Factors associated with poor sleep quality on the Pittsburgh Sleep Quality Index among hospitalized Ghanaian obstetrical patients

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BACKGROUND: Sleep is crucial for overall health, especially during the transformative pregnancy period. However, pregnancy is associated with numerous changes that disrupt sleep patterns and quality. A decrease in sleep quality during the antenatal period is associated with negative fetal and maternal outcomes, including perinatal depression and hypertensive disorders of pregnancy (leading cause of maternal mortality in Ghana). There are limited studies from the sub-Saharan African region, including Ghana, that explored this subject. This study therefore sought to investigate sleep quality and the associated factors among antepartum and postpartum in-patients at the largest tertiary referral center in Ghana.

OBJECTIVE: To determine the sleep quality and associated factors among obstetric inpatients in Ghana.

STUDY DESIGN: This was a facility-based, cross-sectional study of obstetrical patients who were admitted to the Korle Bu Teaching Hospital in Ghana between November 20 and December 22, 2023. Antenatal and postpartum in-patients who were aged 18 years and older were included. Those critically ill or younger than 18 years were excluded. Using a structured questionnaire, we collected data on the participants' sociodemographic characteristics, medical and obstetrical history, and current pregnancy or postpartum presentation and outcomes. We subsequently administered the validated Pittsburgh Sleep Quality Index tool to measure sleep quality, followed by pregnancy distress and perinatal depression screening using the Tilburg Pregnancy Distress Scale and the Patient Health Questionnaire-9, respectively. A logistic regression was used to evaluate factors associated with a positive Pittsburgh Sleep Quality Index screen, which indicated poor sleep quality.

RESULTS: A total of 416 (99%) of the 420 enrolled participants completed the Pittsburgh Sleep Quality Index questionnaire. Overall, 228 (54.3%) participants screened positive for poor sleep quality on the Pittsburgh Sleep Quality Index, including 88 (53.0%) of the 166 antepartum participants and 140 (56.0%) of the 250 postpartum participants. In the final, multivariable model, antepartum participants who had a shorter duration of admission were less likely to have a positive Pittsburgh Sleep Quality Index (marginal effect, −0.009), and postpartum participants who had an emergency cesarean delivery were more likely to have a positive Pittsburgh Sleep Quality Index (marginal effect, 0.166). In addition, a positive screen for pregnancy distress (Tilburg Pregnancy Distress Scale), and depression (Patient Health Questionnaire-9) were associated with poor sleep quality ($P<.01$).

CONCLUSION: Obstetrics participants with an increased duration of hospital stay, emergency cesarean delivery, and concomitant positive screen for depression or pregnancy distress were more likely to have poor sleep quality. These identified factors can help tailor sleep quality screening among obstetrics patients in Ghana to allow for timely, appropriate interventions to reduce the associated negative pregnancy outcomes.

Key words: associated factors, child health, low- and middle-income countries, maternal health, mental health, neonatal health, perinatal depression, pregnancy distress, public health, sleep quality

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Why was this study conducted?

This study aimed to investigate sleep quality and the associated factors among antepartum and postpartum in-patients at the largest tertiary referral center in Ghana.

Key findings

Obstetrics participants with an increased duration of hospital stay, cesarean delivery, and concomitant positive screen for depression or pregnancy distress were more likely to have poor sleep quality.

What does this add to what is known?

These identified factors can help tailor sleep quality screening among obstetrics patients in Ghana to allow for timely, appropriate interventions to reduce the associated negative pregnancy outcomes.

Introduction

Sleep is crucial for overall health, especially during the transformative period of pregnancy. However, pregnancy is associated with numerous changes that disrupt sleep patterns and quality.[1] One study revealed that 76% of pregnant people in the United States report poor sleep quality throughout their pregnancy.[2] A decrease in sleep quality during the antenatal period is associated with negative maternal and fetal outcomes. Studies indicate that decreased sleep quality can lead to maternal stress, depression with peripartum onset, hypertensive disorder of pregnancy, gestational diabetes, and an increased likelihood of having a cesarean delivery.[3,4] Negative fetal outcomes of decreased sleep quality include preterm birth, low birth weight, intrauterine fetal demise, and miscarriage.[4–6]

