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Risk factors for preeclampsia: A case-control study in Makassar City and Gowa Regency, Indonesia

Faktor risiko preeklamsia: Studi kasus-kontrol di Kota Makassar dan Kabupaten Gowa, Indonesia

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Abstract

Preeclampsia remains a serious pregnancy complication with a high prevalence in Indonesia. This case-control study, conducted in Makassar City and Gowa Regency (August–December 2024), aimed to analyze the risk factors for preeclampsia in 78 pregnant women (>20 weeks gestation), diagnosed based on hypertension and proteinuria. Data on obstetric history, diet (FFQ), and anthropometrics were collected, including serum zinc levels measured using ELISA. Independent t-tests indicated a significantly higher pre-pregnancy Body Mass Index (BMI) in the preeclampsia group ($p<0.05$). A Chi-square test revealed that a history of preeclampsia served as an absolute predictor within this sample (95% CI: ∞). Multivariate Binary Logistic Regression showed that Weight Gain was the only statistically significant independent risk factor for preeclampsia incidence ($p=0.045$), with the risk category yielding an Odds Ratio (OR) of 2.928 (95% CI: 1.022–8.387). Other variables, including BMI, were not significant ($p>0.05$). Dietary patterns (fish intake) also showed an association with preeclampsia in preeclampsia women (p=0,022; OR 9.909 and 95% CI 1.396-70.348). The conclusion is that a history of preeclampsia is an absolute predictor in this study sample. There was a relationship between weight gain during pregnancy and fish intake with the incidence of preeclampsia in the study area.

Keywords: Preeclampsia; body mass index; weight gain; food pattern

Abstrak

Preeklamsia tetap menjadi komplikasi kehamilan serius dengan prevalensi tinggi di Indonesia. Studi kasus-kontrol ini, dilakukan di Kota Makassar dan Kabupaten Gowa (Agustus–Desember 2024), bertujuan menganalisis faktor risiko preeklamsia pada 78 wanita hamil (>20 minggu gestasi) yang didiagnosis berdasarkan hipertensi dan proteinuria. Data riwayat obstetri, pola makan dan antropometri dikumpulkan melalui wawancara, sedangkan kadar seng serum melalui ELISA.Uji t-independen menunjukkan Indeks Massa Tubuh (IMT) sebelum kehamilan secara signifikan lebih tinggi pada kelompok preeklamsia ($p<0,05$\). Uji Chi-square mengungkapkan bahwa riwayat preeklamsia berfungsi sebagai prediktor absolut dalam sampel ini (95% CI: ∞). Regresi Logistik Biner Multivariat menunjukkan penambahan berat badan adalah satu-satunya faktor risiko independen yang signifikan terhadap kejadian preeklamsia (p=0,045; OR 2,928 dan 95% CI 1,022–8,387). Pola makan (asupan ikan) juga berhubungan dengan kejadian preeklamsia (p = 0,022; OR 9.909 dan 95% CI 1.396-70.348). Variabel lain, termasuk IMT, tidak signifikan secara independen ($p>0,05$). Kesimpulan penelitian ini adalah bahwa riwayat preeklamsia adalah prediktor absolut dalam sampel ini. Terdapat hubungan antara penambahan berat badan selama kehamilan dan asupan ikan dengan kejadian preeklamsia.

Kata Kunci: Preeklamsia, IMT, kenaikan berat badan, pola makan.

Introduction

Preeclampsia is a disorder of pregnancy associated with new-onset hypertension, usually with accompanying proteinuria, which occurs most often after 20 weeks of gestation and frequently occurs near term (Karrar et al., 2024). In Indonesia, preeclampsia is the third leading cause of maternal death, accounting for approximately 37% of maternal deaths caused by this condition (Ari et al., 2024). Research at RSP Dr. Soetomo recorded 2887 cases of preeclampsia in one year (Lijuwardi et al., 2020), while at RSUD Kota Madiun, the prevalence reached 5.39% (Putri et al., 2022).

