Sleep Medicine: X 5 (2023) 100061

Contents lists available at ScienceDirect

Sleep Medicine: X

journal homepage: www.elsevier.com/locate/sleep

Clinical application of a previously validated pregnancy-specific screening tool for sleep apnea in a cohort with a high prevalence of obesity

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ARTICLE INFO

Article history:
Received 9 April 2022
Received in revised form
23 November 2022
Accepted 7 December 2022
Available online 8 January 2023

Keywords:
Sleep apnea screening
Pregnancy
Obesity
Sleep apnea
Screening tools

ABSTRACT

Objective: The purpose of this project was to determine the positive predictive value of existing obstructive sleep apnea (OSA) screening tools in clinical use, in a real-world clinical population of gravidae, and to explore the development of a new questionnaire for screening for OSA during pregnancy.

Methods: Pregnant people were administered sleep screening questionnaires as part of routine clinical care. These included Facco's four variable OSA screening tool, the STOP-BANG, and the Epworth Sleepiness Scale. Those who screened positive were referred for diagnostic sleep testing, typically with a type III home monitoring device. Here we analyzed the screening responses used by those who completed diagnostic testing to determine the positive predictive value of the existing tools.

Results: 159 pregnant people completed diagnostic OSA testing and were included in this analysis. The positive predictive value of Facco's four variable sleep screening tool was 74.3%, STOP-BANG was 75.3%, and the Epworth Sleepiness Scale was 69.8%. Our sample size was insufficient to create a new screening tool.

Conclusions: Here we calculated the positive predictive value of Facco's 4 variable screening tool for screening for OSA in pregnancy in a real-world pregnant population. While we were not able to generate a new screening tool for screening for OSA during pregnancy, both STOP-BANG and Facco's four variable tool had positive predictive values over 70% in our population which was characterized by high BMI and advanced maternal age. Increased clinical use of the pregnancy-specific tool may be warranted.

1. Introduction

Obesity and some physiological changes of pregnancy increase the risk for obstructive sleep apnea (OSA) [1–7]. The prevalence of OSA in pregnancy has been estimated to range between 3.6 and 32%, and symptoms of OSA, including snoring, daytime sleepiness and fatigue, have been reported to increase from the first to the third trimester [2,6]. Despite an increase in the occurrence of classic symptoms of OSA [4], OSA remains underdiagnosed and undertreated during pregnancy [5].

OSA has been linked with adverse obstetric outcomes, most notably preeclampsia [4,8–12]. There are no guidelines for the treatment of OSA in pregnancy [13], but when continuous positive airway pressure (CPAP) is initiated during pregnancy, treatment has been associated with decreased incidence of preeclampsia [5,8,14].

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https://doi.org/10.1016/j.sleepx.2023.100061

Thus, diagnosing OSA and initiating treatment may be beneficial at reducing adverse pregnancy outcomes.

There are various questionnaires available to screen for OSA [15–18], but most are not validated for use during pregnancy, with some notable exceptions [11,19–21]. The purpose of this project was to determine the positive predictive value of existing OSA screening tools in clinical use during pregnancy [19,20] and also to explore the development of a new questionnaire.

2. Materials and methods

This project was a collaborative effort between the Division of Maternal-Fetal Medicine at the University of Wisconsin-Madison/ UnityPoint Health-Meriter and the Wisconsin Sleep Clinic at the University of Wisconsin-Madison. The project was approved by the Institutional Review Board at UnityPoint Health-Meriter (Meriter IRB# 2019-014).

As part of routine prenatal care, pregnant people with obesity (defined as a pre-pregnancy body mass index (BMI) greater than or equal to 30 kg/m^2) seen at the University of Wisconsin-Madison and affiliated obstetric clinics are screened for sleep apnea using a pregnancy-specific four-variable tool, and also the STOP-BANG questionnaire [17–20]. Patients who self-report snoring or suspicion for sleep apnea to their clinicians also complete these screening questionnaires. If the pregnant person screens positive on either of these screening tools, they are referred to the Wisconsin Sleep Center for an overnight sleep apnea test. The Wisconsin Sleep Center also administers an intake questionnaire which includes the Epworth Sleepiness Scale and questions about the impact of sleep disturbances on the patient's quality of life. The pregnant person is then triaged to undergo either a home sleep apnea test (HSAT) with a four-channel portable device (Respironics Alice PDx®) or polysomnography (PSG), based on clinical history, insurance requirements, and the sleep physician's (M.H.B) decision. The default was to perform HSATs in order to expedite testing and initiation of treatment, except for cases with suspected comorbid sleep disorders such as obesity hypoventilation or restless leg syndrome (RLS), history of previous CPAP noncompliance, or insurance-required face-to-face clinic visit for symptom and exam documentation prior to sleep testing. Ultimate decisions regarding the most appropriate modality of sleep test were made by the sleep physician (M.H.B.).

