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Maternal Obesity and Preeclampsia Risk Among Pregnant Women in a Remote District Hospital of Central Papua: A Cross-Sectional Study

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ABSTRACT

Preeclampsia remains a leading cause of maternal and perinatal morbidity and mortality worldwide, particularly in low- and middle-income countries (LMICs). Maternal obesity is an important modifiable risk factor; however, evidence from geographically isolated regions such as Central Papua remains limited. This study aimed to examine the association between maternal Body Mass Index (BMI) and preeclampsia risk among pregnant women attending a referral hospital in Central Papua, Indonesia. A hospital-based cross-sectional study was conducted using secondary antenatal medical records from RSUD Paniai, Central Papua, collected between January and September 2024. A total of 77 eligible pregnant women were included using total population sampling. Maternal BMI was calculated from weight and height measured at the first antenatal visit and categorized according to World Health Organization criteria as obese (BMI ≥30 kg/m^2) or non-obese (<30 kg/m^2). Preeclampsia was diagnosed by attending obstetricians based on Indonesian National Clinical Practice Guidelines. Associations were assessed using Pearson's Chi-square test and multivariable logistic regression adjusted for maternal age and gestational age. Among the 77 participants, 35 (45.5%) were obese, and 30 (39.0%) had preeclampsia. Mild preeclampsia occurred exclusively among obese women (42.9%), while severe preeclampsia occurred in 31.4% of obese versus 9.5% of non-obese women. After adjustment, obesity remained independently associated with preeclampsia (adjusted OR = 7.85; 95% CI: 2.28–27.00; p < 0.001). In summary, maternal obesity was strongly associated with increased preeclampsia risk in Central Papua. These findings support routine BMI assessment, nutritional counseling, and early identification of high-risk

pregnancies during antenatal care, particularly in geographically remote settings.

Keywords
Body Mass Index
Cross-sectional Study
Maternal Obesity
Preeclampsia
Pregnancy

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Introduction

Hypertensive disorders of pregnancy remain one of the most important causes of maternal and perinatal morbidity and mortality worldwide. Among these disorders, preeclampsia represents the most severe pregnancy-specific hypertensive condition because of its potential to rapidly progress into multisystem organ dysfunction affecting both maternal and fetal outcomes. Globally, preeclampsia complicates approximately 2–8% of all pregnancies and contributes substantially to maternal deaths, preterm birth, fetal growth restriction, placental abruption, stillbirth, neonatal intensive care admission, and long-term cardiovascular disease among affected mothers [1]-[5]. Despite continuous advances in obstetric care, the burden of preeclampsia remains disproportionately high in low- and middle-income countries (LMICs), where delays in diagnosis, inadequate antenatal care, and limited emergency obstetric services continue to compromise maternal survival [6]-[9].

The prevention and early detection of preeclampsia have become global public health priorities and are incorporated into the Sustainable Development Goals (SDG 3), which aim to reduce the global maternal mortality ratio to fewer than 70 deaths per 100,000 live births by 2030 [1]. The World Health Organization also emphasizes comprehensive antenatal care, early risk assessment, nutritional management, and timely referral as key strategies for preventing severe maternal complications [10]. However, implementing these recommendations remains challenging in geographically isolated and resource-constrained settings, where access to healthcare facilities, trained health professionals, diagnostic equipment, and emergency obstetric services is often limited [10]-[14].

The pathogenesis of preeclampsia is complex and multifactorial. Current evidence indicates that abnormal trophoblast invasion during early placentation results in inadequate remodeling of the uterine spiral arteries, leading to placental ischemia and hypoxia [15]. Placental dysfunction subsequently stimulates the excessive release of antiangiogenic factors, inflammatory cytokines, oxidative stress mediators, and endothelial injury markers into the maternal circulation [16]. These biological alterations eventually produce widespread endothelial dysfunction, vasoconstriction, hypertension, and multiple-organ involvement

characteristic of preeclampsia. Increasing evidence also suggests that chronic systemic inflammation, insulin resistance, dysregulated adipokine secretion, and angiogenic imbalance play important roles in amplifying these pathological processes [17]-[19].