The negative impacts of preeclampsia can affect the health of both the fetus and mother. Fetuses from mothers with preeclampsia are at risk of experiencing growth disorders. (Haslan & Trisutrisno, 2022) In addition, a history of preeclampsia in pregnant women is associated with an increased incidence of low birth weight (LBW) babies. (Hanif et al., 2021) The incidence of neonatal asphyxia in mothers with preeclampsia is also three times higher than in mothers without preeclampsia. (Mongdong et al., 2021)

One of the factors influencing the occurrence of preeclampsia is the pre-pregnancy nutritional status and weight gain during pregnancy. Previous research has found that 90% of preeclampsia cases can be reduced by individually controlling weight gain during pregnancy in overweight and obese women (Robillard et al., 2023). A study in China involving 901 respondents also concluded that pre-pregnancy BMI and weight gain during pregnancy influenced the incidence of preeclampsia (Ren et al., 2021).

A history of preeclampsia in a previous pregnancy is also a risk factor for the development of preeclampsia. A study involving 500 pregnant women concluded that a history of preeclampsia, longer duration of hypertension, and lack of systematic antihypertensive treatment were risk factors for chronic hypertension complicated by preeclampsia during pregnancy. The occurrence of preeclampsia in pregnant women with chronic hypertension increases the incidence of maternal HELLP syndrome and fetal distress (Nie et al., 2024). Research in Ethiopia has concluded that a history of preeclampsia is a major risk factor for preeclampsia (Demissie et al., 2022).

Other factors influencing the occurrence of preeclampsia include twin pregnancies, parity, maternal age, diet, and zinc levels. In addition, a history of illness before pregnancy, such as diabetes mellitus, hypertension, and kidney disease, also plays a role (Aprilia et al., 2021). A previous study showed that adherence to a diet rich in vegetables, fruits, fish, and whole grains, and low in meat, processed foods, and sugary foods, has the potential to significantly reduce the risk of preeclampsia in women (Traore et al., 2021). Lower vegetable consumption and increased consumption of fast food, carbonated soft drinks, and table salt were also associated with the incidence of preeclampsia (Moradi et al., 2022).

Many theories have been developed regarding the mechanism of preeclampsia, one of which involves zinc levels. Zinc is a micronutrient that plays an important role in various metabolic processes in the body, including enzyme cofactor, immune function regulation, protein synthesis, and gene expression. Zinc levels in the blood of pregnant women are generally lower than those in non-pregnant women. In addition to the increased need factor, low intake of zinc-rich foods contributes to low serum zinc levels in pregnant women (Hartono et al., 2023). As many as 47% of pregnant women experience zinc deficiency in their diets (De Benedictis et al., 2023).

Zinc deficiency can trigger various complications during pregnancy, including preeclampsia (Grzeszczak et al., 2020). A systematic review and meta-analysis showed a link between preeclampsia and zinc levels (Jin et al. 2022). Pregnant women with serum zinc levels ≤ 45.5 µg/dL had a 3.2 times higher risk of developing preeclampsia than those with serum zinc levels > 45.5 µg/dl (Kaprianti et al., 2022). The mean serum zinc levels in pregnant women with preeclampsia compared to those without were 48.32 ± 11.62 mg/dl and 50.58 ± 10.12 ng/mL, respectively (Hartono et al., 2023). Zinc gluconate supplementation has been shown to improve early signs and pathological processes of preeclampsia in animal models (Lang et al., 2022).

While various factors have been identified to influence the occurrence of preeclampsia, including nutritional status, history of previous

pregnancies, and maternal age, the role of zinc levels remains inconsistent across different studies. Some studies have indicated a significant relationship between low zinc levels and an increased risk of preeclampsia, while others have found no significant association. This inconsistency highlights a research gap that warrants further exploration, particularly within diverse population contexts

