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Higher Risk of Preeclampsia Among Overweight and Obese Pregnant Women Compared to Normal BMI Women

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ABSTRACT

Preeclampsia is a pregnancy complication characterized by hypertension and proteinuria, affecting 2–8% of pregnancies worldwide, with a prevalence of 24% in Indonesia. Its etiology remains unclear due to its complex, multifactorial nature, and several factors, such as age, obesity, pre-existing conditions, and multiple pregnancies, may influence its occurrence. This study aims to investigate the relationship between body mass index (BMI) and preeclampsia in pregnant women. An analytical observational study was conducted using purposive sampling, involving 18 participants in each group. Secondary data were obtained from medical records at Rumah Sakit Cipto Mangunkusumo, Rumah Sakit Budi Kemuliaan, and Puskesmas Senen. Statistical analysis was performed using the Chi-square test. Results show that 17 respondents (47.2%) with overweight or obesity had preeclampsia, whereas 8 respondents (22.2%) with normal BMI did not. The Chi-square test indicated a significant association between BMI and preeclampsia (p=0.007). Higher BMI is significantly associated with preeclampsia. Maintaining a healthy BMI during pregnancy may reduce the risk of this condition.

INTRODUCTION

The World Health Organization reports that maternal mortality continues to pose a significant global health challenge. In 2023, it was estimated that nearly 260,000 women died during pregnancy, childbirth, or the postpartum period. Strikingly, approximately 92% of these maternal deaths occurred in low- and lower-middle-income countries, highlighting persistent disparities in maternal health outcomes across different socioeconomic levels (World Health Organization, 2025). In the ASEAN region, the maternal mortality ratio is recorded at 235 deaths per 100,000 live births (Ministry of Health Republic Indonesia, 2022). According to the Indonesian Demographic and Health Survey (IDHS), maternal and infant mortality rates are key indicators in assessing the overall health status of developing nations. The IDHS findings revealed a concerning trend in Indonesia, where the number of maternal deaths in 2020 increased by more than 500 cases compared to the previous year.

Furthermore, the maternal mortality ratio (MMR), expressed as the number of maternal deaths per 100,000 live births, exhibited considerable fluctuations between 1991 and 2015. However, a downward trend was observed between 2018 and 2019, suggesting temporary progress in maternal health outcomes before the subsequent rise in 2020. This dynamic pattern

highlights the ongoing challenges Indonesia faces in achieving sustained reductions in maternal mortality (Ministry of Health Republic Indonesia, 2022; Ministry of Health Republic Indonesia, 2023).

Preeclampsia is a pregnancy-specific disorder characterized by new-onset hypertension after 20 weeks of gestation and is frequently accompanied by proteinuria or evidence of systemic organ involvement (World Health Organization, 2023). The condition poses severe risks not only to maternal health but also to neonatal outcomes, including intrauterine growth restriction, preterm birth, and perinatal mortality (Indarti et al., 2021). The high prevalence of preeclampsia in Indonesia, reported to exceed global averages, reflects both medical and sociodemographic determinants, ranging from nutritional status to access to health services (Ministry of Health Republic Indonesia, 2022). Thus, identifying risk factors that are contextually relevant to Indonesian populations is essential for developing effective prevention and intervention strategies.

Among the modifiable maternal risk factors, body mass index (BMI) has emerged as a key determinant of preeclampsia. Obesity has been consistently linked to increased risks of hypertensive disorders of pregnancy, mainly due to mechanisms involving systemic inflammation, insulin resistance, and endothelial dysfunction (Suryowati et al., 2023). Conversely, underweight status has also been associated with adverse outcomes such as impaired placental development, which may predispose to preeclampsia and fetal growth restriction (Aji et al., 2022). This double burden of malnutrition—coexisting undernutrition and rising obesity prevalence—presents a unique public health challenge in Indonesia, where transitions in dietary patterns and lifestyles have reshaped maternal health profiles in recent decades (Ministry of Health Republic Indonesia, 2022).

While international studies have established the strong association between BMI and preeclampsia, research in Indonesia remains limited. Previous studies conducted in tertiary hospitals have primarily examined obesity as a categorical risk factor without considering the full spectrum of BMI classifications relevant to Indonesian women (Indarti et al., 2021). For example, a retrospective study at a national referral hospital demonstrated that maternal obesity, particularly class II obesity, was significantly associated with preeclampsia incidence (Indarti et al., 2021). Similarly, a recent case–control study during the COVID-19 pandemic highlighted BMI and hypertension as significant predictors of preeclampsia (Suryowati et al., 2023). However, these studies primarily relied on general WHO BMI cut-off points, which may not fully capture the nuanced nutritional context of Indonesian women, many of whom fall into "borderline" categories between underweight, normal, and overweight.

