ORIGINAL ARTICLE

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Author contributions: In the study, KDPC and VSA contributed to the design of the research project. KDPC collected the clinical data and performed the statistical analysis. All authors reviewed the manuscript and validated its final version.

Ethics committee approval: The research was approved by the Bioethics Committee of Antenor Orrego Private University, RESOLUTION No. 000362-2025-UPAO

Data confidentiality: Information was handled during the research under strict confidentiality rules, solely for research purposes.

Right to privacy: The privacy of clinical records was respected, and informed consent was used.

Funding: The study was self-funded by the authors.

Conflict of interest: The authors declare that they have no conflict of interest.

Use of AI: AI assistance was used exclusively to improve the translation of the text.

Original contribution and importance: This study provides local evidence on the association between gestational diabetes and the risk of sleep apnea in pregnant women in the third trimester, using clinical screening tools. The findings could improve the early detection of OSA in prenatal care.

Received: 18 June 2025

Accepted: 9 October 2025

Online publication: 27 October 2025

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Cite as: Panta-Chumacero K, Serna V. Gestational diabetes and risk of obstructive sleep apnea in the third trimester. Rev peru ginecol obstet. 2025;71(2). DOI: https://doi.org/10.31403/rpgo.v71i2779

Gestational diabetes and risk of obstructive sleep apnea in the third trimester

Diabetes gestacional y riesgo de apnea obstructiva del sueño en el tercer trimestre

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DOI: https://doi.org/10.31403/rpgo.v71i2779

ABSTRACT

Introduction: Physiological changes during pregnancy predispose women to complications such as gestational diabetes (GD) and obstructive sleep apnea (OSA). Recent studies suggest a possible relationship between the two conditions in the third trimester; however, this relationship has not yet been sufficiently explored in local contexts. Objective: To evaluate the association between gestational diabetes (GD) and the risk of obstructive sleep apnea (OSA) in third-trimester pregnant women. Methods: An observational, cross-sectional study included 152 pregnant women with ≥28 weeks' gestational age. OSA risk was assessed using the Epworth, STOP-BANG, and Mallampati scales, while the presence of GD was determined using the IADPSG criteria. Crude prevalence ratios (cPR) and adjusted prevalence ratios (aPR) with 95% confidence intervals were calculated. Results: A significant association was observed between the risk of OSA and gestational diabetes (cPR = 1.465) as well as with hyperglycemia (cPR = 2.03). After the adjusted analysis, only hyperglycemia showed a significant association (aPR = 1.985). Conclusion: The risk of OSA was significantly associated with hyperglycemia in pregnancy, suggesting a possible relationship with alterations in glycemic metabolism.
Keywords: Gestational diabetes, sleep apnea, pregnancy, risk, screening.

RESUMEN

Introducción: Los cambios fisiológicos durante el embarazo predisponen a complicaciones, como la diabetes gestacional (DG) y la apnea obstructiva del sueño (AOS). Estudios recientes sugieren una posible relación entre ambas patologías en el tercer trimestre; sin embargo, esta relación aún no ha sido suficientemente explorada en contextos locales. Objetivo: Evaluar la asociación entre diabetes gestacional (DG) y el riesgo de apnea obstructiva del sueño (AOS) en gestantes del tercer trimestre. Métodos: Estudio observacional y transversal. Incluyó 152 gestantes con ≥28 semanas de edad gestacional. El riesgo de AOS se evaluó mediante las escalas de Epworth, STOP-BANG, y Mallampati; mientras la presencia de DG se determinó por los criterios de la IADPSG. Se calculó razones de prevalencia cruda (RPc) y ajustada (RPa) con intervalos de confianza al 95%. Resultados: Se observó una asociación significativa entre el riesgo de AOS y la diabetes gestacional (RPc = 1,465) así también, con la hiperglucemia (RPc = 2,03). Tras el análisis ajustado solo la hiperglucemia mostró una asociación significativa (RPa = 1,985). Conclusión: El riesgo de AOS se asoció significativamente con hiperglucemia en el embarazo, lo que sugiere una posible relación con alteraciones del metabolismo glucémico.
Palabras clave: Diabetes gestacional, apnea obstructiva del sueño, embarazo, riesgo, tamizaje.