This study aimed to analyze the risk factors for preeclampsia in Makassar City and Gowa Regency. Makassar and Gowa, prominent cities in Eastern Indonesia, are particularly relevant as study sites because of their unique demographic profiles and environmental characteristics. Despite being rich in marine resources and having high fish availability, a prevailing local cultural belief discourages pregnant women from consuming fish. This specific dietary pattern, rooted in local customs, could potentially lead to varying micronutrient intakes (including zinc and omega-3 fatty acids) in pregnant women compared to populations in other regions where such taboos may not exist. Consequently, the unique socio-cultural characteristics, lifestyles, dietary patterns, and environmental factors prevalent in Makassar and Gowa offer the potential for findings that may differ from previous studies, thereby enriching the global understanding of preeclampsia's etiology. Furthermore, the insights gained from this study are expected to provide a robust foundation for the government and relevant stakeholders to formulate more targeted and effective policies for preeclampsia prevention in Indonesia.

Methods

Research Design

This type of research is a quantitative study with a case-control design conducted in Makassar City and Gowa Regency from August 2024 to November 2024.

Population and Sample

The population of this study included all pregnant women with a gestational age of more than 20 weeks who were undergoing pregnancy check-ups at health facilities in Makassar City and Gowa Regency. The research sample was obtained using purposive sampling from the population. The inclusion criteria were pregnant women with a diagnosis of preeclampsia and those with normal blood pressure. The exclusion criteria included various medical conditions that could affect the study results, such as multiple pregnancies, chronic hypertension, and diabetes mellitus. The sample size was calculated using a formula for case-control studies. Based on established parameters—a statistical significance level (α= 0.05), a test power of 80%, and an anticipated control exposure proportion (P_0 0.20)–the minimum clinically relevant effect to be detected was set at an Odds Ratio (OR) of 3.0. The calculation yielded a minimum required sample size of 35 participants per group for each group. To account for a 10% anticipated loss to follow-up or incomplete data, the final sample size was established at 39 participants per group, resulting in a total of 78 subjects. This sample size was deemed adequate to detect a clinically relevant association between risk factors and preeclampsia incidence.

Serum Zinc Level Measurement

Serum zinc level measurement was done by taking the research subjects' venous blood samples. Trained medical personnel performed the sampling process to ensure safe and correct procedures. The collected blood samples were centrifuged to obtain serum, which was then analyzed in the laboratory using a standardized ELISA method to measure serum zinc levels precisely and accurately.

Nutritional Status Assessment and Weight Gain

Nutritional status assessment data on upper arm circumference, height, and current weight were obtained from secondary data from hospitals/health centers. Data on weight before pregnancy were obtained through interviews.

The criteria for weight gain used in this study depended on the nutritional status before pregnancy. Excessive weight gain was defined as follows: BMI before pregnancy was <18.5 kg/m2 and weight gain during pregnancy was >18 kg; BMI before pregnancy was 18.5-22.5 kg/m2 and weight gain during pregnancy was >16 kg; BMI was 23-27 kg/m2 and weight gain during pregnancy was >11.5 kg; and BMI before pregnancy was >27 kg/m2 and weight gain during pregnancy was >9 kg.

Eating Patterns

Data on consumption patterns were collected using the Food Frequency Questionnaire instrument, which records the type and frequency of maternal food in the last 1 week.

Characteristics and Risk Factor Data

Characteristic data such as maternal age, occupation, education, obstetric status, history of preeclampsia, gestational age, distance between pregnancies, and last delivery were obtained through a questionnaire.

Primigravida is when a mother is pregnant for the first time, multigravida if it is the 2nd to fourth pregnancy, and grand multigravida if the mother is experiencing the fifth pregnancy or more times.

Data Analysis

If the data were normally distributed, an independent t-test was performed to determine the relationship between the numeric variables of maternal age, zinc levels, gestational age, and body mass index with the incidence of preeclampsia. However, a Mann-Whitney test was performed if the data were not normally distributed.

A chi-square test was conducted to determine the relationship between the incidence of preeclampsia and variables such as maternal age category, occupation, education level, gravida status, history of preeclampsia, history of abortion, and the distance between the last delivery and the current pregnancy.

