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Association of maternal sleep practices with pre-eclampsia, low birth weight, and stillbirth among Ghanaian women

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Abstract

Objective—To assess sleep practices, and investigate their relationship with maternal and fetal outcomes, among pregnant Ghanaian women.

Methods—In a cross-sectional study conducted at Korle Bu Teaching Hospital, Accra, Ghana, between June and July 2011, postpartum women were interviewed within 48 hours of delivery about sleep quality and practices during pregnancy. Interviews were coupled with a systematic review of participants' medical charts for key outcomes including maternal hypertension, pre-eclampsia, premature delivery, low birth weight, and stillbirth.

Results—Most women reported poor sleep quality during pregnancy. Snoring during pregnancy was independently associated with pre-eclampsia (odds ratio [OR], 3.5; 95% confidence interval [CI], 1.4–8.5; $P=0.007$). The newborns of women who reported supine sleep during pregnancy were at increased risk of low birth weight (OR, 5.0; 95% CI, 1.2–20.2; $P=0.025$) and stillbirth (OR, 8.0; 95% CI, 1.5–43.2; $P=0.016$). Low birth weight was found to mediate the relationship between supine sleep and stillbirth.

Conclusion—The present findings in an African population demonstrate that maternal sleep, a modifiable risk factor, has a significant role in pre-eclampsia, low birth weight, and subsequently stillbirth.

Keywords

Africa; Low birth weight; Pre-eclampsia; Sleep position; Sleep quality; Snoring; Stillbirth

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Conflict of interest

The authors have no conflicts of interest.

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1. Introduction

Despite the Safe Motherhood Initiative launched in 1987 [1] and the Millennium Development Goals—a UN declaration to reduce maternal and child morbidity and mortality by 2015 [2]—maternal mortality remains high in low-income countries. Sub-Saharan Africa has the highest maternal and perinatal mortality rate in the world [3]. In Ghana, the current maternal mortality rate is 350 per 100 000 live births, compared with 21 per 100 000 live births in the USA [3]. In Africa, hypertensive disorders of pregnancy are a leading cause of mortality [4–6].

Located in Accra, Korle Bu Teaching Hospital is the largest hospital in Ghana and is associated with the University of Ghana Medical School. More than 12 000 women deliver at Korle Bu each year, including both self-referrals from the Greater Accra region and tertiary referrals. Between 1995 and 2002, there were 108 maternal and/or perinatal deaths among 93 622 deliveries in Korle Bu Teaching Hospital, and 22 women died before delivery [4]. The leading cause of death was the presence of a hypertensive disorder, and the majority (66%) of perinatal deaths were stillbirths. Sub-Saharan Africa has the highest rate of stillbirth [7], and little progress has been made in mortality reduction. Addressing these disparities presents a major challenge to public health.

Epidemiologic studies from high-resource countries show that poor sleep, particularly sleep-disordered breathing—a spectrum of sleep-related breathing conditions including snoring and obstructive sleep apnea—is causally related to hypertension [8] via mechanisms that include autonomic dysfunction, endothelial dysfunction, and inflammation [9]. Emerging data also demonstrate that sleep-disordered breathing during pregnancy is common, affecting up to one-third of women in their last trimester [10,11]; it has an independent association with gestational hypertension and pre-eclampsia [10–13] and possibly intrauterine growth restriction [12–14]. Furthermore, poor sleep quality, short sleep duration, and sleep position might all be involved in adverse pregnancy outcomes such as cesarean delivery [15], preterm birth [16], and stillbirth [17].

Although sleep disruption in pregnancy may jeopardize maternal blood pressure control and contribute to adverse pregnancy outcomes, reports of sleep disruption are rare in Ghana and non-existent among the pregnant population. Therefore, the aim of the present study was to investigate the prevalence of sleep disruption and sleep practices among Ghanaian women and to investigate its association with maternal and neonatal outcomes.

2. Materials and methods

In an interview-based study, postpartum Ghanaian women were recruited from maternity wards at Korle Bu Teaching Hospital Accra, Ghana, between June 1 and July 31, 2011. Written informed consent was obtained from all participants. The study was approved by Institutional Review Boards at the University of Michigan and the University of Ghana.

The inclusion criteria were delivery within 48 hours of recruitment and a gestation of at least 28 weeks. There were no other exclusion criteria. Both consent and the interview were verbally administered in the primary language of the participant (English, Twi, or Ga) by a research assistant who was blind to the delivery outcome. Because the study formed part of a student summer project, recruitment was limited by the availability of the research assistant.

