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Poor Maternal Sleep Health Adversely Affects Neonatal and Pregnancy Outcomes: An Important Ignored Health Issue in Prenatal Care

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ABSTRACT

Background & Objective: Pregnancy is an exceptionally delicate time in the lives of most women. Sleep disorders during pregnancy can substantially impact a healthy pregnancy. This study investigated the relationship between sleep quality during pregnancy and adverse maternal and fetal pregnancy outcomes.

Materials & Methods: This was a prospective cohort study on 500 pregnant women referred to the Perinatology clinic. The Pittsburgh Sleep Quality Index questionnaire was used to evaluate sleep quality, and demographic data were collected from the case files of routine prenatal checkups. The study participants were followed until delivery. The association between sleep quality and postpartum complications, such as preterm birth, infant Apgar score, and (Neonatal Intensive Care Unit) NICU admission, was investigated.

Results: This study included 500 pregnant women with a mean age of 31.12 ± 5.84 years. The number of pregnancies ranged from one to seven, with a mean of 2.55±1.30. Of the infants, 12% of infants were born prematurely and 27.8% required NICU admission. Poor sleep quality was found to be associated with preterm delivery (OR: 1.27, P = 0.039) and preeclampsia (OR: 0.543, P = 0.004). Women who experienced preeclampsia during pregnancy (P = 0.01), delivered via cesarean section (P = 0.009), and had infants weighing more than 2500 g (P = 0.07) exhibited significantly poorer sleep quality.

Conclusion: We found that poor sleep quality was associated with preterm birth, cesarean section delivery, maternal preeclampsia risk, and the 5-minute Apgar score. Considering the impact of a mother's sleep quality on pregnancy outcomes, assessing mothers' sleep health appears essential in prenatal care.

Keywords: Sleep Quality, Pregnancy, Pregnancy Outcome, PSQI

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Introduction

Sleep is a vital biobehavioral mechanism for human health and the proper functioning of the human body. Sleep stimulates the growth and repair of various body systems, such as the immune, nervous, and musculoskeletal systems **(1, 2)**. Sleep disorders are currently one of the most important health issues **(3)**.

Pregnancy is a critical period in a woman's life. During pregnancy, sleep problems are prevalent. Physiological, metabolic, hormonal, and physical changes during pregnancy are often associated with sleep difficulties. Approximately one-third of pregnant women report various sleep problems **(4)**. According to research, 78% of pregnant women who have trouble sleeping do not have a history of sleep problems before pregnancy **(5, 6)**. Insomnia, sleep latency, poor sleep quality, poor sleep continuity, sleep fragmentation, short sleep duration, restless leg syndrome (RLS), and nocturia are some of the sleep problems during pregnancy **(7-9)**. The most common subjective complaint during pregnancy is the poor quality of sleep, which can manifest in various ways, including short sleep duration, fragmentation, latency, and poor sleep continuity **(10, 11)**. During pregnancy, sleep quality often declines in the first trimester and continues to deteriorate as gestational age increases **(12)**. According to prior research, the changes in the desire for sleep and the length of sleep during pregnancy are caused by mental, physical, and hormonal changes that occur throughout pregnancy **(13, 14)**. In 2010, Naud, Ouellet **(15)** investigated the sleep quality of pregnant women using the Pittsburgh

Sleep Quality Index (PSQI). They discovered that sleep quality is poorer in the first trimester than in the third **(15)**.

Sleep disorders during pregnancy can have negative consequences for both mother and baby. The risk of obesity, hypertension, gestational diabetes, eclampsia, and preeclampsia is higher in mothers with sleep disorders **(16-18)**. Sleep disorders and poor sleep quality, particularly in the third trimester, increase the likelihood of stillbirth, decreased fetal movements, prolonged labor, cesarean section, preterm labor, and fetal intrauterine growth restriction (IUGR). It is also associated with low Apgar scores and infant mortality **(19-22)**. Although sleeping problems during pregnancy are common and can be hazardous to both mother and child, they are rarely acknowledged, and many pregnant women lack the information required to deal with these changes. This study investigates the relationship between sleep quality in pregnancy and the negative maternal/fetal consequences.

