

SCIENTIFIC INVESTIGATIONS

## Burden of sleep disturbance in non-Hispanic Black pregnant women

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**Study Objectives:** Non-Hispanic Black pregnant women disproportionately experience poor perinatal outcomes compared to other racial/ethnic groups. Sleep disruption has emerged as a risk factor for adverse pregnancy outcomes, but there are limited data in minority pregnant women. We examined the prevalence of habitual snoring and its timing of onset with several key sleep-wake disturbances and their associations with perinatal outcomes in a cohort of non-Hispanic Black pregnant women.

**Methods:** Non-Hispanic Black pregnant women in their third trimester were recruited from a large academic medical center and screened for habitual snoring and its timing relative to pregnancy, along with sleep quality, symptoms of insomnia, excessive daytime sleepiness, and daytime function. Clinical diagnoses of hypertensive disorders of pregnancy were obtained along with delivery outcomes.

**Results:** In 235 women, the vast majority (80%) reported 3 or more sleep-wake disturbances, and almost half had at least 5 disturbances. Sixteen percent reported prepregnancy snoring and 20% reported pregnancy-onset snoring. Women with pregnancy-onset snoring had significantly increased odds of poor sleep quality (adjusted odds ratio [aOR] = 8.2), trouble staying asleep (aOR = 3.6), waking up too early (aOR = 2.7), excessive daytime sleepiness (aOR = 2.3), and poor daytime function (aOR = 8.7) but no relationship with perinatal outcomes. In contrast, prepregnancy snoring was related to chronic hypertension, preterm delivery, and fetal growth restriction (aOR = 2.6, aOR = 2.8, and aOR = 5.1, respectively).

**Conclusions:** Sleep-wake disturbances confer a significant burden to pregnant non-Hispanic Black women, an infrequently studied yet disproportionately affected population. Contributions of maternal sleep to racial disparities in perinatal health should be a priority for public health research.

**Keywords:** sleep-disordered breathing, sleep quality, non-Hispanic Black women, pregnancy, health disparities

**Citation:** White KM, Dunietz GL, Pitts DS, Kalmbach DA, Lucchini M, O'Brien LM. Burden of sleep disturbance in non-Hispanic Black pregnant women. *J Clin Sleep Med.* 2022;18(5):1319–1325.

### BRIEF SUMMARY

**Current Knowledge/Study Rationale:** Non-Hispanic Black pregnant women disproportionately experience poor perinatal outcomes compared to other racial/ethnic groups. Sleep disruption has emerged as a risk factor for adverse pregnancy outcomes, but there are limited data in minority pregnant women.

**Study Impact:** Sleep-wake disturbances confer a significant burden to pregnant non-Hispanic Black women. The compounding effect of poor maternal sleep in a population that already carries cumulative psychosocial stressors is an area in need of urgent investigation.

### INTRODUCTION

Non-Hispanic Black women disproportionately experience poor perinatal outcomes such as gestational hypertension, gestational diabetes, preterm birth, low birth weight, and fetal growth restriction compared to other racial/ethnic groups.<sup>1–3</sup> Between 2007 and 2016, pregnancy-related deaths per 100,000 live births were highest for non-Hispanic Black women compared to all other racial/ethnic groups in the United States,<sup>4</sup> with mortality rates 4–5 times higher in non-Hispanic Black women older than age 30 years compared to non-Hispanic White women. Non-Hispanic Black women with some college education had higher mortality rates compared to women in other racial groups with less than a high school education.<sup>4</sup> A systematic review that included data from > 30 million women

showed that Black women have a 2-fold increase in the odds (95% confidence interval, 1.8–2.2) of preterm birth compared to White women. The review noted that the impact was even more pronounced in subgroups of preterm birth (eg, < 34 or < 32 weeks) for Black women and was independent of other risk factors. Moreover, the incidence of low birth weight is almost twice as high in Black women as it is in White women.<sup>5</sup> Despite accounting for multiple potential contributors such as socioeconomic status, maternal education, prenatal care, social support, and stress,<sup>2,6</sup> these sociodemographic and stress-related factors do not fully account for racial disparities in perinatal outcomes.

