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Factors Associated with Blood Glucose Levels in Neonates at Aura Syifa Hospital

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Abstrak

Pada periode neonatal, hipoglikemia merupakan gangguan metabolik yang paling sering terjadi dan berisiko menyebabkan gangguan neurologis jangka panjang. Penelitian ini bertujuan menganalisis faktor-faktor yang berhubungan dengan kadar glukosa darah pada neonatus di Rumah Sakit Aura Syifa, meliputi obesitas maternal, riwayat diabetes melitus gestasional, usia maternal ≥35 tahun, dan hipotermia neonatal. Penelitian ini merupakan penelitian analitik observasional dengan desain *case-control* retrospektif yang melibatkan 36 responden, terdiri atas 18 kelompok kasus dan 18 kelompok kontrol, menggunakan teknik *purposive sampling*. Analisis data dilakukan secara univariat dan bivariat menggunakan uji *Chi-Square* dan *Fisher's Exact Test*. Obesitas maternal ditemukan pada sebagian besar responden, yaitu 58,3%, sedangkan hipotermia dialami oleh sebagian besar neonatus, yaitu 63,9%. Distribusi kadar glukosa darah menunjukkan proporsi yang sama antara kelompok hipoglikemia dan normal, masing-masing sebesar 50%. Hasil uji statistik menunjukkan tidak terdapat hubungan yang signifikan antara obesitas maternal (p = 0,310; OR = 2,000) dan usia maternal ≥35 tahun (p = 0,298; OR = 0,481) dengan kadar glukosa darah neonatus. Terdapat hubungan yang signifikan antara riwayat diabetes melitus gestasional (p = 0,001; OR = 21,250) dan hipotermia (p < 0,001; OR = 4,600) dengan kadar glukosa darah neonatus. Diabetes melitus gestasional selama kehamilan merupakan faktor yang paling dominan berhubungan dengan kadar glukosa darah neonatus, diikuti oleh hipotermia. Tenaga kesehatan diharapkan dapat mengoptimalkan skrining glukosa darah pada neonatus yang lahir dari ibu berisiko serta menerapkan upaya pencegahan hipotermia secara konsisten sejak proses persalinan.

Kata kunci: Kadar Glukosa Darah; Hipoglikemia Neonatal

Abstract

In the neonatal period, hypoglycemia is the most common metabolic disorder that carries a risk of long-term neurological impairment. The purpose of this study was to analyze factors associated with blood glucose levels in neonates at Aura Syifa Hospital, including maternal obesity, history of gestational diabetes mellitus, maternal age ≥35 years, and neonatal hypothermia. This study was an observational analytic study with a retrospective case-control design using 36 respondents (18 cases, 18 controls) through purposive sampling technique. Univariate analysis and bivariate analysis with Chi-Square and Fisher's Exact Test were applied. Maternal obesity was found in the majority of respondents at 58.3%, hypothermia was experienced by most neonates at 63.9%, and blood glucose distribution showed equal proportions of hypoglycemia and normal at 50% each. Based on the statistical test results, there was no significant relationship between maternal obesity (p = 0.310; OR = 2.000) and maternal age ≥35 years (p = 0.298; OR = 0.481) with neonatal blood glucose levels. There was a significant relationship between history of gestational diabetes mellitus (p = 0.001; OR = 21.250) and hypothermia (p = 0.000; OR = 4.600) with neonatal blood glucose levels. Mothers who experienced gestational diabetes mellitus during pregnancy is the most dominant factor associated with neonatal blood glucose levels, followed by hypothermia. It is expected that healthcare providers will optimize blood glucose screening in neonates born to at-risk mothers and consistently implement hypothermia prevention measures from the time of delivery