Methods

2.1. Study design and setting

This prospective cohort study included 500 pregnant women referred to the prenatal outpatient clinic of Imam Hospital in Tehran, Iran, from 2020 to 2021. The study protocol was approved by the ethics committee of the Tehran University of Medical Sciences (IR. TUMS.1398.090). We used the census sampling method to include pregnant women in their second or third trimester of pregnancy who were referred for routine pregnancy follow-up.

2.2. Outcomes and measurements

Demographic (age) and pregnancy characteristics (gravida, gestational age, number of hospitalization days, Body Mass Index (BMI)) were collected using a self-report questionnaire and patients' files. We used the validated Persian version of the Pittsburgh Sleep Quality Index (PSQI) to assess the sleep quality of participants in the past month (23). The Pittsburgh Questionnaire consists of 19 questions. This questionnaire evaluates sleep in seven categories, including subjective sleep quality, sleep onset time, sleep length, sleep adequacy, sleep disturbance, using sleep medication, and daily dysfunction. Each category has a score between zero and three, with lower scores indicating better sleep quality. The total PSQI score, which ranges from zero to 21, is derived by adding the seven component scores. A score greater than five indicates poor quality of sleep (24). Here, we reported four important PSQI components, component one which indicates self-reported sleep quality, component three which indicates self-reported night sleep duration, component five which investigates different sleep disorders, component six which indicates sleep medication use, and component seven which indicates the daytime sleepiness.

We followed the participants until delivery. During pregnancy, outcomes included maternal blood pressure, maternal hospitalization, preeclampsia, and intrauterine growth restriction (IUGR). Delivery and post-pregnancy outcomes included the method of delivery, preterm delivery (earlier than 37 weeks), abortion, neonatal Apgar score, birth weight, infant resuscitation, NICU admission, and stillbirth.

2.3. Statistical analysis

All statistical analyses were conducted using IBM SPSS Statistics for Windows, Version 25.0 (IBM, USA). We used Mean ± standard deviation to report quantitative variables, and frequency to report qualitative variables. Chi-square analysis was used to compare qualitative variables and independent t-test was used to compare quantitative variables. Finally, regression analysis was performed to study the relationship between pregnancy outcomes and PSQI components. $p < .05$ were considered statistically significant.

Results

We included 500 pregnant women. The mean age of the study population was 31.12 $\pm$ 5.84 years old, ranging from 17 to 50. The range for the number of pregnancies was one to seven, with a mean of 2.55$\pm$1.30. The Average mother's gravida and BMI were 2.55$\pm$1.30 and 27.85$\pm$5.47, respectively (Table 1).

The prevalence of pregnancies with IUGR was 9.2%. Twelve percent of infants were preterm and 27.8% needed to be hospitalized in the NICU.

We found a statistically significant relationship between objective sleep quality (component 1) and the type of delivery (p:0.009), stillbirth (P:0.002), birth weight (P:0.07), and pre-eclampsia (P:0.01), Table 2. Mothers who gave birth vaginally to infants weighing less than 2500 grams had lower scores, indicating better sleep quality. Moreover, we indicated that, the worse the quality of sleep (slightly higher component 1), the greater the likelihood of preeclampsia.

Table 1. Participants' characteristics and PSQI components

Maternal		Fatal/Neonatal		Delivery	
Age	31.1±5.8	IUGR	46 (9.2%)	Abortion	28 (5.6%)
Gravida	2.5±1.3	Fatal death	51 (10.3%)	Induction	98 (19.7%)
Gestational age	35.5±6.3	Resuscitation	92 (18.4%)	PROM	46 (9.2%)
BMI	27.8±5.5	1st minute Apgar	6.90±2.85	Type	
Smoker	17 (3.4%)	5-minute Apgar	8.26±2.98	C/S	370 (74%)
Maternal SBP	113.1±12.4	Gender, male	264 (54.2%)	NVD	130 (26%)
Maternal DBP	72.0±31.6	Birth Weight		**PSQI components**	
Preeclampsia	85 (17%)	<2500	114 (23%)	Sleep disorders	9.04±4.27, (0-20)
Smoker	17 (3.4%)	>2500	382 (77%)	Use of sleeping medications	0.02±0.23, (0-3)
Hospitalization days	0.9±3.7			Daily dysfunction	2.19±2.14, (0-6)
Accreta	27 (5.4%)			Coughing or snoring loudly	0.42±0.99, (0-3)