Among the numerous maternal risk factors identified, obesity has emerged as one of the strongest modifiable predictors of preeclampsia. Excess adipose tissue promotes chronic low-grade inflammation through increased production of tumor necrosis factor-alpha (TNF-α), interleukin-6 (IL-6), leptin, and other pro-inflammatory adipokines while simultaneously impairing insulin sensitivity and endothelial function [20], [21]. These mechanisms adversely affect placental vascular development and increase susceptibility to hypertensive disorders during pregnancy [15], [18], [22]. Large prospective cohort studies, systematic reviews, and meta-analyses have consistently demonstrated that women with obesity have substantially higher risks of developing preeclampsia than women with normal body weight [23]-[25].

Although the relationship between maternal obesity and preeclampsia has been extensively investigated in high-income countries and urban referral hospitals, evidence from geographically isolated regions remains limited. Most epidemiological studies conducted in Indonesia have originated from Java and other western provinces with relatively well-developed healthcare systems, while data from eastern Indonesia, particularly Central Papua, are scarce [10],[11],[14]. Consequently, current knowledge regarding the magnitude of obesity-related preeclampsia risk in remote populations remains incomplete [10], [11], [14]. This lack of evidence is particularly important because geographical barriers, limited transportation infrastructure, shortages of healthcare professionals, and delayed access to comprehensive antenatal care may substantially influence pregnancy outcomes and the clinical presentation of hypertensive disorders [22], [26].

Central Papua represents one of Indonesia's most geographically challenging regions. Mountainous topography, dispersed settlements, and limited transportation networks restrict access to routine maternal healthcare services and referral hospitals [11],[14]. Previous studies have demonstrated that women living in remote areas frequently experience delayed antenatal care attendance, reduced continuity of care, and delayed referral for obstetric emergencies [14]. These barriers may contribute to more severe maternal complications and higher maternal mortality compared with women living in urban settings. Therefore, understanding the relationship between maternal obesity and preeclampsia within this unique healthcare context is essential for developing evidence-based maternal health interventions tailored to remote populations [27], [20].

Several systematic reviews and meta-analyses have consistently demonstrated that maternal obesity increases the risk of preeclampsia by approximately two- to four-fold. However, the magnitude of this association varies considerably across populations because of

differences in ethnicity, nutritional transition, healthcare accessibility, socioeconomic conditions, and study design. Most previous investigations have been conducted in tertiary hospitals or national registry databases where antenatal services are relatively comprehensive. Consequently, findings from these settings may not fully represent women living in geographically isolated districts where healthcare accessibility remains a substantial challenge. Generating locally relevant evidence is therefore essential to support context-specific maternal health policies and improve risk-based antenatal care in underserved regions [5], [17], [12].

The novelty of the present study lies in three important aspects. First, this study provides one of the first hospital-based investigations examining the association between maternal obesity and preeclampsia in Central Papua, a region that remains markedly underrepresented in the international maternal health literature [11], [13], [14], [28]. Second, unlike previous studies conducted predominantly in urban or tertiary referral settings, this research evaluates the relationship within a remote district hospital serving geographically isolated communities, where barriers to healthcare access may influence both disease occurrence and clinical outcomes [9], [3]. Third, this study contributes locally generated evidence that may strengthen maternal health surveillance and support the development of risk-based antenatal care strategies for remote populations in eastern Indonesia [4], [12].

Beyond its scientific relevance, this study also has important implications for public health policy. Identifying maternal obesity as a potentially modifiable risk factor may facilitate earlier identification of women at high risk for hypertensive disorders during pregnancy [23], [29], [30]. Routine BMI assessment at the first antenatal visit, strengthened nutritional counseling, and targeted monitoring of obese pregnant women may improve the early detection and management of preeclampsia, particularly in remote healthcare settings where referral opportunities are often limited [1], [4], [6], [22]. These findings may therefore support local health authorities in strengthening antenatal care programs and contribute to national strategies aimed at reducing maternal morbidity and mortality [18], [19], [30], [31], [32].