Keywords: Blood Glucose Levels; Neonatal Hypoglycemia

1. INTRODUCTION

The neonatal period, defined as the first 28 days of life, is one of the most vulnerable stages of infant development. Neonatal hypoglycemia is among the most common metabolic disorders in newborns and is clinically important because it may occur without obvious

symptoms, leading to delayed recognition and treatment (Alsaleem et al., 2019). Globally, neonatal hypoglycemia is estimated to affect 5%–15% of all newborns and up to 50% of neonates with identifiable risk factors (Tadele et al., 2024). Blood glucose levels below 40 mg/dL during the first 0–4 hours of life or below 45 mg/dL during 4–24 hours after birth are commonly used as operational thresholds for neonatal hypoglycemia (Melinda & Wartono, 2021). Persistent or recurrent hypoglycemia may increase the risk of acute neurological injury and long-term neurodevelopmental impairment, including intellectual disability, epilepsy, and visual disorders (Alsaleem et al., 2019; Melinda & Wartono, 2021).

Maternal metabolic conditions, particularly gestational diabetes mellitus (GDM), are strongly associated with neonatal blood glucose disturbances. Maternal hyperglycemia during pregnancy stimulates fetal pancreatic insulin secretion. After delivery, maternal glucose transfer stops abruptly, whereas neonatal insulin levels may remain elevated, resulting in a rapid decline in neonatal blood glucose levels (Kliegman et al., 2024). Previous research reported that neonatal hypoglycemia occurred in approximately 45% of term neonates born to mothers with GDM (Arimitsu et al., 2023). Andrews et al. (2024) also found that infants born to mothers with GDM had a higher risk of neonatal hypoglycemia than infants born to mothers with normal glucose tolerance, with an odds ratio of 4.90.

Other maternal factors, including obesity and advanced maternal age, may contribute to the development of GDM and subsequent neonatal glucose instability. Prepregnancy obesity and excessive gestational weight gain have been associated with a higher risk of GDM, particularly among women of advanced maternal age (Dong et al., 2017). Recurrent GDM has also been reported among multiparous women, indicating that previous glucose intolerance during pregnancy remains clinically relevant in subsequent pregnancies (Mirabelli et al., 2024). These findings support the need to assess maternal obesity, history of diabetes during pregnancy, and maternal age as potential factors associated with neonatal blood glucose levels.

In addition to maternal factors, neonatal hypothermia may directly contribute to hypoglycemia. Hypothermia increases glucose utilization because newborns require additional energy for thermogenesis to maintain body temperature. This condition accelerates the depletion of hepatic glycogen stores, which are already limited in neonates. A case-control study conducted in Ethiopia reported that 84.3% of neonates with hypoglycemia also experienced hypothermia. Hypothermic neonates had a 5.5-fold higher risk of hypoglycemia than non-hypothermic neonates (Wodajo et al., 2024).

In Indonesia, neonatal hypoglycemia remains a relevant clinical problem. Melinda and Wartono (2021) reported a neonatal hypoglycemia incidence of 45.1% in a hospital-based study, whereas Prayoga et al. (2025) estimated that approximately 12.1% of live births experienced neonatal hypoglycemia. Preliminary data from Aura Syifa Hospital, Kediri Regency, showed that 180 newborns experienced hypoglycemia from October to December 2025, of whom 148 required intensive care. These findings highlight the need for early blood glucose screening, particularly among neonates born to mothers with metabolic risk factors and neonates who experience hypothermia. Therefore, this study aimed to analyze factors associated with blood glucose levels in neonates at Aura Syifa Hospital, including maternal obesity, history of diabetes mellitus during pregnancy, maternal age ≥35 years, and neonatal hypothermia.

2. METHOD

This study used a quantitative observational analytic design with a retrospective case-control approach. The case group consisted of newborns with hypoglycemia, while the control group consisted of newborns with normal blood glucose levels. The study was conducted using secondary data from medical records at Aura Syifa Hospital, with data collection carried out from April to May 2026. The study population included all newborns recorded at Aura Syifa

Hospital from January to December 2025. A total of 36 samples were selected using purposive sampling, consisting of 18 cases and 18 controls based on inclusion and exclusion criteria.