PSQI: Pittsburgh Sleep Quality Index; BMI: body mass index; SBP: systolic blood pressure; DBP: diastolic blood pressure; IUGR: intrauterine growth restriction; PROM: premature rupture of membranes; C/S: cesarean section; NVD: normal vaginal delivery.

Table 2. The relationship between PSQI components and pregnancy outcomes

		Self-reported Sleep quality	P	Sleep disorders	P	Use of sleeping medications	P	Daily dysfunction	P	Cough or loud snoring	P
Delivery	C/S	2.51 (0.72)	0.009	9.44 (4.24)	0.0001	0.02 (0.26)	0.41	2.21 (2.18)	0.66	0.47 (1.03)	0.03
	NVD	2.32 (0.71)		7.89 (4.16)		0.00 (0.08)		2.12 (1.98)		0.28 (0.84)	
Birth weight	<2500	2.35 (0.73)	0.07	8.68 (4.48)	0.26	0.03 (0.29)	0.49	2.28 (2.11)	0.61	0.45 (1.04)	0.76
	>2500	2.5 (0.73)		9.20 (4.19)		0.01 (0.21)		2.17 (2.14)		0.42 (0.97)	
Stillbirth	Yes	2.2 (0.699)	0.002	7.9 (4.39)	0.04	0.01 (0.13)	0.88	2.38 (1.99)	0.47	0.47 (1.05)	0.71
	No	2.5 (0.73)		9.18 (4.24)		0.02 (0.24)		2.17 (2.15)		0.42 (0.98)	
Fatal death	Yes	2.37 (0.74)	0.34	8.30 (4.42)	0.18	0.05 (0.42)	0.43	2.01 (1.73)	0.45	0.58 (1.15)	0.30
	No	2.47 (0.72)		9.14 (4.25)		0.01 (0.14)		2.21 (2.17)		0.41 (0.97)	
Resuscitation	Yes	2.52 (0.74)	0.42	9.98 (3.98)	0.03	0.06 (0.44)	0.26	2.09 (2.18)	0.63	0.66 (1.18)	0.03
	No	2.45 (0.72)		8.82 (4.31)		0.01 (0.14)		2.21 (2.12)		0.37 (0.93)	
NICU admission	Yes	2.52 (0.74)	0.26	9.74 (4.10)	0.02	0.04 (0.35)	0.35	2.24 (2.21)	0.74	0.61 (1.13)	0.02
	No	2.44 (0.72)		8.76 (4.31)		0.01 (0.15)		2.17 (2.11)		0.35 (0.91)	
PROM	Yes	2.43 (0.71)	0.77	8.78 (4.64)	0.68	0.00 (0.00)	0.50	2.11 (0.31)	0.31	0.80 (0.11)	0.23
	No	2.46 (0.73)		9.05 (4.23)		0.24 (0.01)		2.14 (0.10)		1.00 (0.04)	

		Self-reported Sleep quality	P	Sleep disorders	P	Use of sleeping medications	P	Daily dysfunction	P	Cough or loud snoring	P
Preterm	Yes	2.41 (0.71)	0.59	10.01 (4.51)	0.06	0.00 (0.00)	0.43	2.40 (2.18)	0.42	0.51 (1.11)	0.46
	No	2.47 (0.73)		8.89 (4.22)		0.02 (0.24)		2.16 (2.13)		0.41 (0.97)	
Preeclampsia	Yes	2.64 (0.75)	0.01	9.23 (4.43)	0.64	0.03 (0.32)	0.56	1.80 (2.05)	0.06	0.76 (1.25)	0.006
	No	2.42 (0.72)		9.00 (4.24)		0.01 (0.21)		2.27 (2.14)		0.35 (0.91)	
IUGR	Yes	2.63 (0.79)	0.11	9.72 (4.57)	0.26	0.00 (0.00)	0.50	1.97 (0.02)	0.47	0.86 (1.32)	0.02
	No	2.44 (0.72)		8.97 (4.24)		0.02 (0.24)		2.21 (2.14)		0.38 (0.93)	