The sub-Saharan African region has the highest rates of maternal and neonatal mortality.[7,8] Despite the known connection between poor sleep and maternal and fetal outcomes, there are limited studies from sub-Saharan African countries, including Ghana, that investigated this crucial subject. The studies that have been conducted suggest similar findings as those in the United States. For example, studies in Ethiopia revealed that 42% to 59% of pregnant individuals experience poor sleep quality.[9–12] Factors associated with reduced sleep quality included high stress, anxiety, depression, unplanned pregnancy, third-trimester gestational age, older maternal age, and poor sleep hygiene.[9–11]

In Ghana, the sleep practice of snoring, evaluated during the postpartum period, was found to be associated with adverse obstetrical outcomes, such as hypertensive disorder of pregnancy.[13] In addition, disruptions in sleep patterns were associated with a significant risk for low birth weight and intrauterine fetal demise, both primary contributors to neonatal mortality.[13,14] No study has examined sleep quality among antepartum patients in Ghana. The implications of decreased sleep quality on maternal and fetal outcomes highlight the importance of screening for poor sleep to enable timely and appropriate therapeutic interventions. Therefore, the link between decreased sleep quality and pregnancy complications warrants further exploration in this region to identify high-risk populations and risk factors that can aid in the mitigation of adverse outcomes. Our research sought to examine the state of sleep quality and the associated factors among antepartum and postpartum obstetrical inpatients at the largest tertiary referral care center in urban Ghana.

Materials and methods

This sleep-focused study was conducted between November 20 and December 22, 2023, as part of an overarching, cross-sectional study of obstetrical patients who were admitted to the Korle Bu Teaching Hospital, the largest referral teaching hospital in urban Ghana, with approximately 9000 annual deliveries.[15] At the time of this study, most participants were admitted to open-ward rooms with closely spaced beds, limited privacy, and inconsistent lighting and noise levels. Eligibility included being aged 18 years or older, admission to the 275-bed maternity block for an antepartum or postpartum indication, alert and oriented, and able to speak 1 of the following languages: English, Twi, or Ga. Those enrolled provided consent to participate. Exclusion criteria included being critically ill or unstable. The Noguchi Memorial Institute for Medical Research at the University of Ghana institutional review board reviewed and approved all study materials and procedures (NMIMR SN:071/22-23). Patients were approached by a research assistant, and eligibility was assessed. After written informed consent was obtained, patients were enrolled in the study.[15]

First, the patients completed a survey regarding their sociodemographic parameters, medical and obstetrical history, the current pregnancy or postpartum presentation and care, and outcomes (Supplemental File 1 contains the full details described in our previously published work).[15] Then, all patients completed the validated Pittsburgh Sleep Quality Index (PSQI).[16] The PSQI is a self-administered questionnaire that is designed to measure sleep quality and enables differentiation between good and poor sleepers; it is also used to evaluate various sleep disturbances over the last month (Supplemental File 1). There are 19 questions for the participant to answer about their own sleep and 5 questions for the participants' bed partner/roommate to answer about the participant's sleep. The 19 questions vary from prompts to provide an occurrence value to multiple choice questions with 4 answer choices, for example, "not during the past month," "less than once a week," "once or twice a week," and "three or more times a week."[16] The PSQI was selected, because it has been validated in a sub-Saharan Africa setting and has been

successfully administered in previous research in Ghana.[17,18] During scale selection, the PSQI was perceived as understandable and translatable to Twi and Ga (primary languages spoken in Ghana) by our team of trained Ghanaian research assistants and was successfully piloted among the study population at the study site. All patients also completed the validated Tilburg Pregnancy Distress Scale (TPDS), which enables the identification of patients at risk for pregnancy distress, and the validated Patient Health Questionnaire-9 (PHQ-9), which enables the identification of patients at risk for depression.[15]

Several variables were re-coded for data analysis as detailed in our previously published work.[15] Per the standard guidelines for scoring the PSQI questionnaire, only the participant-perspective questions were scored.[16] These 19 questions were separated into 7 components. The components included, subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, use of sleep medication, and daytime dysfunction. The final score was obtained by scoring these 7 components from 0 to 3 and summing up the score for all of these. The final individual total PSQI score ranged from 0 to 21. A higher score indicates worsening sleep quality. Finally, the continuous score was categorized as (1) a positive screen that indicated poor sleep quality, defined as a total PSQI score of >5, and (2) a negative screen that indicated good sleep quality, defined as a total PSQI of ≤5.[16]