Poor sleep has emerged in recent years as a strong contributor to adverse health outcomes. Indeed, sleep is an important component of overall health, and sleep deficiencies have been

robustly linked with obesity, hypertension, and diabetes in both adult and pediatric populations.<sup>7–10</sup> Chronic sleep-wake disturbances, including sleep-disordered breathing (SDB), poor sleep quality, excessive daytime sleepiness, and insomnia, have a high prevalence and often greater severity among non-Hispanic Black individuals compared to other racial/ethnic groups.<sup>11–13</sup> The disproportionate burden of poor sleep in non-Hispanic Black people compared to non-Hispanic White people may contribute to the high rates of cardiovascular disease in racial/ethnic minority populations. Moreover, these sleep-wake disturbances are disproportionately elevated among Black women during pregnancy relative to White pregnant women.<sup>14</sup> Note that these sleep-wake disturbances, particularly SDB, have also been linked to an increased risk for adverse pregnancy outcomes such as hypertensive disorders in pregnancy (HDP), gestational diabetes mellitus, poor fetal growth, and preterm birth,<sup>15–22</sup> morbidities that are known to be higher in Black women. Furthermore, the timing of SDB symptoms is an important predictor of pregnancy outcomes, with pregnancy-onset snoring being linked to HDP and chronic or pre-existing habitual snoring being associated with small-for-gestational-age infants.<sup>15,16</sup> Notably, the vast majority of studies of maternal sleep and perinatal outcomes have included largely White populations or have attempted to statistically adjust for—rather than stratify by—racial/ethnic groups.

The historical underrepresentation within clinical studies of non-Hispanic Black individuals in general and particularly non-Hispanic Black pregnant women has limited health professionals' understanding of morbidities in perinatal health in these marginalized/underresourced communities. Therefore, this study examined the prevalence of SDB (chronic and pregnancy-onset) with several sleep-wake disturbances (poor sleep quality, insomnia symptoms, daytime sleepiness, poor daytime function) and their associations with key perinatal outcomes in a cohort exclusively comprising non-Hispanic Black pregnant women.

## METHODS

Pregnant women in their third trimester were recruited from prenatal clinics of Michigan Medicine, a large Midwestern academic medical center. For the purposes of the current study, women were eligible if they were non-Hispanic Black, aged  $\geq 18$  years, and  $\geq 28$  weeks pregnant with a single fetus. Written informed consent was obtained at enrollment, and this study was approved by the institutional review board.

Women completed several brief questionnaires about their sleep. These included questions about the presence and timing of habitual snoring (prepregnancy or pregnancy-onset), with habitual snoring defined as snoring at least 3–4 times per week. The Epworth Sleepiness Scale, an 8-item questionnaire, was used to determine the presence of daytime sleepiness, with a score  $\geq 10$  suggestive of excessive sleepiness.<sup>23</sup> Women also completed the General Sleep Disturbance Scale<sup>24</sup> to determine poor sleep quality, poor daytime function, and symptoms of insomnia. The General Sleep Disturbance Scale is a 21-item instrument that assesses symptoms of sleep disturbance in the previous week (ranging