We used two questionnaires for screening pregnant people at an early pre-natal visit. The first questionnaire was Facco's four variable tool which is a clinician-administered screening tool which queries frequent snoring (snoring 3 or more times in a week), chronic hypertension, age, and pre-pregnancy BMI [19]. The presence of frequent snoring and chronic hypertension were awarded 15 points each [19]. BMI and age were added as their raw numbers. The sum of the raw BMI, age, and 15 points each for chronic hypertension and/or frequent snoring comprised the total score. A score of 75 or greater was considered to be a positive screen and prompted referral to the sleep clinic. Clinically and for the purposes of this analysis, chronic hypertension was diagnosed as per the definitions of the American College of Obstetricians and Gynecologists as follows: hypertension that is diagnosed prior to pregnancy or before 20 weeks gestational age [22]. In pregnancy these criteria include a systolic blood pressure of 140 mmHg or more or a diastolic blood pressure of 90 mmHg or more on two measurements at least 4 h apart [22].

The second questionnaire was STOP-BANG, which is an eight question screening tool which queries the following: S-snoring (Do you snore loudly (louder than talking or loud enough to be heard through closed doors); T-tired (Do you often feel tired, fatigued, or sleeping during daytime; O-observed (Has anyone observed you stop breathing during your sleep); P-blood pressure (Do you have or are your being treated for high blood pressure); B-BMI more than 35 kg/m^2; A-age over 50 years old; N-neck circumference greater than 40 cm; G-gender male [17,18,21,23]. We categorized the STOP-BANG score into 3 groups; mild (1–2), moderate (3–4), and severe (5–6) and considered a score of 3 or greater as a positive screen, prompting referral to the sleep clinic [17,18]. Of note, the categorizations of mild, moderate, and severe are not specific to pregnancy [17,18]. The sensitivity of STOP-BANG in non-pregnant populations exceeds 80% and varies depending upon the AHI cutoff used for diagnosis of OSA [18]. A third questionnaire, the Epworth Sleepiness Scale (ESS), is widely used in sleep medicine as a screen for sleepiness as well as an insurance-required metric for CPAP coverage in cases of "mild" OSA, and here was an additional scale used only by the sleep clinic and included in our analysis. We considered scores $\geq$10 as positive for excessive daytime sleepiness, as described elsewhere, both in pregnant people and the general population [3,19,24]. Of note, the ESS sensitivity for OSA in the non-pregnant population is low, at 66% [25].

Referrals for the analysis period (June 1, 2017- September 1, 2020) were entered into a clinical database created for the purpose of tracking referrals and results of sleep testing. Following IRB approval, the individual responses to each questionnaire were also entered into this database. All data were collected and managed using Research Electronic Data Capture (REDCap) electronic data capture tools hosted at the University of Wisconsin-Madison, School of Medicine and Public Health [26].

Inclusion criteria for this analysis were as follows: 1) documentation of OSA screening during pregnancy, 2) absence of prior OSA diagnosis 3) OSA testing performed during pregnancy. Exclusions were: 1) absence of OSA screening documentation, 2) prior diagnosis of OSA, 3) not pregnant at the time of screening, such as those screened prior to conception or postpartum 4) diagnostic sleep test not performed or performed after the end of pregnancy. Patients diagnosed with OSA prior to pregnancy were excluded from this present analysis, because we sought to evaluate the positive predictive values of these screening tools specifically for people screened during pregnancy. Because this study sought to evaluate the individual items on the sleep screening tools, the individual responses for at least one sleep screening tool needed to be available for inclusion in this analysis.