There are no validated scales for assessing sleep in sub-Saharan Africa. As a result, the questionnaires were based on those that have been validated in high-income countries. Participants were asked 2 questions about their regular sleeping location: “is your sleeping

area (bed) uncomfortable (e.g. hard mattress or floor, too many or not enough blankets)?” and “is your sleeping room uncomfortable (e.g. too hot, bright, stuffy, or noisy)?”

Snoring, as a key symptom of sleep-disordered breathing, was considered to be present if there was a positive response to the question “do you snore loudly?” regardless of whether the response was obtained by self-report or by the comments of a partner. Witnessed episodes of apnea were considered to be present if there was a positive response to the question “has anyone observed you stop breathing during your sleep?”

Sleep quality was measured via a modified version of the sleep quality subscale of the General Sleep Disturbance Scale [18] (GSDS; Supplementary Material S1). This subscale consists of 7 items, and women were asked whether or not they had experienced each item at least 3 nights per week. This dichotomy, although not part of the original GSDS validation, was used because of language difficulties. Women were considered to have poor sleep quality if they positively endorsed 3 or more items. Similarly, daytime sleepiness was measured using a dichotomized version of the sleepiness subscale of the GSDS (Supplementary Material S2), and women were considered to have daytime sleepiness if they positively endorsed 3 or more items (the last item was reverse-scored). The proportion of women with poor sleep quality (or daytime sleepiness) was then calculated.

Usual bedtime and wake time were obtained and used to calculate average sleep duration. Short sleep was defined as 6 hours per night or less, and long sleep was defined as 10 hours per night or more. Women were also queried about their typical sleep position during pregnancy (“while pregnant, what is your most common sleep position?”). Women could provide an open-ended response, which was then coded into “side”, “back”, “back and side,” or “don’t know”. Supine sleep was considered present if the participant reported “back,” or “back and side” sleep. Women were also asked whether they used a treated mosquito net at night. Mosquito nets were considered an important covariate because they are recommended for malaria control and reduce nocturnal mosquito bites, which might potentially improve sleep quality.

Medical records were accessed to obtain key variables including age, gravidity, parity, blood pressure readings, and diagnoses of gestational hypertension or pre-eclampsia. Hypertension was defined as at least 2 blood pressure readings of 140/90 mm Hg or higher. Newborn outcomes included mode of delivery, gestational age, birth weight, Apgar scores, neonatal intensive care unit (NICU) admission, and stillbirth. Neonates were defined as premature if delivery occurred before 37 weeks of gestation, and as low birth weight if they weighed 2500 g or less [19].

All data were double-entered to ensure accuracy and were analyzed with SPSS version 19.0 (IBM, Armonk, NY, USA). Histograms, box plots, and descriptive methods were used to check data for errors and outliers. The population attributable risk percent (PAR%), which represents the proportion of disease (pre-eclampsia, low birth weight, or stillbirth) among the total population that would not have occurred in the absence of exposure (snoring or sleep position), assuming that the exposure contributed in a causal manner to the disease, was calculated as follows:

$$\text{PAR\%} = \frac{\text{incidence}_{\text{total population}} - \text{incidence}_{\text{unexposed}}}{\text{incidence}_{\text{total population}}}$$

Between-group comparisons of continuous variables were done with a *t* test. Dichotomized variables were compared with a χ^2 test. The Pearson correlation coefficient was calculated to assess relationships among continuous variables. Logistic regression was used to determine associations between maternal sleep and pregnancy outcomes, after adjusting for

relevant covariates. The odds ratio (OR) and 95% confidence interval (CI) were calculated. A *P* value 0.05 or less was considered to be statistically significant.

3. Results

During the study period, 234 women were invited to participate and 232 (99%) provided consent. Pregnancy outcome data were available for 220 (94.8%) participants; there was no or limited documentation for the remaining women. As a result, the sample size for all subsequent analyses was 220 women. There were no demographic differences between those with and those without complete outcome data (data not shown).

Overall, 10.9% of women had hypertension and 11.8% had pre-eclampsia (Table 1). One woman had eclampsia. The mean \pm SD body mass index (BMI, calculated as weight in kilograms divided by the square of height in meters) was 24.3 ± 4.1 , but because height and weight data were available for only 47.7% of the participants, BMI was not included in the data analysis.