from 0, “not at all,” to 7, “every day”) and has several subscales, including a sleep quality subscale and a daytime function subscale. The sleep quality subscale includes 7 question items: difficulty getting to sleep, wake up during sleep period, wake up too early at the end of a sleep period, sleep poorly, satisfied with quality of sleep, get too little sleep, and fall asleep at an unscheduled time. Five question items constitute the daytime function subscale: feel sleepy during the day, struggle to stay awake during the day, feel irritable during the day, feel tired or fatigued during the day, and feel alert and energetic during the day. Scores on the subscales range between 0 and 7, with higher scores indicating a greater frequency of sleep disturbance. A subscale score  $\geq 3$  indicates disturbed sleep 3 or more nights during the prior week. This threshold is used to distinguish good sleepers from poor sleepers and corresponds to the *Diagnostic and Statistical Manual of Mental Disorders*, Fifth Edition,<sup>25</sup> criteria for primary insomnia. Scores  $\geq 3$  on the respective subscales were used to distinguish women with poor sleep quality and those with poor daytime function. We also analyzed 3 commonly reported sleep problems as individual question items (difficulty getting to sleep, wake up during sleep period, and wake up too early at the end of a sleep period). Demographic information, clinical diagnoses of hypertensive disorders of pregnancy, and birth outcomes (fetal growth restriction, preterm birth, Apgar scores, and neonatal intensive care unit admission) were abstracted from medical records.

## Statistical analysis

Descriptive statistics were used to estimate the proportions of women in each SDB group (nonhabitual snoring control, pregnancy-onset habitual snoring, and chronic habitual snoring) according to demographic and maternal characteristics. Logistic regression procedures quantified the associations between habitual snoring, prepregnancy or pregnancy onset, and each of the sleep-wake disturbances. Adjusted analyses accounted for maternal age, education, parity, smoking, and body mass index (BMI). Unadjusted and adjusted associations between maternal habitual snoring and pregnancy outcomes were also estimated using logistic regression models. All analyses were conducted using SAS version 9.4 (SAS Institute, Cary, NC).

## RESULTS

A sample of 235 non-Hispanic Black women in their third trimester were enrolled, with approximately 64% of the women receiving health coverage through Medicaid. In total, more than one-third of women reported prepregnancy or pregnancy-onset habitual snoring. Distributions of parity, education level, smoking, receipt of Medicaid, or living with a partner were similar across the groups. However, mean BMI was greater in women with reported habitual snoring in comparison to nonhabitual snoring (Table 1). Sleep disturbances were common; 16% of women reported prepregnancy habitual snoring, 20% reported pregnancy-onset habitual snoring, 74% reported poor sleep quality, 67% reported excessive daytime sleepiness, and 70% reported poor daytime function. Participants also noted symptoms of insomnia (51% difficulty getting to sleep, 82% trouble

**Table 1**—Sociodemographic and health characteristics of 235 non-Hispanic Black pregnant women according to their habitual snoring status.

Sociodemographic and Health Characteristics	Nonhabitual Snoring <sup>a</sup> (n = 151)	Prepregnancy Habitual Snoring (n = 37)	Pregnancy-Onset Habitual Snoring (n = 47)	P
Age, y, mean (SD)	26.7 (5.8)	28.7 (7.0)	27.3 (5.6)	.15
Parity, mean (SD)	1.2 (1.2)	1.2 (1.6)	1.2 (1.2)	.98
Nulliparous, n (%)	52 (34)	18 (49)	18 (38)	.22
Education, n (%)				.26
High school or less	71 (47)	13 (35)	25 (53)	
Post high school education	79 (52)	24 (65)	21 (45)	
Partnered, n (%)	62 (41)	15 (41)	20 (43)	.98
Smoker status, n (%)	30 (20)	6 (16)	7 (15)	.70
BMI, kg/m <sup>2</sup> , mean (SD)	28.2 (8.3)	34.6 (8.5)	32.2 (12.5)	< .001
Medicaid, n (%)	95 (63)	24 (65)	31 (66)	.92
Chronic hypertension, n (%)	21 (14)	13 (35)	5 (47)	.004
Gestational hypertension/preeclampsia, n (%)	23 (15)	13 (35)	9 (19)	.03
Gestational diabetes, n (%)	25 (17)	8 (22)	10 (21)	.65
Type 2 diabetes, n (%)	18 (12)	10 (27)	11 (23)	.12

<sup>a</sup>Women reported never, rare, or infrequent snoring before or during pregnancy. BMI = body mass index, SD = standard deviation.

staying asleep, 67% woke up too early). Mean sleep duration was 8.5 hours (standard deviation = 2.4 hours). The vast majority of women (80%) reported 3 or more sleep-wake disturbances, and almost half had experienced at least 5 disturbances (Figure 1).