The research gap, therefore, lies in the lack of a comprehensive analysis of BMI as a risk factor for preeclampsia using refined and context-specific BMI classifications in Indonesia. Most existing studies categorize women into broad groups—such as underweight, normal, or obese—without exploring intermediate thresholds that may be more predictive of preeclampsia risk in the Indonesian population. Moreover, limited attention has been given to the dual risks posed by both low and high BMI in the same population, reflecting Indonesia's ongoing nutritional transition. This knowledge gap reduces the ability of health professionals to deliver tailored preconception and antenatal counseling and may limit the effectiveness of national programs aimed at reducing maternal mortality.

The novelty of this study lies in its use of a more detailed BMI categorization, contextualized for the Indonesian population, rather than applying international standards solely. By refining BMI cut-off points and examining their relationship with preeclampsia, this research offers a novel perspective that can generate evidence more applicable to local maternal health interventions. Such an approach is expected to inform antenatal risk screening, guide targeted nutritional counseling, and support public health initiatives in addressing both undernutrition and obesity, which are contributors to maternal morbidity.

Therefore, this study aims to investigate the association between maternal BMI and the risk of preeclampsia in Indonesia using refined BMI categories. The findings will contribute to a deeper understanding of how maternal nutritional status influences hypertensive disorders of pregnancy in the Indonesian setting and provide evidence-based insights for improving maternal health strategies at both national and local levels.

METHOD

This study applied a retrospective analytic survey with a case–control design, conducted from January to August 2024 at Cipto Mangunkusumo Hospital, Budi Kemuliaan Hospital, and Senen Health Center in Jakarta. The case group consisted of pregnant women diagnosed with preeclampsia, while the control group comprised normotensive pregnant women with gestational age ranging from 20 to 36 weeks. Purposive sampling was used since specific inclusion and exclusion criteria had to be met to ensure comparability between the two groups (Taherdoost, 2022). The inclusion criteria were singleton pregnancy, gestational age between 20 and 36 weeks, and availability of complete maternal anthropometric and clinical data. Exclusion criteria were multiple pregnancies, pre-existing chronic hypertension or diabetes mellitus, and incomplete or inconsistent medical records. Based on the formula for determining sample size in case–control studies with categorical data, and considering the limited number of eligible cases during the study period, a minimum of 18 respondents was required in each group, resulting in a total sample of 36 participants (Bujang et al., 2021).

Secondary data were collected by reviewing medical records and patient registration logs. A structured checklist sheet was developed to extract maternal demographic information (age, parity, and gestational age), anthropometric data (weight and height), and clinical diagnosis (preeclampsia or normotensive). To strengthen validity, data were cross-verified by two independent reviewers, and inconsistencies were resolved through consensus. Reliability was ensured because the anthropometric and diagnostic data were obtained from standardized hospital records that followed national maternal health reporting guidelines (Ministry of Health Republic Indonesia, 2021). Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared (kg/m^2). Furthermore, it was classified into the following categories: underweight (<18.5), normal (18.5–24.9), overweight (25.0–29.9), and obese (≥30.0), according to the Institute of Medicine classification (Zierle-Ghosh & Jan, 2024).

The association between BMI categories and the occurrence of preeclampsia was analyzed using the Chi-Square (χ^2) test, a suitable statistical method for determining the relationship between two categorical variables (Kim, 2019). A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1. Frequency Distribution of Body Mass Index

BMI	Not PE		PE		Total	
	n	%	n	%	n	%
Underweight	0	0	0	0	0	0
Normal	8	22.2	1	2.8	9	25
Overweight	5	13.9	4	11.1	9	25
Obesity	5	13.9	13	36.1	18	50
Total	18	50	18	50	36	100

Notes: The data are presented as percentages

Table 1 summarizes the distribution of body mass index (BMI) among women with and without preeclampsia (PE). Overall, half of the participants were classified as obese (50.0%), one quarter as overweight (25.0%), and one quarter as normal BMI (25.0%); no participants were underweight.

By outcome group, the non-PE group (n=18) comprised 8/18 (44.4%) with a normal BMI, 5/18 (27.8%) who were overweight, and 5/18 (27.8%) who were obese. In contrast, the PE group (n=18) comprised 1 individual (5.6%) with a normal BMI, 4 individuals (22.2%) who were overweight, and 13 individuals (72.2%) who were obese.