For the purpose of this analysis, OSA was defined by respiratory effort index (REI) with portable HSAT or, in the case of in-lab PSG testing, apnea-hypopnea index (AHI) $\geq$5 events/hour [27]. Either Center for Medicare and Medicare services (CMS) 4% desaturation or American Academy of Sleep Medicine (AASM)-recommended 3% desaturation criteria were used to score hypopneas, per the discretion of the sleep medicine physicians interpreting the HSAT [27]. In cases where initial HSAT was "negative," but subsequent PSG was diagnostic for OSA, the PSG was deemed definitive, and those patients were considered as "OSA diagnosed." Of note, as of October 2021, Wisconsin Sleep has implemented dual AASM and Medicare scoring for all sleep studies, thus facilitating future comparison analyses of diagnostic and clinical outcomes using the two different respiratory scoring criteria.

Demographics and pregnancy outcomes were collected via review of the electronic health record and manually entered into the REDCap database. All pregnancy outcomes were defined as per the contemporary definition described by the American College of Obstetricians and Gynecologists using their Practice Bulletins as guidance [22,28,29]. When gestational age was categorized by trimester, the first trimester was defined as 1 week to 12 weeks 6 days, second trimester as 13 weeks–27 weeks 6 days, and third trimester as 28 weeks–42 weeks. Marital status was categorized as "coupled", including those who were married, living together, or in

a committed relationship or “not coupled”, including those who were single, separated, or divorced.

Established risk factors for OSA to consider for a potential new screening tool during pregnancy were determined based upon review of the literature [2,19,30–32], and were based on biologic plausibility, potential utility to guide future pregnancy care, and clinical experience. These included hypothyroidism, polycystic ovarian syndrome, history of preeclampsia (due to possible undiagnosed OSA during the prior pregnancy), and history of gestational diabetes. If any of these potential risk factors proved to be associated with or potentially predictive of OSA during pregnancy, we planned to incorporate this into a potential new screening tool.

Demographic variables were analyzed using Pearson's chi-squared test and Student's t-test as appropriate. Established and proposed potential risk factors for sleep apnea during pregnancy were similarly analyzed using Pearson's chi-squared test. The positive predictive value (PPV) of each screening tool was calculated as the number of true positives divided by the sum of true positives plus false positives and the negative predictive value (NPV) as the true negatives divided by the sum of true negatives plus false negatives using the formulas shown.

$$\mathrm{PPV} = \frac{true\ positives}{true\ positives + false\ positives}\ x\ 100$$

$$\mathrm{NPV} = \frac{true\ negatives}{true\ negatives + false\ negatives} x\ 100$$

To attempt to develop a pregnancy specific prediction tool for sleep apnea, demographic and clinical characteristics and symptoms associated with sleep apnea with p values < 0.05 in univariate analysis were to be considered as potential candidates for items to include in the screening tool. All statistical analyses were performed utilizing R version 4.0, RStudio version 1.2.5031 (R Core Team (2021)) or Stata Statistical Software: Release 16 (College Station, TX: StataCorp LLC).

3. Results

Between June 1 of 2017 and September 1 of 2020, 462 completed pregnancies were available in the database. We screened four hundred and thirty subjects (Fig. 1), after removing duplicate records and those with incomplete questionnaires. Subjects whose diagnosis of OSA preceded pregnancy (31), those no longer pregnant during their sleep study (25) or who never completed a sleep study (215) were excluded from the analysis (271 total). Therefore, the total number of subjects included in the study for analysis was 159.

As depicted in Table 1, 78.6% of pregnant people in our study were White with an average age of 33.4 years. Overall, 70% were married or had a partner. The majority of the population had obesity (92.5%) with a mean BMI of 40.6 kg/m^2 and 30.2% had chronic hypertension at the time of conception. The average gestational age at the time of screening was 17.4 weeks whereas the average gestational age at the time of sleep study was 21.9 weeks.

Of 159 included pregnant people in the study, 157 completed home sleep study and 18 underwent polysomnography (2 underwent PSG only and 16 underwent PSG following HSAT). Of the 159, 115 were diagnosed with OSA (72.3%). There was a statistically significant association between higher pre-pregnancy BMI (namely BMI $\geq$45 kg/m^2) and diagnosis of OSA.