Introduction

Pregnant women undergo physiological, metabolic, and hormonal changes that predispose them to a range of complications, among which gestational diabetes (GD) and obstructive sleep apnea (OSA) have emerged as conditions of increasing clinical relevance. Recent studies have proposed a potential association between GD and the risk of OSA during the third trimester, a period characterized by anatomical changes and heightened insulin resistance that exacerbate these conditions[1]. Nevertheless, within the Latin American context—particularly in Peru—available evidence remains scarce.

Gestational diabetes refers to alterations in carbohydrate metabolism, usually diagnosed in the third trimester of pregnancy[2]. It is observed in

between 1% and 14% of people, mainly affecting Latin America[3]. Adaptations in maternal metabolism respond to the growing energy needs of the fetus and placenta by prioritizing greater glucose availability[4,5]. Thus, glucose transporters increase their expression due to the increased demand for this substrate[6], while insulin resistance decreases glucose utilization by maternal tissues[7]. To ensure fetal growth, maternal pancreatic β cells adapt[8] and hormones such as placental lactogen, cortisol, progesterone, and estrogens intervene, decreasing insulin sensitivity, which in the context of genetic predisposition leads to gestational diabetes[9,10].

Following childbirth, a considerable proportion of women may develop type 2 diabetes mellitus in subsequent years, underscoring the importance of maintaining metabolic control[11]. This issue has emerged as a public health concern due to its long-term implications for the health of both the mother and the child[12]. Consequently, conditions such as respiratory disorders may be associated with the exacerbation of systemic inflammatory processes induced by GD during pregnancy[13].

Obstructive sleep apnea (OSA) is characterized by recurrent obstruction of the upper airway during sleep, leading to decreased oxygen saturation and the activation of the sympathetic nervous system and catecholamine release, which in turn promote gluconeogenesis[13,14]. The physiological consequences of OSA include oxygen desaturation, tachycardia, hypertension, and cerebral infarction[14]. During OSA-induced hypoxia, pancreatic β-cells exhibit reduced insulin secretion, accompanied by increased insulin resistance in adipose and skeletal muscle tissue[15].

The relationship between OSA and GD may be influenced by pre-pregnancy BMI, history of other pregnancies, and inflammatory status and endothelial dysfunction[15]. During pregnancy, narrowing of the upper airways may occur due to elevated levels of estrogen and progesterone[16]. In addition, the increase in uterine size causes the diaphragm to shift 4 cm upward, reducing residual respiratory capacity by 20% and increasing the risk of breathing difficulties during the night[17]. Given the potential impact of both conditions on maternal health and the possibility of a common pathophysiological link, it is essential to examine whether there is a relationship between the presence of GD and an increased risk of OSA during the third trimester of pregnancy.

A deeper understanding of this association would enhance preventive clinical strategies in prenatal care and improve the timely diagnosis of pregnant women at risk. Accordingly, this study aims to assess the association between GD and a high risk of OSA among pregnant women receiving care at two health facilities in the city of Piura, Peru; to describe their clinical and metabolic characteristics; to determine the frequency of OSA risk and the prevalence of GD in women in their third trimester; and to estimate the crude and adjusted prevalence ratios for high OSA risk in relation to gestational hyperglycemia, obesity, and gestational diabetes among the participants.

Methods

Study design

A basic observational, retrospective, and analytical study was conducted.

Population and sample

The population consisted of 152 pregnant women in their third trimester of pregnancy, treated at the Los Algarrobos Health Center and the Castilla Health Center in the city of Piura during the period 2024–2025. The final sample consisted of 38 pregnant women diagnosed with GD and 114 without this diagnosis.

Inclusion and exclusion criteria

Participants who provided informed consent and had the required laboratory tests in their medical records for the diagnosis of GD were included in the study. Pregnant women whose gestational age fell outside the third-trimester range, as well as those with a prior diagnosis of chronic diseases or psychiatric disorders, were excluded.

Variables

Gestational diabetes was assessed through fasting glucose levels recorded in medical records. Pregnant women with abnormal values (≥92 mg/dL) were referred for a 75g oral glucose toler-

ance test, following the diagnostic criteria proposed by the International Association of the Diabetes and Pregnancy Study Groups (IADPSG)[18] according to research conducted by HAPO and referred to as the "single-step approach"[19].