Overall, 24% of women reported snoring and a large proportion (42.7%) reported either long or short sleep duration (Table 2). The majority of women reported apparent exclusive side sleep. Because the number of women who reported exclusive supine sleep was small ($n=4$), those who reported “back and side sleep” were included as supine sleepers for the purpose of analysis. There were small but significant negative correlations between sleep duration and maternal age ($r=-0.34$; $P<0.001$) and parity ($r=-0.14$; $P=0.038$). However, there were no associations between sleep practices and sleep environment, including use of a mosquito net (Table 3).

The sleep characteristics of snoring women did not differ from those of non-snorers (Table 4). Snoring women, however, were more likely to have pre-eclampsia than were non-snorers (22.6% vs 7.8%; $P=0.0065$).

In a logistic regression model controlling for maternal age, parity, and gestational age at delivery, snoring was independently associated with pre-eclampsia (OR, 3.5; 95% CI, 1.4–8.5, $P=0.007$). If snoring has a causative role in pre-eclampsia, the PAR% value suggests that 34% of cases of pre-eclampsia may be ameliorated by treating snoring.

Snoring, sleep quality, and sleep duration were not associated with the delivery outcomes (prematurity, cesarean delivery, low birth weight, NICU admission, or stillbirth). Women who reported supine sleep were, however, at increased risk of low birth weight (36.8% vs 10.7%; $P=0.004$), NICU admission (36.8% vs 15.2%; $P=0.04$), and stillbirth (15.8% vs 3.0%; $P=0.04$) (Table 5).

In a logistic regression that controlled for the covariates maternal age, gestational age, parity, and the presence of pre-eclampsia, supine sleep was independently associated with low birth weight (OR, 5.0; 95% CI 1.2–20.2; $P=0.025$). Similarly, in a separate logistic regression model that controlled for the same covariates, supine sleep was independently associated with stillbirth (OR, 8.0; 95% CI, 1.5–43.2; $P=0.016$). When low birth weight was added to the latter model, the odds ratio for the relationship between supine sleep and stillbirth was almost eliminated (OR, 4.9; 95% CI, 0.80–31.4; $P=0.09$). This demonstrates that low birth weight mediates the effects of supine sleep on stillbirth. If supine sleep has a causative role in low birth weight and subsequently stillbirth, the PAR% suggests that up to 17% of low birth weight, and consequently 26% of stillbirths, might be prevented by changing maternal sleep position.

4. Discussion

The present study has shown that maternal snoring and sleep position during pregnancy confer a significant risk on maternal and perinatal outcomes in a low-resource country. Pre-eclampsia, low birth weight, and stillbirth are major contributors to the high perinatal mortality rate in Ghana, and the present findings suggest that maternal sleep may have a role.

Increasing evidence in high-income countries indicates that maternal sleep affects maternal blood pressure [11,12,20]. A large prospective study previously showed that pregnancy-onset snoring was independently associated with gestational hypertension and pre-eclampsia [11]. From the results of the present cross-sectional study, it is not possible to determine whether snoring increases the risk of pre-eclampsia or whether pre-eclampsia increases the risk of snoring. The relationship is likely to be bidirectional.

Epidemiologic studies among non-pregnant adults have demonstrated that snoring is predictive of hypertension [21] owing to endothelial dysfunction, inflammation, oxidative stress, and increased sympathetic activity [9]—pathways that are also triggered in pre-eclampsia. Although there is clear overlap in the biologic pathways, pre-eclampsia is thought to originate in early gestation and manifest later in pregnancy; however, it is likely that snoring exacerbates the underlying physiology and accelerates the development of pre-eclampsia [11]. Conversely, women with pre-eclampsia are also at high risk of snoring [22]. These findings suggest that the relationship between snoring and pre-eclampsia may be bidirectional.

Notably, supine sleep during pregnancy was found to be associated with stillbirth via a mediating effect of low birth weight. Women in Ghana have one of the highest rates of stillbirth in the world, yet interventions have had little success [7]. The present findings support those of Stacey et al. [17], who found that supine sleep was associated with a 2.5-fold increased risk of stillbirth in New Zealand, although they did not report birth weight. In their case-control study, women were interviewed within several weeks of delivery; in the present study, women were interviewed within 48 hours of delivery with the researcher blind to delivery outcomes, thereby minimizing biases. Similar to the study of Stacey et al. [17], the present data suggest that (if sleep position is causally related to stillbirth) more than one-quarter of stillbirths might be avoided by altering maternal sleep position.