The independent variables were maternal obesity, history of gestational diabetes mellitus, maternal age ≥35 years, and neonatal hypothermia, while the dependent variable was neonatal blood glucose level, categorized as hypoglycemia or normal. Data were collected using a documentation sheet and analyzed using univariate analysis to describe frequency distributions and bivariate analysis with the Chi-square test or Fisher's exact test when expected cell frequencies were small. Odds ratios with 95% confidence intervals were calculated to estimate the strength of association, with statistical significance set at $p \leq 0.05$. Ethical approval was obtained from the Health Research Ethics Committee of Poltekkes Kemenkes Malang with approval number No. DP.04.03/F.XIII.31/0348/2026.

3. RESULT AND DISCUSSION

RESULT

Univariate Analysis

1) Frequency Distribution of Obese Mothers

Table 1. Frequency Distribution Results of Obese Mothers

Obese Mother	Frequency	Percentage (%)
No	15	41.7
Yes	21	58.3
Total	36	100

Based on the frequency distribution results of obese mothers, it is known that most respondents were in the obese mother category, namely 21 people (58.3%), which means that most of the respondents were included in the obese mother group. Meanwhile, respondents who were included in the non-obese category amounted to 15 people (41.7%), which is classified as almost half of the respondents. Overall, the total number of respondents in this study was 36 people (100%). This shows that the majority of mothers in this study experienced obesity.

2) Frequency Distribution of History of Pregnancy with Diabetes Mellitus

Table 2. Frequency Distribution Results of Pregnancy History

History of Pregnancy with Diabetes Mellitus	Frequency	Percentage (%)
No	25	69.4
Yes	11	30.6
Total	36	100

Based on the frequency distribution results of history of pregnancy with diabetes mellitus, it is known that most respondents did not have a history of pregnancy with diabetes mellitus, namely 25 people (69.4%), which means that most of the respondents did not have this history. Meanwhile, respondents who had a history of pregnancy with gestational diabetes mellitus amounted to 11 people (30.6%), which is classified as almost half of the respondents. Overall, the total number of respondents in this study was 36 people (100%). This shows that

the majority of respondents in this study did not have a history of pregnancy with diabetes mellitus.

3) Frequency Distribution of Maternal Age ≥35 Years

Table 3. Frequency Distribution Results of Maternal Age ≥35 Years

Maternal Age ≥35 Years	Frequency	Percentage (%)
No	23	63.9
Yes	13	36.1
Total	36	100

Based on the frequency distribution results of maternal age ≥35 years, it is known that most respondents were not included in the maternal age ≥35 years category, namely 23 people (63.9%), which means that most of the respondents were under 35 years of age. Meanwhile, respondents who were included in the maternal age ≥35 years category amounted to 13 people (36.1%), which is classified as almost half of the respondents. Overall, the total number of respondents in this study was 36 people (100%). This shows that the majority of respondents were at a maternal age of less than 35 years.

4) Frequency Distribution of Hypothermia

Table 4. Frequency Distribution Results of Hypothermia

Hypothermia	Frequency	Percentage (%)
No	13	36.1
Yes	23	63.9
Total	36	100

Based on the frequency distribution results of hypothermia among 36 respondents, it was found that most respondents experienced hypothermia, namely 23 respondents (63.9%), which means that most of the respondents experienced hypothermia, while respondents who did not experience hypothermia were 13 respondents (36.1%), which is classified as almost half of the respondents. These results show that the occurrence of hypothermia was found more often than respondents who did not experience hypothermia. The high number of hypothermia cases can be influenced by various factors, such as environmental conditions, unstable infant body temperature, age, health status, and suboptimal body temperature regulation.