Table 2. Relationship of BMI (normal, overweight, and obese) with preeclampsia

BMI	Not PE		PE		Total	
	n	%	n	%	n	%
Normal	8	22.2	1	2.8	9	25
Overweight	5	13.9	4	11.1	9	25
Obesity	5	13.9	13	36.1	18	50
Total	18	50	18	18	36	100
p-value						0.011

Notes: The data are presented as percentages. A statistically significant difference was observed between the groups (*p ≤ 0.05).*

The category was removed from Table 2 since there were no pregnant women with an underweight BMI. The chi-square test was then used to conduct the analysis, yielding a p-value of 0.011 (p<0.05). The number of pregnant women with overweight and obese BMI was combined to determine the correlation between pregnant women with normal BMI and those who are overweight or obese, as indicated in Table 3.

Table 3. The relationship between normal and greater than normal BMI and the incidence of preeclampsia

BMI	Not PE		PE		Total		OR (95% CI)	p-value
	n	%	n	%	n	%		
Normal	8	22.2	1	2.8	9	25	0.125 (0.017-0.90)	0.007
Overweight and obese	10	27.8	17	47.2	27	27	1.7 (1.108-2.608)	
Total	18	50	18	50	36	100	0.074 (0.008-0.678)	

Notes: The data are presented as percentages, odds ratios (OR), and 95% confidence intervals (CI). A statistically significant difference was observed between the groups (*p ≤ 0.05).*

Table 3 shows the relationship between body mass index (BMI) and the incidence of preeclampsia. Among 9 respondents with normal BMI, only 1 (2.8%) experienced preeclampsia, while 8 (22.2%) did not. In contrast, among 27 respondents with overweight or obese BMI, 17 (47.2%) experienced preeclampsia and 10 (27.8%) did not. Statistical analysis demonstrated that respondents with overweight and obese BMI had a significantly higher risk of preeclampsia compared to those with normal BMI (OR=1.7; 95% CI: 1.108–2.608; p=0.007).

DISCUSSION

The present study demonstrated that most participants with preeclampsia had abnormal BMI, particularly in the overweight and obese categories. Overweight and obesity were found to significantly increase the risk of preeclampsia, while maintaining a normal BMI served as a protective factor. These findings are consistent with previous global and regional studies that reported a strong association between increasing BMI and the risk of preeclampsia (Bohîlţea et al., 2020; Wang et al., 2024). Similarly, Bellos et al. (2018) observed a significantly higher prevalence of overweight and obesity among women with preeclampsia compared to normotensive pregnancies. Collectively, this evidence supports the view that obesity is not merely a background condition but an independent and moderate risk factor for preeclampsia.

The biological plausibility of this relationship is supported by previous research. Obesity contributes to maternal endothelial dysfunction, oxidative stress, chronic low-grade inflammation, and dyslipidemia, which can impair placental development and function (Spradley et al., 2015; Roberts et al., 2011). Inadequate placental perfusion during early pregnancy promotes the release of anti-angiogenic factors, such as soluble fms-like tyrosine kinase-1 (sFlt-1), and proinflammatory cytokines, including TNF-α, further disrupting maternal vascular homeostasis (Lopez-Jaramillo et al., 2018; Reyes et al., 2012). These mechanisms provide a plausible explanation for why women with higher BMI are more likely to develop preeclampsia. However, it is essential to note that our study did not directly measure biochemical parameters, such as leptin, insulin resistance, or angiogenic markers; thus, these explanations remain theoretical and do not provide causal evidence from our dataset.

Compared with previous literature, this study makes a specific contribution by categorizing maternal BMI into underweight, normal, overweight, and obese within a case–control design, providing local evidence from an Indonesian urban population. Despite the small sample size, the significant odds ratio strengthens the argument that maternal overweight and obesity remain relevant contributors to preeclampsia risk in this setting.

First, the relatively small sample size (n=36) may reduce the statistical power and precision of the estimates. Second, the retrospective design, which relies on secondary medical record data, is susceptible to information bias due to incomplete or inconsistent documentation. Third, as this research was conducted in referral hospitals and one community health center in Jakarta, generalizability to rural areas or the broader Indonesian population may be limited.

Future research should involve larger, prospective, and multi-center studies that incorporate biochemical, lifestyle, and sociodemographic factors to clarify the underlying mechanisms and strengthen causal inference. Intervention studies targeting preconception or antenatal weight management could also help evaluate the effectiveness of preventive strategies in reducing the risk of preeclampsia.