The present study found an association between supine sleep and low birth weight, which might mediate the relationship between supine sleep and stillbirth. More than 20 million neonates with low birth weight are born annually worldwide, with the highest concentration in Asia and Africa [3]. Efforts to reduce the incidence of low birth weight have not been successful in these regions. The possibility that supine sleep has a part in low birth weight, and subsequently stillbirth, is plausible due to uterine compression on the inferior vena cava, resulting in reduced venous filling and cardiac output [23]. A study in awake pregnant women confirmed that altering maternal position from supine to left lateral significantly increased the ejection fraction, and end-diastolic, end-systolic, and cardiac output [24]. The reduction in cardiovascular parameters, particularly cardiac output, in the supine position might impede utero-placental blood flow and increase the risk of growth restriction and stillbirth. Indeed, small-for-gestational-age is a known contributor to stillbirth [25].

In addition to snoring and supine sleep, poor sleep quality and short sleep duration have been postulated to increase the risk of adverse pregnancy outcomes [15,16,20]. The vast majority of Ghanaian women reported poor sleep quality; however, no association with maternal or perinatal outcomes was found. Similarly, there was no association between short sleep and pregnancy outcomes. It is possible that poor sleep in early pregnancy may alter

placental vascular remodeling and subsequently increase the risk of adverse outcomes [26]; however, because we did not perform a longitudinal study, we are unable to address this possibility.

Unexpectedly, an uncomfortable sleeping location (e.g. room too hot) or uncomfortable bed/mattress was not associated with poor sleep. It is possible that women were used to their typical sleeping locations and so falsely ascribed their poor sleep to pregnancy. However, the prevalence of poor sleep during pregnancy in the present study is similar to that of pregnant women in high-income countries who typically have a large degree of control over the comfort of their sleep locations [27]. Thus, it seems unlikely that comfort of the sleeping location is involved in the poor sleep observed among the study participants.

The present study has several limitations. The lack of objective measures of sleep, such as actigraphy or polysomnography, might have impeded the ability to fully measure sleep variables; however, such measures are not readily available in low-resource countries and simple, efficient screening questions might assist the identification of women at risk of poor birth outcomes. In addition, women were enrolled within 48 hours of delivery; although recall bias is possible, it was minimized by this approach. It was not possible to perform a longitudinal study in this population because often the first time a woman presents to the hospital is when there is a problem or she is ready to deliver. Furthermore, the use of hypertensive medications was not considered. Although this would not have altered the relationship between snoring and a clinical diagnosis of hypertension, it might have led to an underestimation of the number of women with high blood pressure in the absence of a clinical diagnosis. If some women were misclassified, however, the study findings might be stronger than presented here.

In addition, height and weight were not available for half of the women; because BMI has strong relationships with both snoring and pregnancy outcomes, it is unfortunate that it was not possible to address the role of obesity. However, data on height and weight are not routinely collected in sub-Saharan Africa. Moreover, the CIs for the logistic regression models of low birth weight and stillbirth were wide. This is probably due to the relatively small sample size, particularly of stillbirths, coupled with wide variability. Lastly, it was not possible to investigate left side versus right side or to delineate sleep position on settling versus position on waking. Nevertheless, the present study clearly demonstrates that maternal sleep practices in a population with high perinatal morbidity is worthy of further investigation in a much larger sample size.

Given the present findings, it would be prudent to develop simple intervention trials. There is no standard treatment for snoring; any underlying obstructive sleep apnea is typically treated by continuous positive airway pressure, an approach not feasible in low-resource countries. However, snoring may be improved by non-supine sleep because the airway is more likely to collapse when sleeping supine. Moreover, non-supine sleep might also reduce the incidence of low birth weight and subsequently stillbirth. This is a simple intervention that can be performed in low-resource countries. Although it is not possible to obtain confirmatory evidence of sleep position, maternal report of position at bedtime and at wake time might be sufficient. Simply querying a pregnant woman about her sleep is an approach that can be adopted easily even by untrained personnel.

In summary, the present data suggest that maternal sleep, a modifiable risk factor, has a significant role in pre-eclampsia, low birth weight, and stillbirth among Ghanaian women. As a country with one of the highest morbidity and mortality rates in the world, Ghana urgently requires inexpensive interventions to improve maternal and perinatal morbidities.

Encouraging pregnant Ghanaian women to avoid sleeping on their back might be one such intervention.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Synopsis

Maternal snoring was found to be associated with pre-eclampsia, and maternal sleep position with low birth weight and stillbirth among Ghanaian women.