Table 2 shows both established and proposed risk factors for OSA in pregnancy. 95.6% of pregnant people diagnosed with OSA had a BMI>30 kg/m^2 compared to 84.1% of those without OSA ($p = 0.01$). Of the pregnant people diagnosed with OSA, 34.8% had chronic hypertension compared to 18.2% of those without OSA (p value $= 0.04$). Overall, 71.1% of those screened reported frequent snoring (3 or more times in a week), but frequent snoring did not show statistically significant association with OSA diagnosis (p value $= 0.65$).

As shown in Table 3, 88.1% of pregnant subjects in our cohort screened positive for OSA using Facco's 4-question screening tool with a positive predictive value of 74%. The STOP-BANG questionnaire screened positive in 45.9% of pregnant people in our study with a positive predictive value of 75%. The Epworth sleepiness scale (ESS) had the lowest positive predictive value at 69.8%.

We were ultimately unable to create a new screening tool due to low numbers and lack of statistical significance of the proposed potential risk factors for OSA.

4. Discussion

Here we used Facco's 4 variable screening tool for clinical screening for OSA during pregnancy in a real-world population of pregnant people, most of whom had obesity [19]. We observed that pre-pregnancy BMI and chronic hypertension were independent risk factors for OSA in our population. Snoring and age were not significant independent factors in our population, unlike in Facco's study [19]. We calculated a positive predictive value of 74.3% for Facco's four variable tool, higher than in Facco's original report which reported a positive predictive value of 55.8% [19].

The discrepancy between our results and Facco's may be due to only “screen positive” pregnant people undergoing testing, a different home sleep apnea testing device, or differences in the demographic characteristics of the populations. For example, in Facco's study, all patients completed sleep apnea testing regardless of screening results [19]. Facco's study also used a different home sleep apnea testing device, namely the WatchPAT®, while we used a four-channel portable device (Respironics Alice PDx) [19]. The patients in our study also had higher BMIs and were less racially and ethnically diverse than those in Facco's study [19].

When we compared our results with the NuMoM2b study [2] - the largest prospective study of OSA in healthy, uncomplicated pregnancies to date - pre-pregnancy BMI was a significant risk factor for OSA in both studies, but age and snoring were not. Notably, our population was older, with a significantly higher average BMI compared to the population in the NuMoM2b study [2].

We used the Epworth Sleepiness Scale (ESS) to assess subjective daytime sleepiness in pregnant people and evaluated scores equal to or greater than 10 as a risk factor for OSA diagnosis. Screening positive on the ESS was not associated with a positive diagnostic sleep apnea test result, which is similar to the findings of prior investigators [19,33].

For the STOP-BANG, a score greater than or equal to 3 was considered a positive screen for sleep apnea. We calculated a positive predictive value of 75.3% and a negative predictive value of 35.9% in our population. Tantrakul et al. validated the STOP-BANG questionnaire during pregnancy and concluded it had acceptable predictive values as pregnancy advances especially in the second trimester [33]. The high prevalence (72.3%) of OSA diagnosed in our study population likely explains the higher positive predictive value of the STOP-BANG compared to other studies. Though snoring was predictive of OSA in other studies, statistical significance was not reached for snoring or excessive daytime sleepiness in our analysis [17,18,21,23,33,34].

Dominguez et al. also studied the performance of screening questionnaires in pregnant people with BMI $\geq$40 kg/m [11], and they were unable to validate Facco's screening tool for their study population. We found chronic hypertension to be an important risk