**Associations between habitual snoring and sleep-wake disturbances**

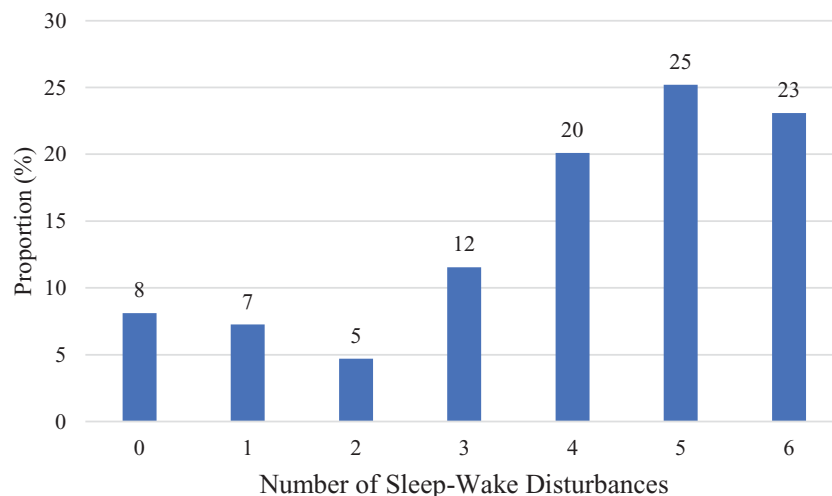
Unadjusted analyses suggested that women with prepregnancy habitual snoring had similar odds of sleep-wake disturbances as nonhabitual snoring control patients. These results remained nonsignificant after adjusting for maternal age, education,

parity, smoking, and BMI (Table 2). In contrast, women with pregnancy-onset habitual snoring had significantly increased odds of poor sleep quality, trouble staying asleep, waking up too early, excessive daytime sleepiness, and poor daytime function. These associations remained significant, after adjusting for maternal characteristics (Table 2).

**Associations between habitual snoring and pregnancy outcomes**

Associations between maternal habitual snoring and pregnancy outcomes were apparent in the prepregnancy habitual snoring group. Adjusted analyses for maternal age, education, parity,

**Figure 1**—Burden of sleep-wake disturbances in non-Hispanic Black pregnant women.



**Table 2**—Associations between habitual snoring and sleep-wake disturbances.

Habitual Snoring	Poor Sleep Quality (n = 175)	Difficulty Getting to Sleep (n = 120)	Trouble Staying Asleep (n = 193)	Wake Up Too Early (n = 158)	Excessive Daytime Sleepiness (n = 117)	Poor Daytime Function (n = 164)	Short Sleep Duration (n = 235)
Unadjusted							
Reference	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Prepregnancy	1.24 (0.54–2.85)	1.29 (0.63–2.66)	1.81 (0.65–5.00)	0.92 (0.44–1.94)	1.31 (0.64–2.69)	1.63 (0.73–3.61)	0.20 (0.03–1.59)
Pregnancy-onset	8.76 (2.03–37.8)	1.77 (0.91–3.46)	4.14(1.21–14.20)	2.74 (1.20–6.29)	2.40 (1.21–4.76)	8.83 (2.62–29.80)	1.30 (0.50–3.37)
Adjusted <sup>a</sup>							
Reference	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Prepregnancy	1.36 (0.49–3.76)	1.33 (0.60–2.93)	1.24 (0.42–3.65)	0.93 (0.41–2.11)	1.11 (0.51–2.42)	1.48 (0.61–3.57)	0.22 (0.03–1.83)
Pregnancy-onset	8.16 (1.85–35.9)	1.55 (0.77–3.09)	3.58 (1.02–12.50)	2.66 (1.13–4.65)	2.29 (1.13–4.65)	8.70 (2.53–29.90)	1.30 (0.48–3.55)