Therefore, this study aimed to examine the association between maternal Body Mass Index (BMI) at the first antenatal visit and the occurrence of preeclampsia among pregnant women attending RSUD Paniai, Central Papua, Indonesia. We hypothesized that maternal obesity (BMI ≥30 kg/m^2) would be independently associated with a significantly higher risk of preeclampsia after adjustment for maternal age and gestational age.

Material and Methods

A. Study Design, Setting, and Participants

A hospital-based cross-sectional study was conducted to examine the association between maternal Body Mass Index (BMI) and preeclampsia among pregnant women attending RSUD Paniai, Central Papua, Indonesia. RSUD Paniai is a secondary referral hospital providing

antenatal, delivery, emergency obstetric, and maternal–neonatal referral services for the surrounding area. The study used routinely collected antenatal medical records from January to September 2024.

The study population comprised all pregnant women who attended antenatal care during the study period. Of 95 women initially identified, 18 were excluded because of incomplete medical records or unavailable BMI measurements at the first antenatal visit. The final analytical sample therefore included 77 pregnant women. Total population sampling was applied by including all records that met the eligibility criteria.

Eligible participants were women with documented antenatal care at RSUD Paniai and complete information on anthropometric measurements, maternal age, gestational age, and preeclampsia diagnosis. Records with missing BMI measurements, incomplete clinical information, or missing pregnancy information relevant to the study were excluded.

B. Study Variables and Outcome Definition

The primary exposure was maternal Body Mass Index (BMI). BMI was initially classified into four categories according to the World Health Organization criteria: underweight, normal weight, overweight, and obese. For the primary association analysis, BMI was dichotomized as non-obese (<30 kg/m^2) and obese (≥30 kg/m^2).

Preeclampsia status was initially recorded in three clinical categories: normal pregnancy, mild preeclampsia, and severe preeclampsia. These categories were retained for descriptive analysis to illustrate the distribution of disease severity. For binary logistic regression, however, the outcome was recoded as no preeclampsia (normal pregnancy) and preeclampsia (mild and severe preeclampsia combined). Maternal age and gestational age were included as potential confounding variables.

Table 1. Study variables and operational definitions

Variable	Role	Measurement/Classification
Preeclampsia	Outcome	Normal pregnancy, mild preeclampsia, or severe preeclampsia based on documented clinical diagnosis
Maternal BMI	Primary exposure	Weight (kg)/height^2 (m^2); underweight, normal, overweight, or obese
Obesity status	Exposure for multivariable analysis	Non-obese (<30 kg/m^2) and obese (≥30 kg/m^2)
Maternal age	Potential confounder	Age documented in the antenatal record
Gestational age	Potential confounder	Gestational age documented at antenatal assessment
Blood pressure	Supporting clinical variable	Systolic and diastolic blood pressure recorded during antenatal care
Proteinuria	Supporting clinical variable	Presence or absence according to clinical record
Maternal complications	Supporting clinical variable	Complications documented by the attending healthcare provider
Occupation	Descriptive variable	Maternal occupation recorded in the medical record
Pregnancy status	Descriptive variable	Pregnancy-related status documented during antenatal care

C. Anthropometric Assessment and Preeclampsia Classification

Maternal height and weight recorded at the first antenatal visit were used to calculate BMI. Height was measured using a calibrated wall-mounted stadiometer to the nearest 0.1 cm, while weight was measured using a calibrated digital scale to the nearest 0.1 kg. BMI was calculated as weight in kilograms divided by height in meters squared. Based on the World Health Organization classification, participants were categorized as underweight (<18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2), or obese (≥30.0 kg/m^2). For multivariable analysis, BMI was further classified into non-obese (<30 kg/m^2) and obese (≥30 kg/m^2). WHO cut-off values were retained to facilitate comparison with international epidemiological studies.

Preeclampsia diagnoses were based on the clinical assessments recorded by attending obstetricians according to the Indonesian National Clinical Practice Guidelines (Pedoman Nasional Pelayanan Kedokteran/PNPK) implemented at RSUD Paniai. Mild preeclampsia was defined by systolic blood pressure of at least 140 mmHg and/or diastolic blood pressure of at least 90 mmHg after 20 weeks of gestation accompanied by proteinuria. Severe preeclampsia was characterized by systolic blood pressure of at least 160 mmHg or diastolic blood pressure of at least 110 mmHg, or by evidence of maternal organ dysfunction, including renal impairment, hepatic dysfunction, neurological manifestations, pulmonary edema, thrombocytopenia, or fetal growth restriction.

D. Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics version 22. Categorical variables were summarized as frequencies and percentages, whereas continuous variables were presented as means and standard deviations, as appropriate. The distribution of normal pregnancy, mild preeclampsia, and severe preeclampsia was first described according to maternal BMI category.

For inferential analysis, mild and severe preeclampsia were combined into a single preeclampsia category and compared with normal pregnancy. The association between obesity status and preeclampsia was initially assessed using the Pearson Chi-square test. Binary logistic regression was then performed to estimate crude and adjusted odds ratios (ORs and aORs) with 95% confidence intervals (CIs). Maternal age and gestational age were included in the adjusted model as clinically relevant potential confounders. Statistical significance was defined as $p < 0.05$.

E. Ethical Considerations

The study was approved by the Health Research Ethics Committee of RSUD Paniai, Central Papua, Indonesia (Approval No. 304/RSUD-PAN/KET/SP/VIII/2024; 12 August 2024). Permission to access hospital medical records was obtained from the hospital administration

before data collection. Because the study relied exclusively on secondary medical records, personal identifiers were removed before analysis to protect participant confidentiality. All data were used solely for research purposes in accordance with the principles of the Declaration of Helsinki.

Results and Discussions

A. Respondent's Characteristics

A total of 77 pregnant women met the study eligibility criteria and were included in the final analysis. The mean maternal age was 28.6 ± 6.4 years. Most participants were aged 20–35 years (75.3%), while 10.4% were younger than 20 years and 14.3% were older than 35 years. Regarding occupation, 51 women (66.2%) were housewives, whereas 26 (33.8%) were employed in various occupations, including civil servants, teachers, and contract workers. Most pregnancies were classified as non-term (76.6%), while 23.4% had reached term gestation at the time of data collection.