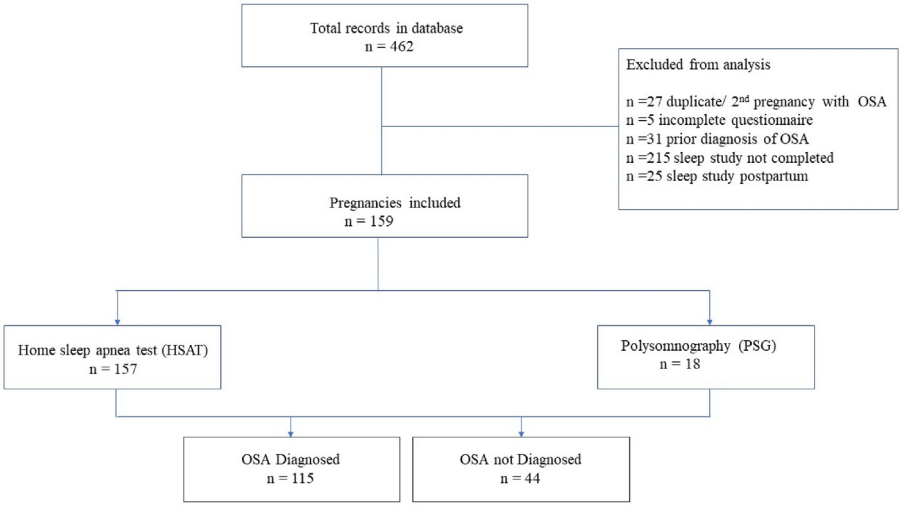

Fig. 1. In our clinic, pregnant people with a prepregnancy BMI ≥30 kg/m^2 and those who complain of snoring are screened for sleep apnea. Those who screen positive and those who have sleep apnea already diagnosed prior to pregnancy are entered into the database to track follow-up and outcomes. For this analysis, of the 462 pregnancies in the database, 159 were pregnancies who were initially screened during pregnancy and completed testing. Of the 159 pregnant people who completed screening during pregnancy, 115 (72.3%) were diagnosed with sleep apnea.

Table 1
Demographic, anthropometric, and pregnancy characteristics.

Variable	n (% or mean)	OSA diagnosed	OSA not diagnosed	p value
	n = 159	n = 115	n = 44	
Maternal age group, years, mean, (SD)	33.4 ± 5.6	33.7 ± 5.6	32.7 ± 5.6	0.2779
Age group, n (%)				0.5477
< 25	9 (5.7)	6 (5.2)	3 (6.8)	X^2 3.061
25–29	25 (15.7)	18 (15.7)	7 (15.9)	df 4
30–34	51 (32.1)	33 (28.7)	18 (40.9)	
35–39	62 (39.0)	49 (42.6)	13 (29.5)	
≥40	12 (7.5)	09 (7.8)	03 (6.8)	
Race, n (%)				
- White	125 (78.6)	91 (79.1)	34 (77.3)	
- Black	14 (8.8)	10 (8.7)	4 (9.1)	0.9988
- Hispanic	10 (6.3)	7 (6.1)	3 (6.9)	X^2 0.098
- Asian	3 (1.9)	2 (1.7)	1 (2.3)	df 4
- Other	7 (4.4)	5 (4.3)	2 (4.5)	
Marital status,n (%)				
				0.9332
- Coupled	111 (69.8)	81 (70.4)	30 (68.2)	X^2 0.007
- Not coupled	48 (30.2)	34 (29.6)	14 (31.8)	df 1
Prepregnancy BMI (kg/m^2), mean ± SD [a]				
< 25, n (%)	40.6 ± 8.3	41.5 ± 8.3	38.2 ± 8.3	0.972
25–29.9	5 (3.1)	3 (2.6)	2 (4.5)	**0.0201**
30–44.9	7 (4.4)	2 (1.7)	5 (11.3)	X^2 9.828
≥45	100 (62.9)	71 (61.7)	29 (65.9)	df 3
	47 (29.6)	39 (33.9)	8 (18.2)	
Gestational age at screening, mean ± SD				
1st trimester, **n (%)**[b]	17.43 ± 8.5	17.43 ± 8.3	14.9 ± 8.3	0.116
2nd trimester	65 (40.8)	46 (40.0)	19 (43.2)	0.781
3rd trimester	73 (45.9)	53 (46.1)	20 (45.4)	X^2 0.494
	19 (11.9)	15 (13.0)	4 (9.1)	df 2
Gestational age at testing, mean ± SD[c]	21.91 ± 8.1	22.69 ± 8.1	19.91 ± 7.7	0.051
1st trimester, n (%)	25 (15.9)	15 (13.3)	10 (22.7)	0.219
2nd trimester, n (%)	88 (56.1)	63 (55.5)	25 (56.8)	X^2 3.034
3rd trimester, n (%)	44 (28.0)	35 (31.0)	9 (20.5)	df 2