We analyzed the data using Stata, version 16 (StataCorp, College Station, TX). We used descriptive statistics to summarize the sociodemographic and clinical variables and to calculate the PSQI scores. Then, bivariate inferential statistics, including cross-tabulation with chi-square analysis and *t* tests, were used to evaluate associations with a positive PSQI screen. The TPDS and PHQ-9 scores were analyzed separately because these were from screening tools and may not necessarily correlate with diagnosis. A *P* value <.05 was considered statistically significant. Finally, the logistic regression models, separately for antepartum and postpartum patients, were run with a positive PSQI screen as the outcome variable. The logistic regression models' variables included those with a *P* value <.1 in the chi-square or *t* test analysis. In addition, the following variables were deemed conceptually important by the research team: age, relationship status, highest level of education completed, number of current gestation, and delivery outcome. We included odds ratios with their 95% confidence interval. Following the regression, we applied the "margins, dydx" command, which calculated and reported the marginal effects (or derivatives) of a specified variable on the predicted outcome. The marginal effect was interpreted as the change in the predicted outcome for a 1-unit change in the specified variable while holding the other variables constant.

Results

During the study period, 420 (95%) of the 440 eligible patients enrolled in our study. Our previous work with the same enrolled participants highlighted the specific demographics (Supplement 2).[15] A total of 416 (99%) participants completed the PSQI questionnaire. Overall, 228 (54.3%) participants screened positive for poor sleep quality with the PSQI, comprising 88 (53.0%) of the 166 antepartum participants and 140 (56.0%) of the 250 postpartum participants.

In the bivariate analysis for antepartum participants, no factors were associated with a positive PSQI (Tables 1 and 2). The bivariate analysis for postpartum participants demonstrated that a monthly income of <650 cedis (approximately 55 USD at the time of the study) (*P*=.008) and cesarean delivery being the mode of delivery (*P*=.009) were associated with a positive PSQI (Tables 1 and 2).

For antepartum participants, the logistic regression determined that those with a shorter duration of admission were 0.9% less likely to have a positive PSQI (marginal effect, −0.009) when controlling for age, relationship status, highest level of education completed, monthly household income, number of current gestation, and hypertensive diagnosis (Table 3). For postpartum participants, the logistic regression determined that patients who had an emergency cesarean delivery were 16.6% more likely to have a positive PSQI (marginal effect, 0.166) when controlling for age, relationship status, highest level of education completed, monthly household income, duration of admission, and delivery outcome (Table 3).

Participants with a positive screen for pregnancy distress on the Tilburg Pregnancy Distress Scale (*P*<.01) and those with depression with peripartum onset, as measured using the Patient Health Questionnaire-9 (*P*<.01), had an association with poor sleep quality (Table 4).

Discussion

This study examined sleep quality among obstetrical inpatients at the largest referral center in Ghana.

In our study, 228 (54.3%) participants had a positive PSQI screen, indicating that they reported poor sleep quality. In the multivariable model, antepartum participants who had a shorter duration of admission were less likely to have poor sleep quality, and postpartum participants who had an emergency cesarean delivery were more likely to have a positive PSQI. In addition, based on the bivariate analysis, a positive Tilburg Pregnancy Distress Scale and Patient Health Questionnaire-9 screen were associated with poor sleep quality.

Among the studies conducted in Ghana that used the PSQI (4 student populations, 1 diabetic patient population, and 1 postpartum patient population), poor sleep quality prevalence ranged from 40% to 92%, although most studies reported a prevalence that affected about half of their sample size.[18–23] This is similar to our study's findings of 54.3% of the participants that had a positive PSQI.[18–23]

Although studies have evaluated sleep quality using the PSQI among antepartum patients in some countries (Ethiopia, Peru, Poland, China, Turkey, Iran, and the United States), we did not identify any studies that evaluated the