To assess the risk of OSA, three tools were used: the Epworth Sleepiness Scale, the STOP-BANG Questionnaire, and the Mallampatti Classification, which are validated clinical screening instruments and indirect clinical findings that identify situations and characteristics that put people at risk for OSA. The Epworth Scale showed a sensitivity of 61% and a specificity of 76% for OSA in pregnant women; the STOP-BANG questionnaire showed a sensitivity of 62.5% and a specificity of 93.8% for identifying symptoms and history of OSA[20]. Meanwhile, the modified Mallampati classification addresses anatomical characteristics that pose a risk of upper airway obstruction[21]. Therefore, the risk of OSA was classified as follows:

- Low risk: Pregnant women with a score <10 on the Epworth Sleepiness Scale, a score ≤2 on the STOP-BANG questionnaire, and Mallampati classification grade I or II.
- Moderate risk: Pregnant women with a score of 10-12 on the Epworth Sleepiness Scale, a score between 3-4 on the STOP-BANG questionnaire, and Mallampati Classification grade III.
- High risk: Pregnant women with a score >12 on the Epworth Sleepiness Scale, between 5-8 on the STOP-BANG questionnaire, or Mallampati IV.

Other variables considered were maternal age, gestational age, body mass index (BMI), and measurement of the neck circumference at the level of the cricoid cartilage.

Data analysis

The data collected were anonymized and coded in accordance with ethical principles of confidentiality and voluntary participation. The information was organized into a Microsoft Excel database. Categorical variables were presented as absolute and relative frequencies, while numerical variables were analyzed using measures of central tendency and dispersion. The association between clinical characteristics and the risk of OSA was analyzed using the chi-square test, considering a statistical significance level of $p < 0.05$. Finally, the prevalence ratio (PR) was calculated to estimate the magnitude of the association between exposure (gestational diabetes) and outcome (risk of OSA), along with their respective confidence intervals.

Ethical aspects

In accordance with the Universal Declaration on Bioethics and Human Rights (UDBHR), the Declaration of Helsinki, and the CIOMS guidelines[22], this study was conducted in adherence to the principles of medical ethics and deontology, ensuring respect for patient dignity and the reliability of the research process. Written informed consent was obtained from all pregnant women who agreed to participate, following a detailed explanation of the study's objectives, benefits, risks, and procedures. Participant privacy was protected using codes or identifiers to maintain data confidentiality. The study was conducted under the supervision of an ethics committee, ensuring compliance with ethical standards and the protection of participants' rights.

Results

Table 01 presents the quantitative baseline characteristics evaluated in the sample of 152 pregnant women in their third trimester of pregnancy, where the average maternal age is 25.6 years (SD: 5.05); the mean gestational age was 34.8 weeks (SD: 1.92); and the mean body mass index (BMI) was 26.5 (SD: 3.43); this indicates that most of the pregnant women studied are young and tend to be overweight. In terms of respiratory health, the median Epworth Sleepiness Scale score was 12 and the median STOP BANG questionnaire score was 2, suggesting that most pregnant women are at intermediate risk for OSA; while according to the Mallampati Classification, with a median of 2, they are at low risk.

Table 2 shows the categorical variables evaluated, where 46.7% (N=71) of pregnant women had gestational hyperglycemia, and 25% (N=38) had gestational diabetes, which means that there is a large proportion of pregnant women with impaired glucose metabolism who, without adequate control, could belong to the GD group. According to the risk of obstructive sleep

apnea, 36.2% (N=55) presented moderate risk and 42.1% (N=64) presented high risk. In terms of body composition, 44.7% (N=68) were overweight, which was more prevalent than obesity, with 18.4% (N=28) presenting this characteristic. Likewise, 25.7% (N=39) of pregnant women had an increased neck circumference (>41 cm).

Figure 01 shows the frequency distribution of OSA risk, where it can be seen that 42.1% of the pregnant women evaluated are at high risk of OSA, while 36.2% are classified as moderate risk and 21.7% as low risk. Regarding the prevalence of gestational diabetes in pregnant women, it is estimated that 25% of the pregnant women evaluated have GD, while 75% do not meet the diagnostic criteria for this condition.

Ordinal logistic regression was used to analyze the association between the clinical and metabolic characteristics of pregnant women and the risk of obstructive sleep apnea, with maternal age and body mass index variables showing statistical significance. Older maternal age (26.58 ± 4.991) was associated with a higher risk of OSA, as was a higher BMI (27.736 ± 3.121).