<sup>a</sup>Adjusted for age, education, smoking, and body mass index. Ref = reference.

smoking, and BMI showed significant odds for chronic hypertension, preterm delivery, and fetal growth restriction (Table 3). There were no significant relationships between pregnancy-onset habitual snoring and hypertensive disorders of pregnancy, fetal growth restriction, or preterm birth. Neither prepregnancy nor pregnancy-onset habitual snoring was associated with Apgar scores or neonatal intensive care unit admission (data not shown).

**DISCUSSION**

In this cohort of pregnant non-Hispanic Black women, we found a significant burden of sleep-wake disturbances. The vast majority of women reported at least 3 sleep-wake disturbances, and almost half had 5 or more. Pregnancy-onset habitual snoring was associated with significantly increased odds of sleep-wake disturbances, whereas prepregnancy habitual snoring was associated with chronic hypertension, preterm delivery, and fetal growth restriction. These findings highlight the excess risk

that SDB confers to sleep-wake disturbances and perinatal outcomes in an infrequently studied yet highly vulnerable population.

Whereas a number of studies have reported an association between sleep-wake disturbances and adverse maternal outcomes, few have focused on Black pregnant women. Moreover, most have investigated associations with perinatal outcomes and have not considered the role of SDB in other commonly reported sleep difficulties. For example, several large studies have shown independent associations between SDB and HDP or gestational diabetes mellitus<sup>15,26,27</sup> along with preterm birth and fetal growth problems,<sup>16,27,28</sup> but despite their size, none stratified the results by racial/ethnic background. Rather, in several studies, race was either not considered or was adjusted for in the analysis and reported as a risk factor for worse outcomes. Although Black women are at high risk for poor perinatal outcomes compared to White women, focusing on an exclusively Black population allows an examination of excess risk related to sleep disturbances within a frequently studied but disproportionately impacted population.

**Table 3**—Associations between habitual snoring and pregnancy outcomes.

Habitual Snoring	Hypertensive Disorders of Pregnancy (n = 42)	Chronic Hypertension (n = 39)	Preterm Delivery (n = 36)	Fetal Growth Restriction (n = 27)
Unadjusted				
Reference	Ref	Ref	Ref	Ref
Prepregnancy	2.48 (1.07–5.73)	3.35 (1.48–7.59)	2.77 (1.19–6.47)	2.46 (0.96–6.36)
Pregnancy-onset	1.39 (0.59–3.27)	—	0.78 (0.28–2.20)	0.83 (0.264–2.64)
Adjusted <sup>a</sup>				
Reference	Ref	Ref	Ref	Ref
Prepregnancy	2.37 (0.96–5.88)	2.57 (1.06–6.25)	2.75 (1.10– 6.92)	5.06 (1.68–15.20)
Pregnancy-onset	1.23 (0.50–3.02)	—	0.60 (0.20–1.85)	1.03 (0.32–3.93)

<sup>a</sup>Adjusted for age, education, smoking, and body mass index. Ref = reference.