This study highlights that overweight and obesity significantly increase the risk of preeclampsia, with normal BMI acting as a protective factor. These findings underscore the importance of early BMI screening, nutritional counseling, and maternal weight management before and during pregnancy as part of comprehensive clinical and public health strategies to mitigate the burden of preeclampsia.

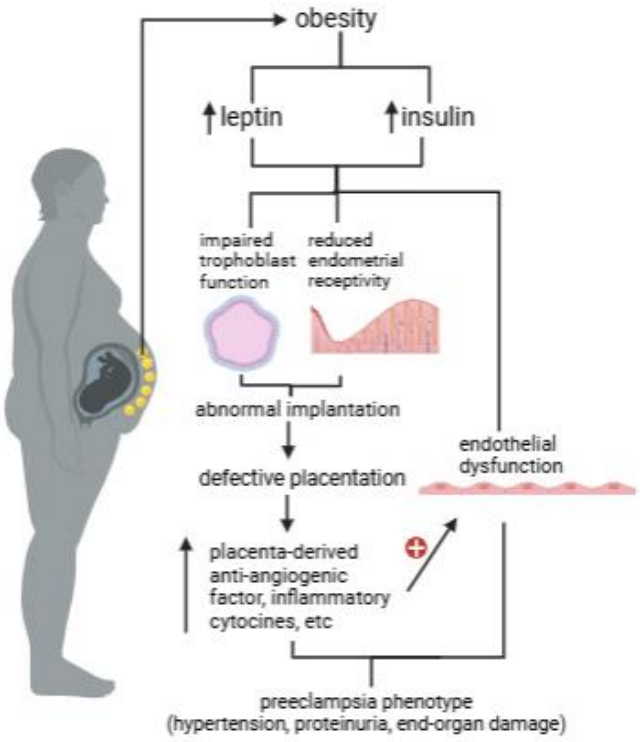

Figure 1. A graphical overview of how maternal obesity contributes to the pathogenesis of preeclampsia (created with BioRender.com in Wang et al., 2024).

One well-known sign of obesity is hyperinsulinemia. During the in vitro maturation-in vitro fertilization-embryo transfer cycle, women with insulin-resistant polycystic ovarian syndrome (PCOS) had a decreased implantation rate. Early embryonic development is unaffected by insulin resistance (Chang et al., 2013). Studies on animals have demonstrated that insulin signaling is essential for the normal development and function of the endometrium. However, excessive insulin has a detrimental effect on endometrial receptivity. For instance, Li R. et al. found that administering insulin exogenously to wild-type (WT) female mice before mating induced hyperinsulinemia (Li et al., 2017).

In both humans and animals, obesity is associated with hyperleptinemia, or elevated plasma leptin levels, which is linked to preeclampsia (Mendieta Zerón et al., 2012). PCOS cases with elevated serum leptin levels exhibited decreased expression of the γ-epithelial Na+ channel (γ-ENaC), which is crucial for embryo implantation, in the secretory phase of the endometrium, and an increased risk of very early pregnancy loss (Lin et al., 2015).

CONCLUSION

This study demonstrated that overweight and obese pregnant women had a significantly higher risk of developing preeclampsia compared to those with normal BMI. Conversely, maintaining a normal BMI exerted a protective effect, reducing the odds of preeclampsia. These findings provide strong evidence that maternal overweight and obesity represent statistically significant risk factors for preeclampsia.

For clinical practice and public health policy, the results underscore the importance of implementing early screening of maternal BMI during antenatal care, along with structured nutritional counseling and weight management programs for women of reproductive age. Such preventive interventions may help reduce the burden of preeclampsia and its associated maternal–fetal complications.

Future research should be directed toward larger, multi-center studies with prospective or longitudinal designs to confirm these findings and to establish causal relationships better. Intervention studies focusing on the effectiveness of pre-pregnancy weight optimization and targeted lifestyle modifications are also recommended to evaluate their direct impact on reducing the incidence of preeclampsia.

AUTHOR'S DECLARATION

Authors' contributions and responsibilities

FK: Writing original draft, visualization, funding acquisition, conceptualization; **ARP:** writing original draft (supporting), supervision; **YP:** writing original draft (supporting), supervision; **WWD, AJS:** review, editing, finishing manuscript.

Availability of data and materials

All data are available from the authors.

Competing interests

All authors have no competing interest.

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