In relation to gestational diabetes, a higher prevalence was identified in the high-risk OSA group (32.8%) compared to the moderate-risk (30.9%) and low-risk groups, where no cases were reported (p = 0.003). Similarly, gestational hyperglycemia shows a significant association with the risk of OSA (p = 0.000). In the high-risk group, 64.1% of pregnant women have hyperglycemia, while in the moderate-risk group, this proportion is 54.5%. Nutritional status also shows a statistically significant association with the risk of OSA (p = 0.000). It is observed that the proportion of pregnant women who are overweight and obese increases with the level of OSA risk. In the high-risk group, 53.1% are overweight and 29.7% are obese, while in the low-risk group these proportions are 24.2% and 9.1%, respectively. Finally, increased neck circumference shows a strong association with the risk of OSA (p = 0.005). In the high-risk group, 37.5% of pregnant women have this condition, compared to 18.2% in the moderate-risk group and 15.2% in the low-risk group.

When analyzing these proportions using Poisson regression with robust variance to estimate crude prevalence ratios (PR), a significant association was identified between GD and high risk of OSA (PR = 1.47; p = 0.044). Other variables also showed significant associations with high risk of OSA, such as gestational hyperglycemia (PR = 2.03; p = 0.001), obesity (PR = 1.52; p = 0.026), and increased neck circumference (PR = 1.74; p = 0.002). However, after performing the adjusted analysis, only gestational hyperglyce-

Table 01. Baseline quantitative characteristics of the pregnant population

	N	Normal parameters			p*
		Mean	Standard Deviation	Median	
Maternal age	152	25.66	5.051	25.00	<0.001
Gestational age	152	34.76	1.921	35.00	<0.001
Epworth Scale score	152	12.02	2.801	12.00	<0.001
Mallampati Scale score	152	2.55	0.890	2.00	<0.001
Stop Bang Questionnaire score	152	3.56	1.161	4.00	<0.001
Body mass index	152	26.514	3.427	25.900	<0.001

**Kolmogorov-Smirnov test for a sample.*

Table 02. Categorical variables of the population of pregnant women during the third trimester

		N	%
Risk of Obstructive Sleep Apnea Syndrome	Low risk	33	21.7
	Moderate risk	55	36.2
	High risk	64	42.1
Gestational Diabetes	No	114	75.0
	Yes	38	25.0
Gestational Hyperglycemia	No	81	53.3
	Yes	71	46.7
Nutritional Status	Normal	47	30.9
	Malnutrition	9	5.9
	Overweight	68	44.7
	Obesity	28	18.4
Increased Neck Circumference	No	113	74.3
	Yes	39	25.7

Data collection form

Figure 01: Frequency of risk of Obstructive Sleep Apnea Syndrome in pregnant women.

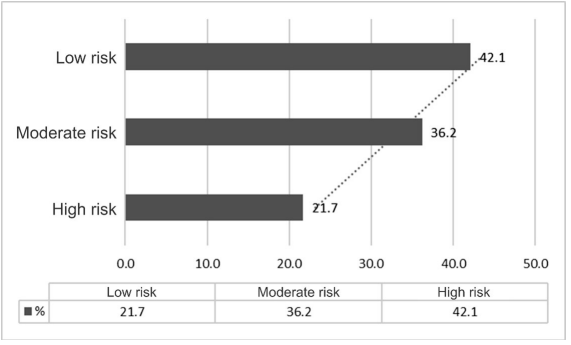

Table 03. Association between risk of obstructive sleep apnea and clinical and metabolic characteristics of pregnant women in the study.

		Risk of Obstructive Sleep Apnea			p*
		Low risk	Moderate risk	High risk	
Maternal Age		24.55 ± 4.251	25.25 ± 5.444	26.58 ± 4.991	0.006
Gestational Age		34.70 ± 1.879	34.45 ± 1.762	35.06 ± 2.054	0.408
Body Mass Index		25.597 ± 2.492	25.644 ± 3.840	27.736 ± 3.121	0.000
Gestational Diabetes	No	33 (100.0%)	38 (69.1%)	43 (67.2%)	0.003
	Yes	0 (0.0%)	17 (30.9%)	21 (32.8%)	
Gestational Hyperglycemia	No	33 (100.0%)	25 (45.5%)	23 (35.9%)	0.000
	Yes	0 (0.0%)	30 (54.5%)	41 (64.1%)	
Nutritional Status	Normal	22 (66.7%)	14 (25.5%)	11 (17.2%)	0.000
	Malnutrition	0 (0.0%)	9 (16.4%)	0 (0.0%)	
	Overweight	8 (24.2%)	26 (47.3%)	34 (53.1%)	
	Obesity	3 (9,1%)	6 (10.9%)	19 (29.7%)	
Increased neck circumference	No	28 (84.8)	45 (81.8)	40 (62.5)	0.005
	Yes	5 (15.2)	10 (18.2)	24 (37.5)	

** Ordinal logistic regression*

Table 04. Association between categorical variables and high risk of obstructive sleep apnea (OSA) syndrome in pregnant women.