Categorical variables (n (%) were analyzed by Pearson's chi-squared or Fisher's test exact test, as appropriate. Continuous variables (mean ± SD) were compared using Student's t-test (two tailed).
[a] Categorized based upon distribution of BMI.
[b] Gestational age at referral was not available for two patients.
[c] Gestational age at sleep study was not available for two patients.

factor for screening for OSA instead of age, which is in contrast to Dominguez et al.'s results [11]. Notably, of the OSA screening tools tested by Dominguez et al., Facco's tool had the highest area under the receiver operator curve and was the only tool significantly associated with a diagnosis of OSA in their study [11]. Dominguez also found that age, BMI, neck circumference, frequently witnessed

Table 2
Univariable evaluation of established and proposed risk factors for sleep apnea during pregnancy.

Risk factor	n (%)	*OSA diagnosed n (%)*	*OSA not diagnosed n (%)*	p value
	n = 159	n = 115	n = 44	
Pre-pregnacy BMI (kg/m^2) ≥ 30, n (%)	147 (92.4)	110 (95.6)	37 (84.1)	**0.0135** X2 6.096 df 1
Chronic hypertension, n (%)	48 (30.2)	40 (34.8)	08 (18.2)	**0.0452** X^2 3.411 df 1
Frequent snoring, n (%)	113 (71.1)	80 (69.6)	33 (75.0)	0.654 X^2 0.062 df 1
Pre-pregnancy BMI (kg/m^2), mean ± SD [a]				
< 25, n (%)	40.6 ± 8.3	41.5 ± 8.3	38.2 ± 8.3	0.972
25–29.9	5 (3.1)	3 (2.6)	2 (4.5)	**0.0201**
30–44.9	7 (4.4)	2 (1.7)	5 (11.3)	X^2
≥45	100 (62.9)	71 (61.7)	29 (65.9)	df 3
	47 (29.6)	39 (33.9)	8 (18.2)	
Chronic hypothyroidism, n (%)	22 (13.8)	16 (13.9)	6 (13.6)	1 X^2 2.48[a]10^{-30} df 1
History of preeclampsia/gestational hypertension in prior pregnancy, n (%)	22 (13.8)	17 (14.7)	5 (11.3)	0.796 X^2 0.069 df 1
History of GDM[a] in prior pregnancy, n (%)	14 (8.8)	12 (10.4)	2 (4.5)	0.406 X^2 0.689 df 1
Type 2 diabetes mellitus, n (%)	23 (14.4)	18 (15.6)	5 (11.3)	0.663 X^2 0.190 df 1
PCOS, n (%)[b]	24 (15.1)	20 (17.3)	4 (9.1)	0.24 X^2 1.344 df 1

[a] Gestational diabetes mellitus.
[b] Polycystic ovarian syndrome.

Table 3
Positive predictive value of three screening tools used to screen for sleep apnea during.

Screening tool	*High risk for OSA n 159* n (%)	*OSA diagnosed n 115* n (%)	*OSA not diagnosed n 44* n (%)	p value	Positive predictive value	Negative predictive value
Facco et al	140[a] (88.1)	104 (90.4)	36 (81.8)	0.117 X^2 2.448 df 1	74.3	47.1
STOP- BANG[b]	73[c] (45.9)	55 (47.8)	18 (40.9)	0.2268 X^2 2.967 df 2[a]	75.3	35.9
Epworth sleepiness scale (ESS)[d]	43 (27.0)	30 (26.1)	13 (29.5)	0.227 X^2 1.72[a]10^{-31} df 1	69.8	28.8

[a] Representing total number of patients considered high risk for OSA with Facco score ≥75.
[b] Moderate and severe were both considered to be screen positive for sleep apnea.
[c] Representing total number of patients considered high risk for OSA with STOP- BANG score ≥3.
[d] Representing total number of patients considered high risk for OSA with ESS score ≥10.

apneas, and likelihood to fall asleep while driving were associated with OSA in their population [11]. While these findings were published after implementation of our clinical OSA screening protocol, incorporation of these additional factors may improve screening accuracy [20].