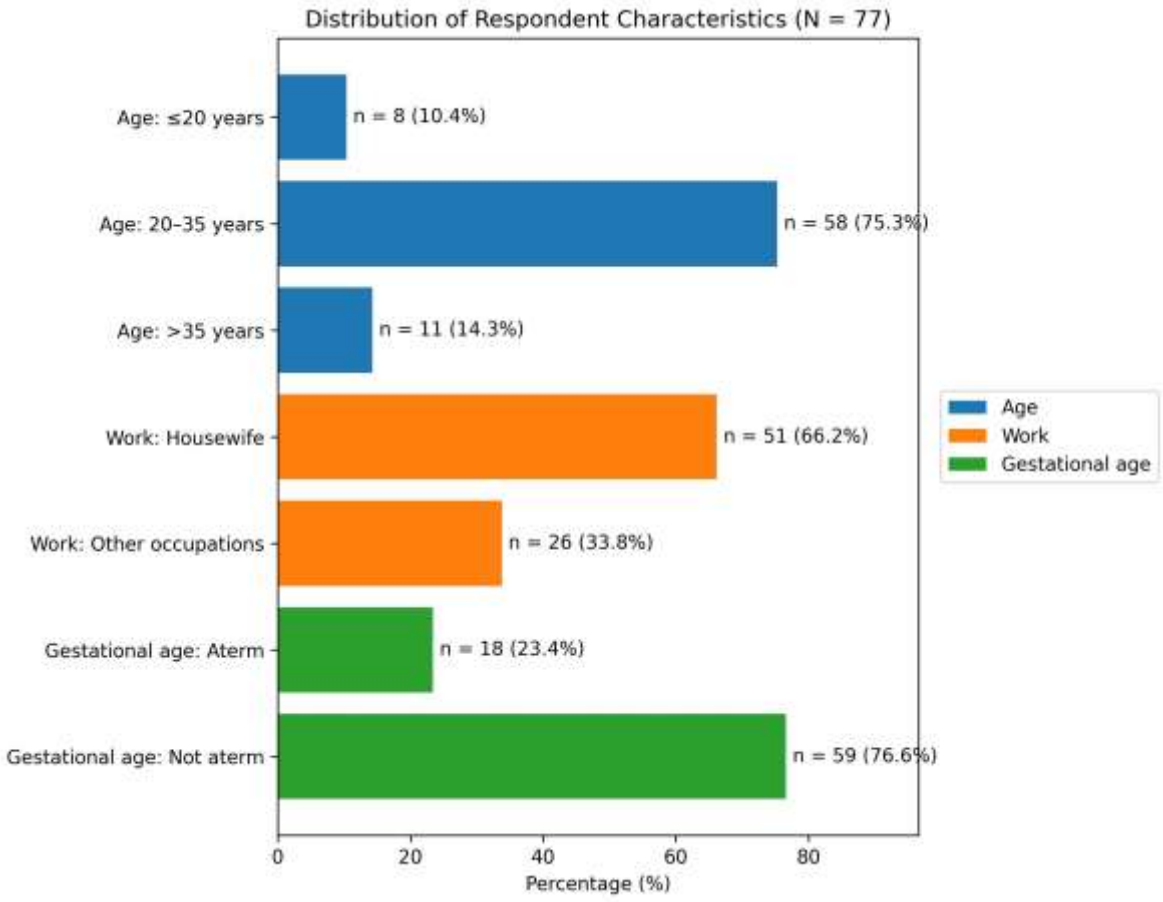

Fig. 1. Characteristics of the Study Respondents

B. Distribution of Maternal BMI and Preeclampsia

Among the 77 pregnant women, 35 (45.5%) were classified as obese according to the WHO BMI classification, while 42 (54.5%) were classified as non-obese. Overall, 30 women (39.0%)

developed preeclampsia, consisting of 15 (19.5%) with mild preeclampsia and 15 (19.5%) with severe preeclampsia. Mild preeclampsia occurred exclusively among obese women (42.9%), whereas severe preeclampsia was observed in both BMI groups but occurred considerably more frequently among obese women (31.4%) than among non-obese women (9.5%).

Table 2. Distribution of Preeclampsia Severity According to Maternal Obesity Status

Preeclampsia	Obese n (%)	Non-obese n (%)	Total
Normal	9 (25.7)	38 (90.5)	47
Mild	15 (42.9)	0 (0)	15
Severe	11 (31.4)	4 (9.5)	15
Total	35 (100)	42 (100)	77

C. Association Between Maternal BMI and Preeclampsia

Pearson's Chi-square analysis demonstrated a statistically significant association between maternal BMI and preeclampsia (χ^2 = 35.82, p < 0.001), indicating that obese women experienced substantially higher rates of preeclampsia than non-obese women. To determine whether this association remained independent after controlling for potential confounding factors, a multivariable logistic regression analysis was performed including maternal age and gestational age.

Table 3. Multivariable Logistic Regression Analysis

Variable	Adjusted OR	95% CI	p-value
Obesity	7.85	2.28–27.00	<0.001
Maternal age (20–35 years)	1.15	0.35–3.76	0.820
Non-term pregnancy	1.33	0.42–4.17	0.630

The multivariable logistic regression model was statistically significant (Omnibus Test χ^2 = 45.661; p < 0.001), indicating that the predictors collectively explained the occurrence of preeclampsia. Model calibration was satisfactory according to the Hosmer–Lemeshow goodness-of-fit test (χ^2 = 1.644; df = 5; p = 0.896), suggesting an adequate fit between the observed and predicted outcomes. The model explained approximately 60.7% of the variation in preeclampsia occurrence (Nagelkerke R^2 = 0.607) and correctly classified 83.1% of study participants. After adjustment for maternal age and gestational age, maternal obesity remained the only variable independently associated with preeclampsia. Obese women had 7.85 times higher odds of developing preeclampsia than non-obese women (adjusted OR = 7.85; 95% CI: 2.28–27.00; p < 0.001). Maternal age (p = 0.820) and gestational age (p = 0.630) were not significantly associated with preeclampsia after adjustment.