Variable	Crude PR	95% CI	*p*-value
Gestational hyperglycemia	2.034	1.365 – 3.031	0.001
Gestational diabetes	1.465	1.011 – 2.123	0.044
Obesity	1.518	1.051 – 2.192	0.026
Neck circumference Increased	1.738	1.223 – 2.471	0.002

Poisson regression with robust variance to estimate crude prevalence ratios (cPR).

Table 05. Adjusted association between categorical variables and high risk of obstructive sleep apnea syndrome (OSA) in pregnant women.

Variable	Adjusted PR	95% CI	*p*-value
Gestational hyperglycemia	1.985	1.269 – 3.105	0.003
Gestational diabetes	0.818	0.546 – 1.226	0.331
Obesity	1.325	0.924 – 1.899	0.126
Increased neck circumference	1.382	0.963 – 1.983	0.079

Poisson regression with robust variance to estimate adjusted prevalence ratios (aPR).

mia remained a significantly associated factor (adjusted PR = 1.985; 95% CI: 1.269–3.105; p = 0.003), suggesting that this condition acts as an independent factor related to the elevated risk of OSA in this population.

Discussion

This study showed a significant association between high risk of OSA and the presence of gestational hyperglycemia (PR = 2.03; p = 0.001), obesity (PR = 1.52; p = 0.026), gestational diabetes (OR = 1.47; p = 0.044), and increased neck circumference (OR = 1.74; p = 0.002). However, in the adjusted analysis, only gestational hyperglycemia maintained a statistically significant association (adjusted OR = 1.985; 95% CI: 1.269–3.105; p = 0.003), suggesting that this condition acts as an independent factor related to the high risk of OSA in this pregnant population. These results are consistent with international studies that have reported a higher prevalence of OSA in women with glucose metabolism disorders. For example, a study by Newbold et al[23] found that pregnant women with OSA had a higher risk of metabolic disorders, including GD.

Another novel aspect is the integration of clinical screening tools for OSA with metabolic diagnosis during pregnancy. In this study, a moderate average sleepiness score was obtained on the Epworth Sleepiness Scale, and a high proportion of pregnant women were classified as having intermediate or high risk of OSA according to the STOP-BANG questionnaire; likewise, the Mallampati Scale showed an intermediate distribution.

A higher prevalence of GD was identified in the high-risk OSA group (32.8%) compared to the low-risk group. This relationship was even more evident when considering gestational hyperglycemia in general, with a prevalence of 64.1% in the high-risk group (p = 0.000). These results support the hypothesis of a significant association between OSA and alterations in glucose metabolism during pregnancy. The study by Izci Balserak et al.[24] reinforces the evidence that the risk of OSA is significantly related to metabolic

alterations during pregnancy. This is consistent with studies by Bourjeily[25], in which pregnant women diagnosed with OSA have a significantly higher risk of conditions such as hypertensive disorders and gestational diabetes.

These findings create new avenues for future research across diverse population contexts, enabling a more comprehensive understanding of this association and facilitating the exploration of the potential benefits of early diagnosis and treatment of OSA. Nevertheless, the present study is subject to certain limitations. The retrospective design and data collection from medical records may have generated information biases or limitations in the availability of relevant variables. In addition, the use of clinical screening tools, although validated, does not replace diagnostic confirmation by polysomnography, considered the gold standard for the diagnosis of OSA.

In conclusion, the present study suggests that OSA may be associated with alterations in glucose metabolism that, while not necessarily meeting the diagnostic criteria for GD, nonetheless constitute a significant clinical risk. Consequently, the presence of OSA risk could serve as an indicator of metabolic dysfunction during pregnancy, underscoring the importance of its early detection within preventive strategies for pregnant women.

Acknowledgements

I would like to thank the pregnant women who voluntarily participated in this study for their willingness and trust. I would also like to acknowledge the health personnel at the Los Algarrobos Health Center and the Castilla Health Center for their collaboration during the data collection process. I am also grateful to the School of Medicine at Antenor Orrego Private University in Piura for its institutional support in the development of this research.

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