C/S: cesarean section; NVD: normal vaginal delivery; NICU: neonatal intensive care unit; IUGR: intrauterine growth restriction; PROM: premature rupture of membranes.

The pregnant women with preeclampsia significantly reported more coughing or loud snoring (p:0.006). Higher rates of coughing or snoring loudly were significantly associated with higher rates of cesarean delivery (P:0.03), resuscitation (0.03), NICU admission (0.02), and IUGR (0.02).

Daily dysfunction was only associated with preeclampsia, and it was common in pregnant women with preeclampsia (P:0.06, Table 2). There were statistically significant correlations between PSQI components and quantitative variables like age, gestational age, 5th minute Apgar, etc. However, all have a correlation coefficient of less than 0.3, indicating a very weak correlation, Table 3.

Table 3. The relationship between PSQI components and quantitative variables

	Pearson coefficient	Age	N[1]	GA	BMI	Hosp. Days[2]	1st min Apgar	5th min Apgar	SBP	DBP
Mental sleep quality	CC	0.128	0.055	0.143	0.050	- 0.063	0.100	0.118	0.039	-0.042
	P value	0.004	0.22	0.001	0.27	0.16	0.03	0.008	0.41	0.38
Sleep disorders	CC	0.050	- 0.015	0.070	0.093	- 0.047	0.067	0.090	0.094	-0.017
	P value	0.27	0.74	0.12	0.04	0.29	0.14	0.04	0.05	0.72
Use of sleeping medications	CC	0.052	0.100	- 0.024	0.050	- 0.025	- 0.024	- 0.031	0.052	-0.003
	P value	0.25	0.03	0.59	0.27	0.58	0.59	0.48	0.28	0.96
Daily dysfunction	CC	0.054	0.016	- 0.063	- 0.005	- 0.034	- 0.012	- 0.022	- 0.021	-0.009
	P value	0.23	0.72	0.16	0.92	0.45	0.80	0.62	0.66	0.85
Coughing and loud snoring	CC	0.123	0.041	0.010	0.229	0.065	- 0.030	- 0.013	0.146	0.015
	P value	0.006	0.36	0.83	0.00	0.15	0.51	0.77	0.002	0.75

1. **Number of pregnancies**
2. **Hospitalization days;**

SBP: systolic blood pressure; DBP: diastolic blood pressure

Regarding preterm labor, IUGR, NICU admission and preeclampsia as outcome, multiple logistic regression revealed that preterm labor was significantly associated with sleep quality (P: 0.039, OR:1.27) and sleep disorders (p:0.028, OR: 0.90), and preeclampsia was associated with sleep quality (P:0.004, OR:0.543) and daily dysfunction (P:0.021, OR:1.148), Table 4.

Table 4. The Multiple regressions showing the relationship between pregnancy outcomes and PSQI questionnaire components

Outcome	Preterm labor			IUGR			NICU Admission			Preeclampsia			5th minute Apgar		
PSQI components	B	P	OR	B	P	OR	B	P	OR	B	P	OR	B	P	R^2
Sleep quality	-0.474	0.039	1.270	-0.28	0.252	0.756	-0.016	0.947	0.950	0.587	0.004	0.543	-0.030	0.237	
Sleep disorders	0.089	0.028	0.898	-0.039	0.371	1.011	0.000	0.996	0.960	-0.014	0.688	1.049	-0.057	0.047	0.772
Use of sleeping medications	-16.097	0.999	113210034	16.369	0.999	5233855	-0.015	0.983	0.673	0.393	0.379	.659	-0.012	0.583	
Daily dysfunction	0.031	0.678	1.033	0.105	0.202	1.071	-0.050	0.519	1.013	-0.159	0.021	1.148	0.022	0.371	