5) Frequency Distribution of Blood Glucose Levels

Table 5. Frequency Distribution Results of Blood Glucose Levels

Blood Glucose Level	Frequency	Percentage (%)
Normal	18	50
Hypoglycemia	18	50
Total	36	100

Based on the frequency distribution results of blood glucose levels, it is known that the number of respondents in the normal and hypoglycemia categories was the same, each amounting to 18 people (50%), which means that half of the respondents experienced hypoglycemia and the other half were normal. Overall, the total number of respondents in this study was 36 people (100%). This shows that the proportion of respondents who experienced hypoglycemia and respondents who were normal had a balanced distribution.

Chi-Square Bivariate Analysis

1) Relationship between Obese Mothers and Blood Glucose Levels in Neonates

Table 6. Relationship between Obese Mothers and Blood Glucose Levels in Neonates

Obese Mother	Blood Glucose Level				Total		P Value	OR (95% CI)
	Normal		Hypoglycemia					
	n	%	n	%	n	%		
No	9	25	6	16.7	15	41.7	0.310	(0.520–7.691)
Yes	9	25	12	33.3	21	58.3		
Total	18	50	18	50	36	100		

Based on the results of the analysis of the relationship between obese mothers and blood glucose levels in neonates, it is known that in the group of mothers who were not obese, there were 9 respondents (25%) whose babies had normal blood glucose and 6 respondents (16.7%) whose babies experienced hypoglycemia. Meanwhile, in the group of obese mothers, there were 9 respondents (25%) whose babies had normal blood glucose and 12 respondents (33.3%) whose babies experienced hypoglycemia.

The statistical test results showed a p value of 0.310 (>0.05), so it can be concluded that there was no significant relationship between maternal obesity and blood glucose levels in neonates. The OR value of 2 with 95% CI (0.520–7.691) indicates that mothers who experienced obesity had a 2 times greater risk of experiencing hypoglycemia compared with mothers who were not obese, but this relationship was not statistically significant because the confidence interval range included the number 1.

2) Relationship between History of Pregnancy with Diabetes Mellitus and Blood Glucose Levels in Neonates

Table 7. Relationship between History of Pregnancy with Diabetes Mellitus and Blood Glucose Levels in Neonates

History of Pregnancy with DM	Blood Glucose Level				Total		P Value	OR (95% CI)
	Normal		Hypoglycemia					
	n	%	n	%	n	%		
No	17	47.2	8	22.2	25	69.4	0.001	(2.306–195.804)
Yes	1	2.8	10	27.8	11	30.6		
Total	18	50	18	50	36	100		

Based on the results of the analysis of the relationship between history of pregnancy with diabetes mellitus and blood glucose levels in neonates, it is known that among respondents who did not have a history of pregnancy with diabetes mellitus, there were 17 respondents

(47.2%) whose babies had normal blood glucose and 8 respondents (22.2%) whose babies experienced hypoglycemia. Meanwhile, among respondents who had a history of pregnancy with diabetes mellitus, there was 1 respondent (2.8%) whose baby had normal blood glucose and 10 respondents (27.8%) whose babies experienced hypoglycemia.

The statistical test results showed a p value of 0.001 (≤0.05), so it can be concluded that there was a significant relationship between pregnancy with diabetes mellitus and blood glucose levels in neonates. The OR value of 21.250 with 95% CI (2.306–195.804) indicates that respondents who had a history of pregnancy with diabetes mellitus had an approximately 21.25 times greater risk of experiencing hypoglycemia compared with respondents who did not have a history of pregnancy with diabetes mellitus. Because the confidence interval range did not include the number 1, this relationship was declared statistically significant.