Statistical analysis was conducted in two primary stages. First, a Bivariate Analysis (using either the chi-square test or simple Logistic Regression) was performed to examine the association between each independent variable and the incidence of preeclampsia. Variables with p-values < 0.25 were selected for inclusion in the subsequent multivariate model. Second, Multivariate Binary Logistic Regression was employed to identify the independent and dominant risk factors, controlling for the effect of other variables simultaneously. The variable history of preeclampsia was excluded from the multivariate model because of the presence of Perfect Separation, which rendered the standard logistic regression model estimation invalid and unstable. The final model results were interpreted based on a significance level of $p < 0.05$, with the strength of association measured by the Odds Ratio (Exp(B)) and 95% Confidence Interval (CI 95%). Data analysis was performed using the SPSS software.

Ethics

This study was approved by the UIN Alauddin Makassar Health Research Ethics Committee.

Result and Discussion

This study included 39 pregnant women with preeclampsia in the case group and 39 pregnant women without preeclampsia in the control group.

Table 1. Characteristics of Study Subjects (n = 78)

Characteristics	Category	Preeclampsia (n = 39)	Normal (n = 39)	Total (n = 78)
Maternal Age	<20 or >35 years	13 (33.3%)	8 (20.5%)	21 (26.9%)
	20–35 years	26 (66.7%)	31 (79.5%)	57 (73.1%)
Maternal Education Level	Low	29 (74.4%)	26 (66.7%)	55 (70.5%)
	High	10 (25.6%)	13 (33.3%)	23 (29.5%)
Maternal Occupation	Housewife	31 (79.5%)	29 (74.4%)	60 (76.9%)
	Employee	8 (20.5%)	10 (25.6%)	18 (23.1%)
Husband's Education Level	Low	31 (79.5%)	24 (61.5%)	55 (70.5%)
	High	8 (20.5%)	15 (38.5%)	23 (29.5%)
Marriage Duration	1–5 years	17 (43.6%)	20 (51.3%)	37 (47.4%)
	6–10 years	9 (23.1%)	9 (23.1%)	18 (23.1%)
	11–15 years	4 (10.3%)	5 (12.8%)	9 (11.5%)
	16–20 years	6 (15.4%)	2 (5.1%)	8 (10.3%)
	>20 years	3 (7.7%)	3 (7.7%)	6 (7.7%)
Gestational Age	Aterm (37–42 weeks)	21 (53.8%)	23 (59.0%)	44 (56.4%)
	Preterm (28–36 weeks)	15 (38.5%)	13 (33.3%)	28 (35.9%)
	Second trimester (20–27 weeks)	3 (7.7%)	3 (7.7%)	6 (7.7%)

The characteristics of the study subjects can be seen in Table 1, where the majority of subjects were aged 20-35 years (73.08%), the level of education of both mother and husband was low (70.51%), employment status as a housewife (76.92%), and age of marriage 1-5 years (47.44%).

The characteristics of the study subjects showed conditions commonly found in the study population. The majority of mothers with and without preeclampsia in this study were of young reproductive age (20-35 years) with a relatively low level of education. The job profile of the housewife and the husband as an employee/entrepreneur reflected the socio-economic conditions commonly found in the study population.

The distance between the last delivery and the current pregnancy, which was mostly 2-5 years, showed a relatively short distance, although it was not a high-risk factor for preeclampsia. Nutritional status that tends to be excessive can be a risk factor for many complications in pregnancy.

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Table 2. Analysis of the Relationship between Serum Zinc Levels, Maternal Age, Gestational Age and Body Mass Index to the Incidence of Preeclampsia

Variable	Preeclampsia		Normal		p-value
	mean±SD	median (min-max)	mean±SD	median (min-max)	
Zinc (umol/L)	1,99±1,66	1,39 (0,21-8.19)	1,92±1,85	1,39 (0,34-9,64)	0,764[a]
Maternal Age (years)	31,26±7,03	30 (18-44)	29,36±6,07	29 (19-45)	0,206[b]
Gestasional Age (weeks)	36,21±4,35	37 (24-43)	35,74±4,94	37 (20-42)	0,829[a]
Body Mass Index (kg/m2)	26,58±5,43	25,7 (16-40,3)	23,33±3,92	22,6 (17,10-33,30)	0,003[b]

[a]Mann-whitney test; [b]T-Independent test

Table 2 shows the relationship between maternal body mass index and the incidence of preeclampsia. The average BMI of subjects who experienced preeclampsia had a BMI of 26.58±5.43 kg/m2, while that of subjects who did not experience preeclampsia had a BMI of 23.33±3.92 kg/m2.