TABLE 1
Comparison of sociodemographic factors in relation to a positive PSQI

Participant factor		Antepartum			Postpartum		
		Poor sleep quality n (%) (n=88)[a]	Good sleep quality n (%) (n=78)[a]	*P* value	Poor sleep quality n (%) (n=140)[a]	Good sleep quality n (%) (n=110)[a]	*P* value
Language	English	56 (63.6)	47 (60.3)	.836	79 (56.4)	49 (44.6)	.152
	Ga	3 (3.4)	3 (3.8)		5 (3.6)	4 (3.6)	
	Twi	29 (33.0)	28 (35.9)		55 (39.3)	57 (51.8)	
Age (y)	18–24	9 (10.2)	13 (16.7)	.191	20 (14.3)	21 (19.1)	.396
	25–34	57 (64.8)	40 (51.3)		75 (53.6)	61 (55.5)	
	≥35	22 (25.0)	25 (32.0)		45 (32.1)	28 (25.4)	
Relationship status	Married	57 (64.8)	53 (67.9)	.728	80 (57.1)	65 (59.1)	.625
	Not married—cohabitating	14 (15.9)	8 (10.3)		26 (18.6)	23 (20.9)	
	Not married—single	9 (10.2)	10 (12.8)		13 (9.3)	12 (10.9)	
	Not married—divorced or separated	8 (9.1)	7 (9.0)		20 (14.3)	10 (9.1)	
	Not married—widowed	0 (0.0)	0 (0.0)		1 (0.7)	0 (0.0)	
Highest completed education	Primary school or less	9 (10.2)	6 (7.7)	.493	13 (9.3)	17 (15.5)	.120
	Junior high school	18 (20.5)	18 (23.1)		40 (28.6)	37 (33.6)	
	Senior high school	27 (30.7)	31 (39.7)		38 (27.1)	31 (28.2)	
	Tertiary	34 (38.6)	23 (29.5)		48 (34.3)	24 (21.8)	
Insurance status	Public and private	86 (97.8)	75 (96.2)	.270	136 (97.1)	108 (98.2)	.461
	None	1 (1.1)	3 (3.8)		4 (2.9)	2 (1.8)	
Monthly household income (GHS)	<650 (<55 USD)	36 (40.1)	33 (42.3)	.914	70 (50.0)	67 (60.9)	.008
	650–1000	19 (21.6)	19 (24.4)		24 (17.1)	26 (23.6)	
	>1000 (>85 USD)	31 (35.2)	26 (33.3)		45 (32.1)	17 (15.5)	
Residence	Municipal district	69 (78.4)	58 (74.4)	.842	102 (78.9)	82 (74.5)	.790
	Metropolitan district	5 (5.6)	6 (7.7)		7 (5.0)	7 (6.4)	
	Submetropolitan district	13 (14.8)	12 (15.4)		28 (20.0)	19 (17.3)	

[a] Categories may not sum to equal total number because of missing values.

Thiyagarajan. Poor sleep quality among Ghanaian obstetrics patients. Am J Obstet Gynecol Glob Rep 2025.

effect of duration of admission of antepartum patients. In this regard, our study found that a shorter duration of admission was protective against a positive PSQI screen.[9–11,24–31] However, in these other studies, some found that the factors of age, gravity/parity, socioeconomic status/income, and relationship status were significantly associated with poor sleep quality, which our study did not find to be significantly associated.[9–11,24–31]

Similar to studies from New Zealand and Italy, our study also identified that participants who underwent an emergency cesarean delivery were more likely to have a positive PSQI.[32,33] In addition, other studies from Turkey, Malaysia, Indonesia, and Taiwan also reported that patients who had a cesarean delivery have poor sleep quality.[34–37] It is possible that the stress associated with the postoperative recovery process, including the limited sleeping position options, in this patient population may explain their higher burden of poor sleep quality. In our bivariate analysis of postpartum participants, a low monthly income was associated with a positive PSQI, consistent with studies from Brazil and the United States.[38,39] Generally, a low income and poverty are strongly linked to poorer sleep quality, and people who are facing financial hardship are more likely to experience difficulty falling asleep, less sleep, and lower quality sleep. These have been attributable to various factors, including stress, a lack of access to resources, and increased work hours to meet financial needs.[40]

Although we did not identify any previous studies that directly observed pregnancy distress and its association with poor sleep quality, several studies support our findings that anxiety and depression are associated with poor sleep quality among obstetrical patients.[9–11,24,30,31,35,38,41]