3) Relationship between Maternal Age ≥35 Years and Blood Glucose Levels in Neonates

Table 8. Relationship between Maternal Age ≥35 Years and Blood Glucose Levels in Neonates

Maternal Age ≥35 Years	Blood Glucose Level				Total		P Value	OR (95% CI)
	Normal		Hypoglycemia					
	n	%	n	%	n	%		
No	10	27.8	13	36.1	23	63.9	0.298	(0.120–1.927)
Yes	8	22.2	5	13.9	13	36.1		
Total	18	50	18	50	36	100		

Based on the results of the analysis of the relationship between maternal age ≥35 years and blood glucose levels in neonates, it is known that among respondents with maternal age <35 years, there were 10 respondents (27.8%) whose babies had normal blood glucose and 13 respondents (36.1%) whose babies experienced hypoglycemia. Meanwhile, among respondents with maternal age ≥35 years, there were 8 respondents (22.2%) whose babies had normal blood glucose and 5 respondents (13.9%) whose babies experienced hypoglycemia.

The statistical test results showed a p value of 0.298 (>0.05), so it can be concluded that there was no significant relationship between maternal age ≥35 years and blood glucose levels in neonates. The OR value of 0.481 with 95% CI (0.120–1.927) indicates that respondents with maternal age ≥35 years had a tendency of lower risk of experiencing hypoglycemia compared with respondents aged <35 years. However, because the confidence interval range included the number 1, this relationship was not statistically significant.

4) Relationship between Hypothermia and Blood Glucose Levels in Neonates

Table 9. Relationship between Hypothermia and Blood Glucose Levels in Neonates

Hypothermia	Blood Glucose Level				Total		P Value	OR (95% CI)
	Normal		Hypoglycemia					
	n	%	n	%	n	%		
No	13	36.1	0	0	13	36.1	0.000	(2.118–9.989)
Yes	5	13.9	18	50	23	63.9		
Total	18	50	18	50	36	100		

Based on the results of the relationship test between hypothermia and blood glucose levels in neonates with 36 respondents, it was found that all respondents who did not experience hypothermia had normal blood glucose levels, namely 13 respondents (36.1%). Meanwhile, in the group of respondents who experienced hypothermia, there were 18 respondents (50%) who experienced hypoglycemia and 5 respondents (13.9%) who had normal blood glucose levels. This shows that the occurrence of hypoglycemia was found more frequently in respondents who experienced hypothermia.

The statistical test results showed a p value of 0.000. This value was smaller than 0.05 ($0.000 \leq 0.05$), so it can be concluded that there was a significant relationship between hypothermia and blood glucose levels in neonates. Thus, the alternative hypothesis (H1) was accepted and the null hypothesis (H0) was rejected. The results of this study show that hypothermia was associated with an increased occurrence of hypoglycemia. Hypothermia can cause increased glucose use by the body to maintain normal body temperature. In addition, hypothermia can also interfere with metabolic processes and blood glucose level regulation, thereby increasing the risk of hypoglycemia.

The Chi-Square test results showed a p value of 0.000 ($p \leq 0.05$), which means that there was a significant relationship between hypothermia and blood glucose levels in neonates. Risk analysis showed that respondents who did not experience hypothermia had a 4.600 times greater possibility of having normal blood glucose levels compared with respondents who experienced hypothermia (95% CI: 2.118–9.989), indicating that hypothermia was a factor that significantly increased the risk of hypoglycemia in neonates.

DISCUSSION

Analysis of the Relationship Between Maternal Obesity and Blood Glucose Levels in Neonates

Based on the study results, among the 36 respondents, most were categorized as obese mothers, namely 21 respondents (58.3%), while 15 respondents (41.7%) were not obese. Among obese mothers, 12 respondents (33.3%) had neonates with hypoglycemia, while 9 respondents (25.0%) had neonates with normal blood glucose levels. Among non-obese mothers, 6 respondents (16.7%) had neonates with hypoglycemia, while 9 respondents (25.0%) had neonates with normal blood glucose levels.

The Chi-square statistical test showed a p value of .310 ($p > .05$), indicating no significant relationship between maternal obesity and blood glucose levels in neonates. The odds ratio (OR) was 2.000 with a 95% CI of 0.520–7.691, indicating that neonates born to obese mothers had a twofold greater tendency to experience hypoglycemia than neonates born to non-obese mothers. However, this relationship was not statistically significant because the confidence interval included 1.