There was no significant difference in serum zinc levels between pregnant women with and without preeclampsia. The results of this study showed no significant difference in serum zinc levels between pregnant women with and without preeclampsia. Several studies have also not found a significant association between low zinc levels and the incidence of preeclampsia. Research by Zheng showed no significant difference in zinc levels between mothers with preeclampsia and controls (Jin et al., 2022) In a study by Gul, no significant difference in serum zinc levels was found between 43 mothers with preeclampsia and 45 pregnant women without preeclampsia (Gul et al., 2022)

Although several studies have indicated a relationship between zinc deficiency and an increased risk of preeclampsia, the pathogenesis of preeclampsia is complex and multifactorial. Low zinc levels are likely not the only causative factor but play a role as one component in a network of interactions involving genetic, epigenetic, inflammatory, endothelial dysfunction, and other environmental factors. The complex interactions between these factors result in the heterogeneous clinical manifestations of preeclampsia. Another factor that influences preeclampsia is the level of oxidative stress in the body. Previous research has found differences in the average levels of Superoxide Dismutase (SOD) and malondialdehyde (MDA) between normal and preeclamptic pregnancies (Nela, 2020). In addition, vitamin D levels in the body also play a role, as shown by Karajibani et al., who found that the average serum vitamin D level in pregnant women with preeclampsia or eclampsia was lower than that in the healthy group (p = 0.002) (Karajibani et al., 2022). The complex interplay among these factors could lead to heterogeneous clinical manifestations of preeclampsia, potentially masking the direct effect of zinc in certain populations or under specific conditions.

Second, although the measurement of serum zinc levels is standardized, it might not fully capture the body's total zinc status or its bioavailability at the cellular level. Other factors, such as dietary intake variability, individual

metabolic differences, or the presence of other micronutrient deficiencies or excesses, could influence zinc utilization and its impact on pregnancy outcomes. Although low intake of zinc-rich foods contributes to low serum zinc levels in pregnant women, and a significant percentage of pregnant women experience zinc deficiency in their diet, the specific dietary patterns and zinc sources in the Makassar population may have a unique impact.

Table 3. Analysis of the Relationship between Maternal and Obstetrics Factors and the Incidence of Preeclampsia

Variable	Preeclampsia		Normal		p-value[a]	CI 95%
	n	%	n	%		
Maternal Age						
High risk (< 20 years or > 35 years)	13	33.33	8	20.51	0.205	0.696-5.391
Low risk (20-35 years)	26	66.67	31	79.49		
Occupational Status						
Unemployed	31	79.49	29	74.36	0.592	0.464-3.852
Employed	8	20.51	10	25.64		
Educational Level						
Low	29	74.36	26	66.67	0.457	0.544-3.862
High	10	25.64	13	33.33		
Gravida						
Primigravida	11	28.2	13	33.33	0,624	0.300-2.061
Multigravida	28	71.8	26	66.67		
Abortion History						
Yes	9	23.08	5	12.82	0,244	0.615-6.762
No	30	76.92	34	87.18		
Pregnancy Interval						
High Risk (≤ 2 years)	20	51.28	20	51.28	1.000	0.411-2.430
Low Risk (>2 years)	19	48.72	19	48.72		
Preeclampsia History						
Yes	11	28.21	0	0.00	0.001	0.000-N/A
No	28	71.79	39	100.00		
Body Mass Indeks (BMI)						
≥23 kg/m2	29	74.36	19	48.72	0.022	1.175-7.928
<23 kg/m2	10	25.64	20	51.28		
Weight Gain						
Excessive weight gain	19	48.7	8	20.5	0.011	1.355-9.998
Not Excessive weight gain	20	51.3	31	79.5		

Table 3 shows that there was no relationship between maternal age, employment status, and maternal education level and the incidence of preeclampsia. Low education levels include elementary, junior high, and high school, whereas higher education levels include diplomas and bachelor's degrees. There was no relationship between gravidity status, history of abortion, and the distance between the last pregnancy and preeclampsia. However, there is a relationship between a history of preeclampsia in previous pregnancies, pre-pregnancy BMI, and weight gain with the incidence of preeclampsia.