The relatively high prevalence of preeclampsia observed in this study (39.0%) likely reflects the role of RSUD Paniai as the main referral hospital in Central Papua, where complicated pregnancies are more frequently managed than in primary healthcare facilities. Furthermore, the absence of mild preeclampsia among non-obese women should be

interpreted cautiously because of the relatively small sample size and the limited number of women in each BMI category.

Discussion

The present study demonstrated that maternal obesity was independently associated with a substantially increased risk of preeclampsia among pregnant women attending RSUD Paniai, Central Papua. After adjustment for maternal age and gestational age, obese women had nearly eight-fold higher odds of developing preeclampsia than non-obese women (adjusted OR = 7.85; 95% CI: 2.28–27.00; $p < 0.001$). These findings reinforce the growing body of evidence identifying maternal obesity as one of the strongest modifiable risk factors for hypertensive disorders during pregnancy [16],[23],[29]. Recent systematic reviews and meta-analyses consistently report that overweight and obesity significantly increase the likelihood of preeclampsia, although the magnitude of risk varies across populations according to demographic characteristics, healthcare accessibility, and study settings [16], [23], [29].

The association observed in the present study was considerably stronger than pooled estimates reported in previous international meta-analyses. Ulhaq et al. [29] reported approximately a threefold increased risk of preeclampsia among obese women, while Moradi et al. [23] likewise demonstrated a significant but more moderate pooled effect across multiple countries. The larger effect size identified in the present study may reflect the unique characteristics of the study population. Unlike previous investigations conducted primarily in urban referral hospitals or national registry databases, the present study was undertaken in a geographically isolated district hospital serving remote mountainous communities in Central Papua. Women attending this hospital frequently experience delayed access to antenatal care, transportation barriers, and referral delays, which may increase the proportion of advanced or complicated pregnancies [3], [14]. Consequently, maternal obesity may interact with delayed diagnosis and limited healthcare access, resulting in a stronger observed association with preeclampsia [8], [14].

The relatively high prevalence of preeclampsia (39.0%) observed in this study should also be interpreted within the context of the hospital's referral function. RSUD Paniai serves as the principal secondary referral hospital for surrounding districts and receives a disproportionate number of complicated pregnancies requiring specialist management. Referral hospitals commonly report higher prevalence estimates than community-based studies because women with uncomplicated pregnancies are generally managed at primary healthcare facilities [3], [7]. Similar observations have been reported in studies conducted in referral hospitals across low- and middle-income countries, where case-mix differences substantially influence estimates of obstetric complications [3], [9].

The biological mechanisms linking maternal obesity and preeclampsia are well established. Excess adipose tissue promotes chronic low-grade systemic inflammation characterized by increased production of pro-inflammatory cytokines, including tumor necrosis factor-alpha (TNF-α), interleukin-6 (IL-6), and leptin, accompanied by reduced adiponectin concentrations [17]-[19]. These alterations contribute to insulin resistance, oxidative stress, endothelial dysfunction, and angiogenic imbalance, all of which interfere with normal placental development during early pregnancy [12], [18]. Inadequate trophoblastic invasion and incomplete spiral artery remodeling subsequently reduce uteroplacental perfusion, triggering placental ischemia and the release of anti-angiogenic factors such as soluble fms-like tyrosine kinase-1 (sFlt-1), ultimately leading to widespread maternal endothelial dysfunction and the clinical manifestations of preeclampsia [5], [15]. These mechanisms have been consistently described in recent pathophysiological studies and remain the predominant explanation for obesity-associated preeclampsia [15], [17], [18].

Geographical conditions may further amplify these biological risks. Central Papua is characterized by mountainous terrain, widely dispersed settlements, and limited transportation infrastructure, creating substantial barriers to routine antenatal care and emergency obstetric referral [11], [14]. Previous studies from eastern Indonesia have demonstrated that women living in remote areas frequently initiate antenatal care later, attend fewer antenatal visits, and experience delayed recognition of pregnancy complications [14]. Limited access to nutritional counseling, routine BMI monitoring, laboratory investigations, and specialist obstetric services may reduce opportunities for early intervention among obese pregnant women, thereby increasing the severity of hypertensive disorders before referral. These contextual factors distinguish the present study from previous investigations conducted in better-resourced healthcare settings [10], [14].

