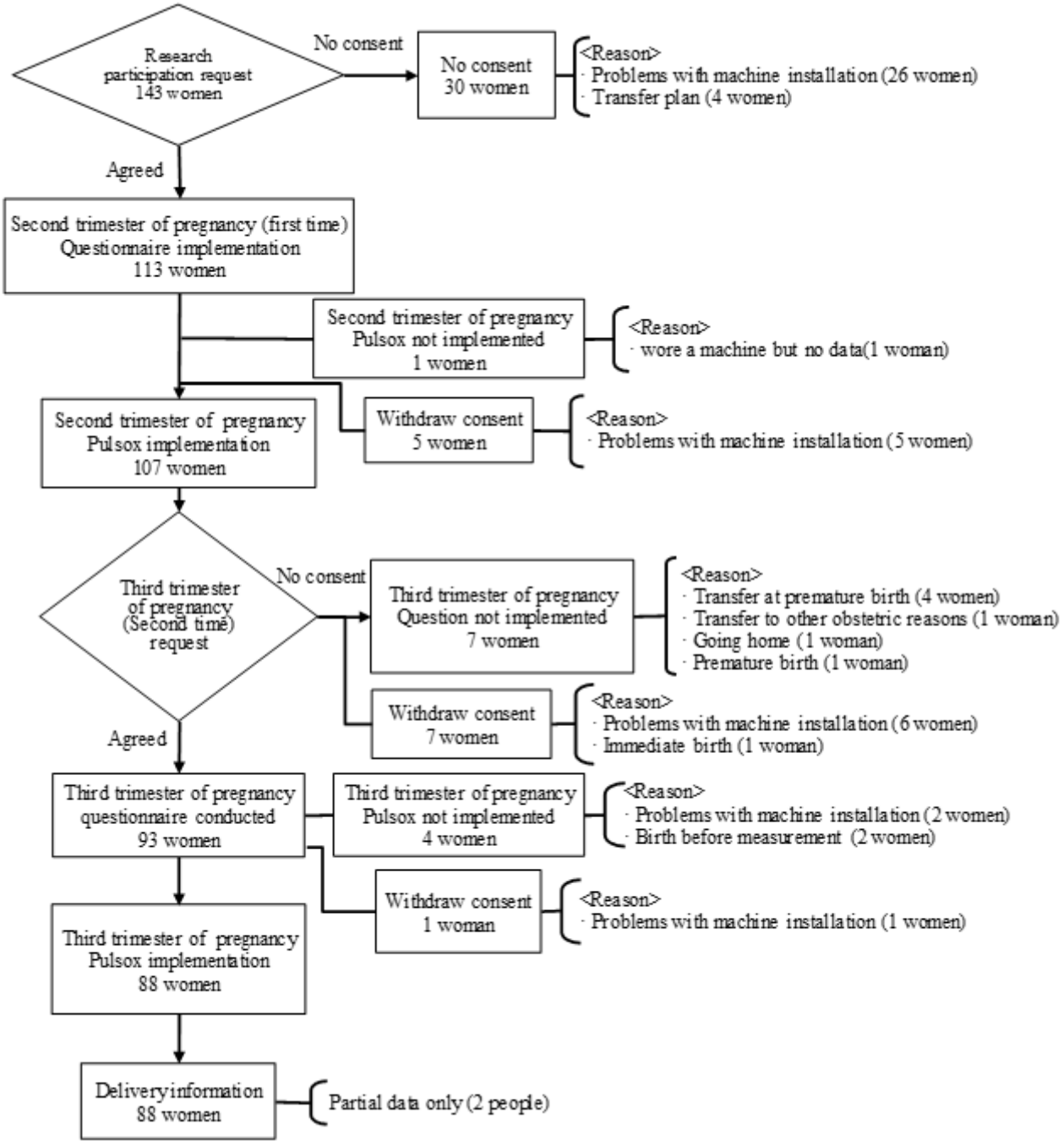

Figure 1

Data collection algorithm

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Supplementarymaterial.pdf

- data.csv