Despite the awareness that poor sleep quality negatively affects maternal and

TABLE 2
Comparison of clinical factors in relation to a positive PSQI

		Antepartum			Postpartum		
Participant factor		Poor sleep quality n (%) (n=88)[a]	Good Sleep Quality n (%) (n=78)[a]	*P* value	Poor sleep quality n (%) (n=140)[a]	Good sleep quality n (%) (n=110)[a]	*P* value
Parity	Mean (SD)	1.5 (0.137)	1.4 (0.155)	.355	2.4 (0.112)	2.3 (0.128)	.254
Number of spontaneous miscarriages	<2	80 (90.9)	68 (87.2)	.441	126 (90.0)	98 (89.1)	.815
	≥2	8 (9.1)	10 (12.8)		14 (10.0)	12 (10.9)	
Overall satisfaction with care	Satisfied	78 (88.6)	66 (84.6)	.726	124 (88.6)	103 (93.6)	.184
	Not satisfied	10 (11.4)	10 (12.8)		14 (10.0)	6 (5.5)	
Total duration of admission (d)	Mean (SD)	4.03 (6.85)	8.22 (19.2)	.059	4.27 (0.427)	5.56 (0.972)	.099
Antepartum-only factors							
Gestational age (wk)	Mean (SD)	31.2 (0.757)	29.1 (1.030)	.108			
Number of current gestation	Singleton	76 (86.4)	69 (88.5)	.252			
	Multiples	12 (13.6)	6 (7.7)				
History of cesarean delivery	Yes	29 (33.0)	21 (26.9)	.431			
	No	58 (65.9)	55 (70.5)				
Hypertension diagnosis	Yes	12 (13.6)	19 (24.4)	.077			
	No	76 (86.4)	59 (75.6)				
Satisfaction with counseling on reason for admission	Satisfied	73 (83.0)	64 (82.1)	.829			
	Not satisfied	15 (17.0)	12 (15.3)				
Postpartum-only factors							
Previous antepartum admissions	Yes				27 (19.3)	14 (12.7)	.140
	No				112 (80.0)	96 (87.3)	
Received blood transfusion during this admission	Yes				19 (13.6)	19 (17.3)	.461
	No				118 (84.3)	91 (82.7)	
Delivery outcome	Live birth				130 (93.0)	104 (94.5)	.779
	Stillbirth				10 (7.0)	6 (5.5)	
Sex of neonate	Female				77 (55.0)	63 (57.3)	.866
	Male				60 (42.9)	47 (42.7)	
Birth weight	≥1500 g				125 (89.3)	101 (91.8)	.680
	<1500 g				8 (5.7)	8 (7.3)	
Apgar score at 5 min	0–3				13 (9.3)	9 (8.2)	.909
	4–6				9 (6.4)	6 (5.5)	
	7–10				114 (81.4)	91 (82.7)	
Mode of delivery	Vaginal delivery				57 (40.7)	62 (56.4)	.009
	Cesarean delivery				83 (59.3)	48 (43.6)	
Delivered by cesarean delivery					n=83	n=48	
Timing status	Emergency				61 (73.5)	29 (60.4)	.096
	Elective				21 (25.3)	19 (39.6)	
Satisfaction with counseling for cesarean delivery	Yes				66 (79.5)	42 (87.5)	.303
	No				16 (19.3)	6 (12.5)	
Satisfaction with postoperative care	Yes				75 (90.4)	45 (93.8)	.374
	No				8 (9.6)	3 (6.2)	
Type of anesthesia	Regional				72 (86.7)	44 (91.7)	.291
	General				11 (13.3)	4 (8.3)	

SD, standard deviation.

[a] Categories may not sum to equal total number because of missing values.

Thiyagarajan. Poor sleep quality among Ghanaian obstetrics patients. Am J Obstet Gynecol Glob Rep 2025.

TABLE 3
Multivariate logistic regression with positive PSQI screen as outcome variable

		Antepartum		Postpartum	
Participant factor		Odds ratio (95% CI)	Marginal effects	Odds ratio (95% CI)	Marginal effects
Age (y)	18–24	Ref	Ref	Ref	Ref
	25–34	1.927 (0.654–5.677)		1.16 4 (0.5434–2.56)	
	≥35	1.219 (0.366–4.055)		1.33 (0.561–3.14)	
Relationship status	Married	1.215 (0.404–3.655)		.808 (0.323–2.02)	
	Not married—cohabitating	1.912 (0.472–7.732)		1.11 (0.400–3.06)	
	Not married—single	Ref	Ref	Ref	Ref
	Not married—divorced or separated	1.803 (0.415–7.827)		1.94 (0.623–6.08)	
Highest completed education	Primary school or less	Ref	Ref	Ref	Ref
	Junior high school	0.573 (0.148–2.218)		1.65 (0.667–4.08)	
	Senior high school	0.436 (0.118–1.613)		1.68 (0.655–4.31)	
	Tertiary	0.661 (0.161–2.708)		2.26 (0.783–6.53)	
Monthly household income (GHS)	<650 (<55 USD)	Ref	Ref	Ref	Ref
	650–1000	1.050 (0.416–2.649)		0.898 (0.444–1.82)	
	>1000 (>85 USD)	1.308 (0.518–3.300)		2.08 (0.918–4.69)	
Duration of admission		0.959 (0.923–0.997)[a]	−0.009	1.01 (0.956–1.06)	
Number of current gestation	Singleton	Ref	Ref		
	Multiples	1.981 (0.660–5.946)			
Hypertension diagnosis	Yes	0.475 (0.199–1.134)			
	No	Ref	Ref		
Mode of delivery	Vaginal delivery			Ref	Ref
	Elective cesarean delivery			1.35 (0.609–2.98)	
	Emergency cesarean delivery			2.06 (1.10–3.84)[a]	0.166
Delivery outcome	Live birth			Ref	Ref
	Stillbirth			1.20 (0.408–3.55)	

CI, confidence interval

[a] *P* value <.05.