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Although SDB is a significant risk factor for HDP,<sup>15,17,26</sup> non-Hispanic Black women may present a unique risk profile. They are more likely to have hypertension before pregnancy and subsequently develop preeclampsia compared to women from other minority groups,<sup>29</sup> this trend seems to be reflected in our finding that there was a significant association between pre-pregnancy snoring and chronic hypertension. Notably, pregnancy may be a window to long-term cardiovascular health because HDP are associated with increased cardiovascular disease later in life.<sup>30</sup> In the general adult population, the prevalence of hypertension across racial/ethnic groups is similar to the observed pattern of cardiovascular disease that occurs later in life<sup>31</sup> and is likely related to the disproportionate exposure of people from racial/ethnic minority groups to economically/socially marginalized environments and other chronic stressors that lead to increased activation of the hypothalamic-pituitary-adrenal-axis.<sup>32</sup>

Racial/ethnic disparities in sleep-wake disturbances have been previously reported in pregnant women.<sup>33</sup> A higher prevalence of short sleep, worse sleep quality, more insomnia symptoms, greater difficulty in falling asleep, sleep difficulties resulting from breathing issues, and waking up gasping for air have all been observed in Black pregnant women compared to White pregnant women.<sup>14,34</sup> Indeed, Kalmbach et al<sup>14</sup> showed that Black women, in comparison to White women, were 75% more likely to score > 8 on the Pittsburgh Sleep Quality Index,<sup>35</sup> indicative of worse sleep quality; were more than twice as likely to sleep less than 6 hours per night; and were more likely to report SDB symptoms. Notably, poverty and obesity rates were higher among Black women in this study, relative to White women, which contributed to racial disparities in sleep quality and SDB symptoms. It has been reported that Black women are even less likely than White women to report sleep problems to their health care provider.<sup>36</sup>

Results from the present study build on these prior findings by highlighting that a large proportion of non-Hispanic Black pregnant women report multiple sleep-wake disturbances and that habitual snoring increases the odds for their presence. The timing of symptoms suggests that the chronic presence of habitual snoring (rather than gestational-related snoring) may drive the associations with fetal growth restriction and preterm birth. It is plausible that poor sleep in early pregnancy—such as that which occurs in women with chronic habitual snoring—could increase systemic inflammation and disturb the normal remodeling of maternal blood vessels that perfuse the placenta.<sup>37</sup> This process may result in compromised placental blood flow to the fetus, with consequent fetal growth restriction. Early identification of women with habitual snoring may serve as a modifiable risk factor to reduce adverse newborn outcomes.

Although socioeconomic status and overall health seem to contribute to racial disparities in sleep as observed in some studies,<sup>14</sup> a study of nonpregnant women indicated racial disparities in sleep, even after accounting for socioeconomic status.<sup>38</sup> Biological and environmental contributors, in addition to social determinants, have been consistently linked to racial disparities in health.<sup>39</sup> Furthermore, recent research has shown that sleep and health are negatively impacted by structural racism and discrimination.<sup>40</sup> Chronic stressors have also been

associated with adverse pregnancy outcomes, including low birth weight and preterm deliveries,<sup>41–43</sup> and responses to such stressors, which include anxiety and depression, have been suggested as pathways leading to the disproportionately higher poor birth outcomes in women of racial and ethnic minorities.<sup>44</sup> Note that chronic sleep disturbance elicits a stress-related hypothalamic-pituitary-adrenal axis response with an abnormal immune/inflammatory reaction, which can negatively impact pregnancy outcomes.<sup>45</sup> Poor sleep during pregnancy can therefore lead to stress overload in a population already impacted by high levels of chronic psychosocial stress and discrimination.<sup>46</sup> It is thus plausible that adverse maternal and fetal outcomes could be exacerbated by such sleep disruption.

Stratified associations between sleep disturbances and perinatal outcomes within racial/ethnic groups are infrequent. A study with 79 Black women reported that poor sleep quality was associated with 10 times the odds of preterm birth compared to Black women with good sleep quality.<sup>47</sup> In contrast, no relationship was found between sleep quality and preterm birth in White women. Significant associations between poor sleep quality and shortened gestation as measured on a continuum were also observed among Black pregnant women, associations that were again absent among White women.<sup>47</sup> Excessive inflammation during pregnancy has been shown to predict lower birth weight and shortened gestation,<sup>48,49</sup> and Black women seem to exhibit a larger inflammatory response compared to White women at similar levels of poor sleep, which suggests an enhanced physiological response.<sup>48,50</sup> Non-Hispanic Black women may have an elevated vulnerability for sleep-induced inflammatory dysregulation, which may contribute to racial disparities in perinatal outcomes.