Table 1Demographic data of the study participants (n=220)^a

Characteristic	Value
Age	29.0 ± 5.7
14–19 y	10 (4.5)
20–29 y	108 (49.1)
30–39 y	96 (43.6)
40 y	6 (2.7)
Gestational age at delivery	38.3 ± 2.6
22–26 wk	3 (1.4)
27–31 wk	3 (1.4)
32–36 wk	35 (15.9)
37–41 wk	171 (77.7)
42 wk	8 (3.6)
Gravidity	
1	47 (21.3)
2	59 (26.9)
3	48 (21.8)
4	34 (15.3)
5	32 (14.7)
Parity	
0	71 (32.3)
1	62 (28.2)
2	51 (23.2)
3	22 (10.0)
4	9 (4.1)
5	5 (2.3)
Hypertension (excluding pre-eclampsia)	24 (10.9)
Pre-eclampsia	26 (11.8)

^aValues are given as mean ± SD or number (percentage).

Table 2Sleep characteristics of the study participants (n=220)^a

Characteristic	Value
Sleep duration per night	8.3 ± 2.2
6 h	37 (16.8)
10 h	57 (25.9)
Snoring	54 (24.0)
Poor sleep quality	190 (86.4)
Daytime sleepiness	115 (52.3)
Supine sleep ^b	21 (9.7)
Uncomfortable room	61 (27.7)
Uncomfortable bed	44 (20.0)
Slept near a light source	85 (38.6)
Used a treated mosquito net	49 (22.3)

^aValues are given as mean ± SD or number (percentage).

^bData were available for only 216 women.

Table 3Associations between environment and sleep practice^a

	Uncomfortable room		Uncomfortable bed		Use of mosquito net		Slept near a light source	
	Yes	No	Yes	No	Yes	No	Yes	No
Sleep duration, h	8.4 ± 2.0	8.3 ± 2.3	8.0 ± 2.2	8.4 ± 2.2	8.3 ± 2.1	8.2 ± 2.3	8.4 ± 2.3	8.2 ± 2.2
Short sleep	16.1	17.5	21.3	16.0	21.1	16.0	15.9	17.9
Long sleep	25.8	26.6	17.0	28.8	26.4	26.6	31.8	23.1
Poor sleep quality	88.7	85.3	87.2	85.9	86.8	86.0	87.6	85.3

^aValues are given as mean ± SD or percentage.

Table 4Sleep characteristics and pregnancy outcomes among snoring and non-snoring women^a

Characteristic	Snoring (n=53)	Non-Snoring (n=167)	P value
Age, y	29.1 ± 5.5	28.8 ± 5.8	
Parity	1.4 ± 1.5	1.3 ± 1.3	
Sleep duration, h	8.1 ± 2.4	8.4 ± 2.2	
Short sleep duration	11 (20.9)	27 (16.2)	
Long sleep duration	13 (24.5)	46 (27.5)	
Witnessed apneas	7 (13.2)	8 (4.8)	0.05
Poor sleep quality	45 (84.9)	144 (86.2)	
Excessive daytime sleepiness	28 (52.8)	87 (52.1)	
Supine sleep	5 (9.4)	14 (8.4)	
Hypertension (excluding pre-eclampsia)	4 (7.7)	21 (12.6)	
Pre-eclampsia	12 (22.6)	13 (7.8)	0.0065
Cesarean delivery	19 (35.8)	42 (25.1)	
Low birth weight	6 (11.3)	21 (12.6)	
NICU admission	12 (22.6)	25 (15.0)	
Stillbirth	2 (3.8)	7 (4.2)	

Abbreviation: NICU, neonatal intensive care unit.

^aValues are given as mean ± SD or number (percentage) unless stated otherwise.

Table 5Delivery outcomes associated with supine sleep (n=216)^a

	Supine sleep (n=19)	Non-supine sleep (n=197)	P value
Gestational age, wk	37.0 ± 4.3	38.2 ± 2.7	
Birth weight, g	2830.5 ± 949.4	3073.4 ± 601.2	
Apgar score			
1 min	6.9 ± 1.5	7.0 ± 1.0	
5 min	8.2 ± 1.3	8.3 ± 0.9	
Premature delivery	6 (31.6)	35 (17.8)	
Cesarean delivery	5 (26.3)	57 (28.9)	
Low birth weight	7 (36.8)	21 (10.7)	0.004
NICU admission	7 (36.8)	30 (15.2)	0.04
Stillbirth	3 (15.8)	6 (3.0)	0.04

Abbreviation: NICU, neonatal intensive care unit.

^aValues are given as mean ± SD or number (percentage) unless stated otherwise. Four individuals reported that they did not know their sleep position; thus, the total sample size was 216.