The data demonstrated a perfect association between the History of Preeclampsia and the Incidence of Preeclampsia. This was evidenced by the zero cell count in the cross-tabulation, indicating that all subjects with a history of preeclampsia developed the condition, and conversely, no subjects without a prior history experienced it.

Multivariate Binary Logistic Regression was employed to determine the independent factors associated with Preeclampsia Incidence. Consistent with the methods, variables exhibiting a p-value of < 0.25 in the initial bivariate analysis were included in the model. However, the History of Preeclampsia variable

was excluded from the multivariate analysis due to the presence of perfect separation, which rendered the standard logistic regression model estimation invalid and unstable. Consequently, this factor was concluded to be an absolute and highly significant risk factor, based solely on the bivariate analysis. The final model results, presented in Table 4, identify significant independent predictors at a statistical threshold of $p < 0.05$, utilizing the odds ratio (Exp(B)) and its 95% confidence interval (CI 95%) as measures of association.

Table 4 Logistic Multivariate of risk factors for Preeclampsia

Variable	Regression Coefficient	Standard Error	Wald Value	p-value	OR Value (95% CI)
Maternal Age	0.444	0.584	0.577	0.447	1.558 (0.496-4.894)
Abortion History	0.514	0.685	0.563	0.453	1.672 (0.437-6.403)
Body Mass Indeks (BMI)	0.820	0.519	2.489	0.115	2.270 (0.820-6.283)
Weight Gain	1.074	0.537	4.033	0.045	2.928 (1.022-8.387)

The multivariate logistic regression analysis, which simultaneously assessed the factors that met the bivariate selection criterion of a p-value < 0.25, revealed that only weight gain was an independent and statistically significant predictor of preeclampsia incidence (p=0.045). Subjects in the specified weight gain category had an odds ratio (OR) of 2.928 (95% CI: 1.022-8.387), indicating a nearly threefold increase in the odds of developing preeclampsia compared to the reference group, controlling for all other variables in the model. Variables such as Body Mass Index (BMI) (p=0.115) were not found to be independently significant in the final model. Furthermore, the history of preeclampsia was excluded from this multivariate analysis because of the presence of perfect separation, which rendered the standard regression coefficient estimation invalid.

The data obtained from this study align with previous research by Chairanisa, which found no significant relationship between maternal age and the incidence of preeclampsia in the inpatient room of Dr. Yuliddin Away Tapaktuan Hospital in 2023 (Anwar et al., 2023). Pregnant women under the age of 20 or over 35 years are susceptible to various problems in pregnancy because at that age the function of organs, the quality of egg cells, and the placenta begin to decline, so the risk of experiencing abnormalities in pregnancy, including preeclampsia, also increases.

The results of this study differ from those of a study conducted by Daeli, who found a relationship between maternal age and the incidence of preeclampsia. The study found that pregnant women under 20 years of age or over 35 years of age were 2.40 times more likely to experience preeclampsia than pregnant women aged 20-35 years (Daeli et al., 2023). Pregnant women under the age of 20 or over 35 years are susceptible to various problems in pregnancy because at that age, the function of organs, the quality of egg cells, and the placenta begin to decline, increasing the risk of experiencing abnormalities in pregnancy, including preeclampsia.

This study showed different results from those of the study conducted by Aurellia, who found that working status was related to preeclampsia (Aurellia & Herwana, 2024). The dual role of a worker and caregiver often causes significant psychological burdens, where work and family demands compete with each other. Heavy workloads can trigger physiological stress responses that negatively impact the health of pregnant women (Baiq Disnalia Siswari et al., 2022).