However, the unique contribution of sleep to the perinatal morbidity of non-Hispanic Black women remains elusive. Minimizing race-related unmeasured confounding that is often present in racially/ethnically heterogeneous populations should be a priority area for further research. Few studies have investigated the role of sleep disturbance in adverse perinatal outcomes exclusively in non-Hispanic Black women. One study in Ghanaian women failed to find an association between sleep quality, snoring, or sleep duration with preterm birth, cesarean delivery, low birth weight, neonatal intensive care admission, or stillbirth, although it did find a relationship with habitual snoring and hypertension.<sup>51</sup> In reality, being a Black woman in the United States seems to increase the risk for adverse birth outcomes,<sup>52</sup> possibly because of the discrimination and racism that are pervasive across the lifespan.<sup>53,54</sup>

There are a number of strengths in our study. First, this cohort exclusively comprised non-Hispanic Black pregnant women, thus unmeasured racial heterogeneity was minimized. Second, the focus of this study on several prevalent sleep-wake disturbances and their relationship with habitual snoring is unique in the literature. Furthermore, the reported findings show a differential influence of habitual snoring on several sleep-wake disturbances and perinatal outcomes that is dependent on its timing of onset. Given the high burden of the perinatal complications in non-Hispanic Black women, these findings reinforce the importance of screening for habitual snoring particularly in non-Hispanic Black women, who are more likely

than non-Hispanic White women to enter pregnancy with chronic morbidities.

Nonetheless, this study is not without limitation. The sample size was relatively small, and symptoms were self-reported. Whereas we were unable to account for psychosocial stressors, we accounted for several important confounders such as maternal education, BMI, and smoking status. Nonetheless, in this cohort of non-Hispanic Black pregnant women, stratified by habitual snoring, the proportions of women with a partner or in receipt of Medicaid were similar across strata, a strong correlate of psychosocial stress. Despite this finding, racial background was self-assigned and reflects a social rather than biological construct.

In summary, sleep-wake disturbances confer a significant burden to pregnant non-Hispanic Black women, with the vast majority of women reporting 3 or more such disturbances. The presence of chronic (prepregnancy) habitual snoring is associated with chronic hypertension, preterm delivery, and fetal growth restriction, pregnancy outcomes that have known racial disparities. The compounding effect of poor maternal sleep in a population that already carries cumulative psychosocial stressors is an area in need of urgent investigation. How sleep disruptions interact with environmental, biological, and psychosocial predictors of perinatal morbidity in non-Hispanic Black women should be a priority for public health interventions. In light of perinatal morbidities linked to maternal sleep disturbances, interventions to address sleep disruption during pregnancy—a modifiable risk factor—provide a window of opportunity to improve the long-term health of both mother and child.

## ABBREVIATIONS

aOR, adjusted odds ratio

BMI, body mass index

HDP, hypertensive disorders of pregnancy

SDB, sleep-disordered breathing

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## ACKNOWLEDGMENTS

The authors thank the women who participated in this study.

## SUBMISSION & CORRESPONDENCE INFORMATION

**Submitted for publication July 27, 2021**

**Submitted in final revised form December 1, 2021**

**Accepted for publication December 21, 2021**

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## DISCLOSURE STATEMENT

All authors have seen and approved the final version of the manuscript. Work for this study was performed at Michigan Medicine. This study was funded by the Gene and Tubie Gilmore Fund for Sleep Research, the University of Michigan Institute for Clinical and Health Research grant UL1RR024986 and seed pilot grant F021024, and the National Heart, Lung, and Blood Institute (HL089918; Dr. O'Brien). Dr. Dunietz was supported by K01HL144914. The authors report no conflicts of interest.