Few studies have evaluated Facco's 4 variable screening tool in clinical practice, and here we did so in a clinical setting, in a pregnant population with a high prevalence of obesity (92%) and chronic hypertension (30%). Strengths of our study include our use of a commonly used portable HSAT, the Alice PDX®, whereas the WatchPAT® device used by Facco et al. is not widely used in clinical practice in the US [19]. Limitations include the fact that we were not able to perform diagnostic testing on individuals who screened negative for sleep apnea. Accordingly we used two screening tools, but this does not overcome the possibility that someone may have OSA but screen falsely negative on both tools. Other limitations include our small sample size, and low completion rate for the objective HSAT or PSG. Specifically, 215 out of 462 (46%) of pregnant people referred for testing did not complete a sleep study. We are separately analyzing the characteristics of pregnant people who did or did not complete sleep apnea testing, to evaluate for predictors of sleep study completion in this population. Non-completion of the sleep test introduces sample bias as it may be that only those with significant symptoms undergo testing, or it may also be that only those with sufficient resources to pick up and return the testing device undergo testing. The former scenario would result in

an overestimate of the percentage of referred patients who ultimately have OSA and would suggest that our present analysis overestimates the positive predictive value of these tools. Predictors of sleep study completion are being analyzed separately. Quality improvement measures will focus on addressing any identified disparities. The diversity of age, race, and ethnicity in our population was low, which limits the generalizability of our findings.

Only pregnant people with a pre-pregnancy BMI $\geq$30 kg/m^2 were clinically screened in a systematic fashion [20]. BMI is one of the predictors of obstructive sleep apnea in pregnant cohorts, but it is not the only predictor [2,19]. Thus, there may have been pregnant people with lower BMIs who could have screened positive. Further, because we did not perform sleep testing on pregnant people who screened negative, we could not calculate the sensitivity or specificity of the screening tools. Our assessment of the negative predictive value was similarly limited in that only those who screened positive on at least one questionnaire underwent diagnostic testing, therefore, those screening falsely negative on more than one test would not have undergone testing. A final limitation is the difference in scoring criteria, as some sleep tests were scored using 3% versus 4% desaturation. When re-analyzing PPV by 3 v. 4% criteria, the PPV was about 15–20% lower using 4% versus 3% criteria. However, the difference in scoring criteria used reflects the reality of clinical sleep medicine.

5. Conclusions

OSA is a common condition among pregnant people with obesity. While we were not able to generate a new screening tool based upon our small sample size, further research may establish a more reliable screening tool. Here we found that the positive predictive value of the pregnancy-specific tool and STOP-BANG were similar in a cohort with a high prevalence of obesity, but the negative predictive value of STOP-BANG was lower. Increased use of the pregnancy-specific screening tool may be warranted.

Funders

This work was supported by the University of Wisconsin School of Medicine and Public Health Departments of Obstetrics and Gynecology and Neurology. Via the use of REDCap for clinical tracking, the project described was also supported by the Clinical and Translational Science Award (CTSA) program, through the NIH National Center for Advancing Translational Sciences (NCATS), grant UL1TR002373. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH. The funders played no role in the study design, collection, analysis, and interpretation of data, in the writing of the report, and in the decision to submit the article for publication.

CRediT authorship contribution statement

Sakshi Bajaj: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Visualization, Validation, Roles, Writing – original draft, Writing – review & editing. **A. Lauren Rice:** Data curation, Investigation, Resources, Writing – review & editing. **Payden White:** Data curation, Resources, Writing – review & editing. **Abigail M. Wiedmer:** Data curation, Resources, Writing – review & editing. **Natalie M. Jacobson:** Data curation, Resources, Writing – review & editing. **Nathan R. Jones:** Conceptualization, Formal analysis, Investigation, Methodology, Resources, Software, Validation, Visualization, Writing – review & editing. **Mihaela H. Bazalakova:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Supervision, Writing – review & editing. **Kathleen M. Antony:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Supervision, Writing – review & editing.

Declaration of competing interest

None.

Acknowledgements

We would like to thank the University of Wisconsin School of Medicine and Public Health Departments of Obstetrics and Gynecology and Neurology, Unity Point Health-Meriter's Center for Perinatal Care, and Wisconsin Sleep for their support in the development of the obstetric sleep clinic. Via the use of REDCap for clinical tracking, the project described was supported by the Clinical and Translational Science Award (CTSA) program, through the NIH National Center for Advancing Translational Sciences (NCATS), grasnt UL1TR002373. We would also like to thank Robert Koehler for reviewing the literature and procuring articles.

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