The researcher assumed that there was no relationship between the mother's working they had different stress levels, so it was difficult to draw firm conclusions about the relationship between work status and the risk of preeclampsia in this study, status and the incidence of preeclampsia because housewives dominated the study population. Hence, the group of working mothers was too small for a significant comparison. Second, this study did not measure stress levels. Although they were both housewives,

This study also did not find any relationship between gravida status, history of abortion, and the last pregnancy interval with the incidence of preeclampsia. This result is in line with previous studies with a retrospective cohort design on pregnant women with preeclampsia at the Wagir Health Center (Daeli

et al., 2023). Another study conducted on preeclampsia mothers at a hospital in Banda Aceh also found no relationship between parity and the incidence of preeclampsia (Hermawati 2020). The last pregnancy interval was not related to the incidence of preeclampsia (Oktarida & Zahra, 2024).

The insignificant results obtained in this study could be due to the high ANC compliance of the pregnant women who were the study subjects. High ANC compliance also affects the incidence of preeclampsia. By conducting routine ANC, early detection of preeclampsia risk factors can be performed so that appropriate education can be obtained to prevent further pregnancy complications (Reni et al., 2024). Another study by Daeli also found a significant relationship between ANC service visits and the incidence of preeclampsia (p = 0.00) and a Risk Ratio (RR) value of 4.01 (Daeli et al., 2023).

Regarding nutritional status, this study found that the maternal body mass index before pregnancy and weight gain during pregnancy were associated with the incidence of preeclampsia. This result strengthens previous research on preeclampsia mothers at Drs H. Abu Hanifah Hospital in 2022 (Peratama et al., 2023). Pregnant women with class I obesity nutritional status are at risk for preeclampsia at RSIA Sitti Khadijah 1 Muhammadiyah Makassar in 2020-2021 (Rahis et al., 2024). Nopala (2023) reviewed 10 articles and found a relationship between weight gain during pregnancy and the risk of preeclampsia (Nopala & Rachmiyani, 2023).

Obesity or excessive weight gain during pregnancy will act as a triggers chronic inflammation, which can increase the risk of preeclampsia in pregnant women. Inflammation due to obesity triggers an excessive immune response, damages blood vessels, and disrupts the function of vital organs. This condition is exacerbated by the role of adipose tissue, which actively produces inflammatory substances, increasing the susceptibility of pregnant women to preeclampsia (Nopala & Rachmiyani, 2023).

Table 5. Analysis of the Relationship between Food Pattern and the Incidence of Preeclampsia

Food Type	Consumption Frequency	P-value	OR	CI 95%
Meat (meat, mutton, etc)	Rarely (Ref.)		1	
	Frequent(3-6x/week)	0.069	0.168	0.024-1,151
	Daily (every day)	0.711	1.658	0.114-24.081
Poultry (chicken, etc)	Rarely (Ref.)		1	
	Frequent(3-6x/week)	0.09	3.99	0.807-19.726
	Daily (every day)	0.582	0.529	0.055-5.106
Fish	Rarely (Ref.)		1	
	Frequent(3-6x/week)	0.121	5.345	0.643-44.433
	Daily (every day)	0,022*	9.909	1.396-70.348
Legume Products	Rarely (Ref.)		1	
	Frequent(3-6x/week)	0.203	0.322	0.056-1.846
	Daily (every day)	0.796	0.803	0.153-4.224
Dairy products	Rarely (Ref.)		1	
	Frequent(3-6x/week)	0.585	0.62	0.111-3.448
	Daily (every day)	0.994	0.995	0.214-4.621
Eggs	Rarely (Ref.)		1	
	Frequent(3-6x/week)	0.602	0.692	0.173-2.764
	Daily (every day)	0.333	2.512	0.389-16.228
Vegetables	Rarely (Ref.)		1	
	Frequent(3-6x/week)	0.978	1.028	0.148-7.164
	Daily (every day)	0.665	1.469	0.257-8.395
Processed foods/snacks	Rarely (Ref.)		1	
	Frequent(3-6x/week)	0.666	0.668	0.106-4.194
	Daily (every day)	0.141	0.266	0.046-1.551
Fruits	Rarely (Ref.)		1	
	Frequent(3-6x/week)	0.142	3.71	0.645-21.34
	Daily (every day)	0.094	4.508	0.772-26.315