Thiyagarajan. Poor sleep quality among Ghanaian obstetrics patients. Am J Obstet Gynecol Glob Rep 2025.

TABLE 4
Comparison of positive Tilburg Pregnancy Distress Scale and positive Patient Health Questionnaire-9 in relation to a positive PSQI

Participant factor		Poor Sleep Quality n (%) (n=228)	Good Sleep Quality n (%) (n=188)	*P* value
Tilburg Pregnancy Distress Scale	Positive	102 (44.7)	53 (28.2)	<.01
	Negative	126 (55.3)	135 (71.8)	
Patient Health Questionnaire-9	Positive	84 (36.8)	39 (20.7)	<.01
	Negative	144 (63.2)	149 (79.3)	

Thiyagarajan. Poor sleep quality among Ghanaian obstetrics patients. Am J Obstet Gynecol Glob Rep 2025.

fetal outcomes, there is no standardized protocol for sleep quality screening among antepartum or postpartum patients in Ghana.[3–6,21] Our study has identified that obstetrical participants who had an increased duration of hospital stay, low-income, cesarean delivery, and known depression or pregnancy distress were more likely to screen positive for poor sleep. These findings will enable targeted screening to allow for early intervention that could help to decrease pregnancy-related morbidity and mortality from poor sleep quality. Implementing such targeted screening would help to minimize the burden on the healthcare system by reducing the need to screen all patients routinely.

Future research would benefit from an understanding of sleep quality among the general Ghanaian obstetrical population rather than our population of only those who were currently hospitalized in an urban, tertiary, referral center. Additional research should be conducted across other lower levels of healthcare to understand how best to implement targeted sleep quality screening, such as the level of training needed to administer the screening tool, and the timepoints during their obstetrical care to administer the screening for optimal intervention and change in clinical outcomes.

Our study evaluated sleep quality among antepartum patients in Ghana and factors other than hypertension that affected the sleep quality among postpartum patients in Ghana.[21] It also examined the relationship between pregnancy distress, perinatal depression, and sleep quality among obstetrical patients in Ghana, thereby generating crucial data to inform guidelines and practice protocols for mitigating the negative synergistic impact of these on maternal and child outcomes. Our study is limited by the screening tool being translated and back-translated from English to Twi or Ga. However, the trained research assistants who administered the survey were fluent in all 3 languages, and similar results of positive and negative screens were identified across languages. We collected data directly from the patients, which may influence the accuracy of the clinical factors. We also administered this tool at only 1 point in time during their hospitalization period in this urban, referral center, and thus our findings may be limited by the likelihood of recency bias, because sleep may be more disrupted while in the hospital and also within the initial postpartum period because baby care needs. This limits the ability to generalize these data to the obstetrical population given the changes in sleep quality observed during the pregnancy and postpartum period, outside of hospitalization, and the level of care of the hospital.

Poor sleep quality can negatively affect maternal and fetal outcomes.[3–6] Our study identified that those with an increased duration of hospital stay, low-income, cesarean delivery, and known depression or pregnancy distress were more likely to have poor sleep quality. The use of these factors can help to tailor sleep quality screening among obstetrical patients in Ghana to enable timely, appropriate interventions to reduce the associated negative pregnancy outcomes. ■

CRediT authorship contribution statement

Dhanalakshmi Thiyagarajan: Writing – review & editing, Writing – original draft, Formal analysis. **Astrid Sarfo:** Writing – review & editing, Writing – original draft, Investigation, Data curation. **Alim Swarray-Deen:** Writing – review & editing, Data curation, Conceptualization. **Promise E. Sefogah:** Conceptualization, Writing – review & editing, Formal analysis, Data curation. **Emma Lawrence:** Conceptualization, Writing – review & editing, Formal analysis, Data curation. **Sarah Compton:** Formal analysis, Writing – review & editing, Methodology.

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Supplementary materials

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