Interestingly, maternal age and gestational age were not independently associated with preeclampsia after multivariable adjustment. Although advanced maternal age is widely recognized as an established epidemiological risk factor, the relatively homogeneous age distribution within the present sample and the limited sample size may have reduced the statistical power to detect independent associations [22], [33]. Residual confounding may also explain these findings because several clinically relevant variables—including parity, chronic hypertension, gestational diabetes mellitus, previous preeclampsia, socioeconomic status, and gestational weight gain—were unavailable in the secondary medical records and therefore could not be included in the regression model [23], [26].

The present study contributes to scientific knowledge in several important ways. First, it provides one of the first epidemiological analyses examining maternal obesity and preeclampsia in Central Papua, a region that remains substantially underrepresented in

international maternal health research. Second, the findings extend existing evidence by demonstrating that the association between obesity and preeclampsia may be considerably stronger in geographically isolated populations than previously reported in international meta-analyses [22], [29]. Third, this study highlights the importance of considering healthcare accessibility and geographical context when interpreting risk factors for hypertensive disorders of pregnancy [3], [14]. Collectively, these findings enrich the existing literature by providing evidence from a remote district hospital that has not been adequately represented in previous epidemiological studies.

The findings also have important implications for maternal health policy and clinical practice. Routine BMI assessment during the first antenatal visit should be strengthened as part of early risk stratification for hypertensive disorders of pregnancy [4], [8], [22]. Pregnant women identified as obese should receive intensified nutritional counseling, individualized weight management, more frequent blood pressure monitoring, and timely referral when early signs of preeclampsia develop [4], [22]. In geographically remote regions such as Central Papua, strengthening community-based antenatal care, improving referral systems, expanding maternal health outreach services, and increasing access to comprehensive obstetric care may substantially reduce preventable maternal complications associated with obesity and preeclampsia [1], [14]. These findings may therefore support local health authorities in developing evidence-based strategies to improve maternal health outcomes in underserved regions.

Several limitations should be acknowledged. The cross-sectional design precludes causal inference because exposure and outcome were assessed simultaneously [26]. The use of secondary medical records may have introduced information bias and limited the availability of potentially important confounding variables [26]. The relatively small sample size and single-center design may reduce external validity and limit generalizability to other populations. Nevertheless, data were obtained from routine clinical practice within the principal referral hospital in Central Papua, providing valuable real-world evidence from an area that remains poorly represented in maternal health research. Future multicenter prospective cohort studies involving larger sample sizes and broader adjustment for clinical, behavioral, nutritional, and socioeconomic factors are required to confirm these findings and improve external validity [23], [30].

Conclusion

This study demonstrated that maternal obesity was independently associated with a significantly increased risk of preeclampsia among pregnant women attending RSUD Paniai, Central Papua. After adjustment for maternal age and gestational age, obese women had nearly eight-fold higher odds of developing preeclampsia than non-obese women (adjusted OR = 7.85;

95% CI: 2.28–27.00), confirming maternal obesity as an important and potentially modifiable risk factor for hypertensive disorders during pregnancy.

Beyond confirming previous evidence, this study contributes new epidemiological data from Central Papua, one of Indonesia's most geographically isolated and underrepresented regions in maternal health research. The findings extend current knowledge by demonstrating that the association between maternal obesity and preeclampsia may be substantially stronger in remote healthcare settings, where geographical barriers and limited access to antenatal care may influence maternal outcomes.

These findings have important implications for clinical practice and health policy. Routine BMI assessment at the first antenatal visit, strengthened nutritional counseling, early identification of high-risk pregnancies, and improved referral systems should be prioritized to reduce the burden of preeclampsia, particularly in geographically remote and resource-limited areas. Future multicenter prospective studies involving larger populations and additional clinical and socioeconomic variables are recommended to validate these findings and improve their generalizability.

Conflict of Interest

The authors declare no conflict of interest.

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