Multivariate binary logistic regression analysis revealed that, after adjusting for the consumption of other food variables, the only factor with a statistically significant association with preeclampsia incidence was Daily Fish Consumption (always). Daily Fish Consumption was significantly associated with an increased risk of preeclampsia (AOR = 9.909; 95% CI: 1.396–70.348; p-value = 0.022), indicating that mothers consuming fish every day had an almost 10-fold higher risk of developing preeclampsia compared to the reference group (infrequent consumption). All other food variables in the model, including meat, chicken, eggs, dairy products, vegetables, fruits, rice, nuts, and snacks, were not significantly associated with the incidence of preeclampsia.

This result is not in accordance with previous studies that have found a relationship between fish consumption and the incidence of preeclampsia. Fish contains nutrients that are required during pregnancy. Nutrient deficiency during pregnancy increases the risk of preeclampsia (Azza et al., 2021). Although fish is a known protective source of Omega-3 fatty acids, the present study's findings indicate that daily consumption is associated with an elevated preeclampsia risk. This result might be attributable to two primary factors: the potential for high mercury exposure due to the frequent consumption of certain fish species by the study participants or the use of specific preparation methods, such as high-salt preservation or frying, which are known to exacerbate hypertension risk factors.

Despite the multivariate model identifying Weight Gain as an independent risk factor, this study has several methodological limitations that restrict its external validity and the generalizability of its findings. As a retrospective case-control study, it is inherently susceptible to recall bias, particularly in the collection of obstetric history and dietary data using questionnaires. Furthermore, the detection of perfect separation in the history of preeclampsia necessitated its exclusion from the final multivariate model. This limits the ability of the presented logistic regression model to provide a complete overview of all independent risk factors. We also acknowledge the potential influence of unmeasured confounding factors (e.g., quality of antenatal care or unrecorded history of chronic diseases), which may affect the strength of observed associations.

The interpretation of the findings regarding the association between maternal dietary habits and the incidence of preeclampsia should be considered within the scope of this study's limitations. A primary limitation of this study is that the measurement of food consumption was restricted solely to the frequency of eating. Quantitative measurements of the portion size of food consumed were not performed, meaning that information on the total amount of energy and specific nutrient intake (such as total protein, fat, or Omega-3s) is incomplete. Furthermore, despite the significant findings related to daily fish consumption, this study did not explore detailed information regarding the specific fish species consumed, their potential mercury contamination, or the methods of preparation and cooking used by the respondents. Consequently, the observed association may be confounded by unmeasured variables, such as high sodium (salt) intake from preserved or heavily salted fish or high intake of unhealthy fats from frying, which are independent risk factors for hypertension and preeclampsia. This limitation may restrict the comprehensive interpretation of the study findings.

Conclusion

Pre-pregnancy BMI, history of preeclampsia, gestational weight gain, and fish consumption were identified as risk factors for preeclampsia in this study.

Future investigations are strongly recommended to transition towards more rigorous quantitative dietary assessments, utilizing tools such as the Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ) or detailed 24-hour recalls to precisely capture specific nutrient and energy intake rather than merely consumption frequency. Furthermore, to definitively address the paradoxical association with fish, subsequent research should adopt a hierarchical approach by differentiating fish species (e.g., high-mercury vs. high-omega-3 content), meticulously controlling for preparation methods, and including objective measurements of major confounding variables, such as total sodium intake within the multivariate model, to isolate the true biological effect of dietary components on preeclampsia pathogenesis.

We recommend that to reduce preeclampsia risk in Makassar, efforts should focus on optimizing pre-pregnancy BMI, managing gestational weight gain, and diligently monitoring those with a history of preeclampsia.

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