PSQI: Pittsburgh Sleep Quality Index; IUGR: Intrauterine Growth Restriction; NICU: Neonatal Intensive Care Unit

Discussion

This study of 500 pregnant women indicated that cesarean delivery, stillbirth, birth weight of >2500 grams, and preeclampsia were associated with poor self-reported sleep quality during pregnancy. Moreover, we found a relationship between sleep disturbances during pregnancy and cesarean delivery, preterm labor, neonatal resuscitation, and NICU admission.

The lower the mother's sleep quality, the lower the 5th-minute Apgar score of the infant. Moreover, the higher the sleep disturbances during pregnancy, the lower the 5th-minute Apgar score.

In agreement with our findings, a prospective observational study, performed in Indian pregnant women, showed that pregnant women who were persistently positive on modified Berlin questionnaire (MBQ) had increased odds for gestational hypertension and cesarean delivery **(25)**. Our findings indicated that the sleep quality of moms who delivered through the cesarean section was poorer. Consistent with our findings, previous studies indicated that moms with sleep disorders had a higher likelihood of cesarean delivery **(26-30)**. Nonetheless, there are studies that have identified no relationship between sleep quality and cesarean section birth **(31-33)**. Different methodologies might account for this discrepancy in results. In addition, numerous intermediate conditions need cesarean delivery, including breech presentation, umbilical cord, placenta previa, etc.

Du, Liu **(34)** reported that 34.14% of pregnant women had poor sleep quality during early pregnancy. History of stillbirth (OR = 2.45), induced abortion (OR = 1.26), general health-related quality of life (OR = 3.98), insufficient physical activity (OR = 1.18), smoking (OR = 1.59), and being vegetarian (OR = 2.18) were risk factors for poor sleep quality. Poor sleep quality during early pregnancy had increased the risk of Premature Rupture of Membranes (PROM) by 12% **(34)**. In contrast, we did not find an association between sleep quality and PROM, this could be due to little number of PROM cases in our study (about 10% of total sample), while they have more than 1400 (33%) PROM cases.

Pregnancy-related sleep disorders are common, and they can have serious effects on both the mother and the baby. Therefore, it seems crucial to provide these women with the necessary care they need **(35)**. There is growing evidence that identifying and treating prenatal sleep disorders may decrease adverse pregnancy outcomes and improve mother and fetal health. Nonpharmaceutical management approaches, such as sleep hygiene counseling and lifestyle modifications, are safe and effective treatment options. There are medications available. However, they are not recommended as first-line management **(20)**. Sleep disorders may appear anytime during pregnancy, some might have adverse effects on the mother or fetus. Identifying sleep disorders in pregnancy requires a

strong clinical suspicion, and their treatment should be assessed by a multidisciplinary team **(35)**.

Conclusion

Poor sleep quality is associated with cesarean delivery, preterm birth, NICU admission, neonatal resuscitation, intrauterine growth restriction, and preeclampsia in pregnant women. Training in sleep health and prenatal counseling might be useful in preventing these adverse outcomes.

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Author's Contributions

M.S. contributed to the conception and design of the work, data acquisition, and interpretation. M.SH. contributed to the conception and design of the work, data acquisition, analysis, interpretation of data, and the drafting of the manuscript. O.A. contributed to the conception and design of the work and data acquisition. S.E. contributed to the conception and design of the work, analysis, and interpretation of data E.H. contributed to the data analysis, interpretation of data, and manuscript drafting. A.B. contributed to the data interpretation, drafting, and substantively revising of the manuscript. A.N. contributed to the conception and design of the work, data acquisition and interpretation, and substantively revising the manuscript. All authors have read and approved the submitted version.

Conflict of Interest

The authors declare no conflict of interest.

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