This finding is inconsistent with the theory proposed by Cunningham et al. (2018), which states that maternal obesity, particularly visceral fat accumulation, may induce insulin resistance even before pregnancy. Adipose tissue produces proinflammatory cytokines, such as TNF-α and IL-6, which reduce insulin sensitivity. During pregnancy, physiological insulin resistance increases further because of placental hormones, including human placental lactogen, estrogen, progesterone, and cortisol. In obese mothers, pancreatic β-cell compensation may be limited, resulting in maternal hyperglycemia. Maternal hyperglycemia subsequently stimulates fetal hyperinsulinemia, which becomes the primary mechanism of neonatal hypoglycemia after placental glucose transfer is interrupted at birth (Cunningham et al., 2018).

This result also differs from the findings of Wodajo et al. (2024), who reported that maternal overweight status was more frequently found among neonates with hypoglycemia (19.3%) than among neonates without hypoglycemia (6.6%). Overweight and obesity may increase susceptibility to impaired fetal glucose regulation, thereby increasing the risk of

neonatal hypoglycemia (Cao et al., 2023). The absence of a statistically significant relationship in the present study may be associated with the relatively small sample size, which reduced statistical power. Weight control before and during pregnancy through structured nutritional counseling and regular body mass index monitoring during antenatal care remains necessary. Health facilities should also establish standard operating procedures for neonatal blood glucose screening among infants born to obese mothers as an early preventive measure.

Analysis of the Relationship Between History of Gestational Diabetes Mellitus and Blood Glucose Levels in Neonates

Based on the study results, among the 36 respondents, most did not have a history of gestational diabetes mellitus, namely 25 respondents (69.4%), while 11 respondents (30.6%) had a history of gestational diabetes mellitus. Among respondents with a history of gestational diabetes mellitus, 10 respondents (27.8%) had neonates with hypoglycemia, while only 1 respondent (2.8%) had a neonate with normal blood glucose levels. In contrast, among respondents without a history of gestational diabetes mellitus, 8 respondents (22.2%) had neonates with hypoglycemia, while 17 respondents (47.2%) had neonates with normal blood glucose levels.

The Chi-square statistical test showed a p value of .001 ($p \leq .05$), indicating a significant relationship between a history of gestational diabetes mellitus and blood glucose levels in neonates. The OR was 21.250 with a 95% CI of 2.306–195.804, indicating that respondents with a history of gestational diabetes mellitus had approximately 21.25 times greater odds of having neonates with hypoglycemia than respondents without a history of gestational diabetes mellitus.

This finding is consistent with the theory proposed by Cunningham et al. (2018), which explains that gestational diabetes mellitus occurs when maternal pancreatic β-cells are unable to meet the increased insulin demand during pregnancy. This condition increases maternal blood glucose levels and affects the fetus through transplacental glucose transfer. Sustained maternal hyperglycemia allows excess glucose to enter the fetal circulation, stimulating fetal pancreatic insulin secretion as a compensatory response. Fetal hyperinsulinemia becomes the primary mechanism of neonatal hypoglycemia. After birth, maternal glucose transfer through the placenta stops abruptly, but neonatal insulin levels remain high. During the first hours of life, this condition increases tissue glucose utilization, reduces endogenous glucose production, rapidly depletes hepatic glycogen stores, and ultimately causes significant neonatal hypoglycemia (Cunningham et al., 2018).

Kliegman et al. (2024) also explain that high maternal glucose exposure in mothers with gestational diabetes mellitus stimulates the fetal pancreas to increase insulin secretion. After birth, the maternal glucose supply suddenly stops, while neonatal insulin levels remain elevated, resulting in a sharp decline in blood glucose levels and the development of neonatal hypoglycemia. This condition may cause severe symptoms, including tremor, lethargy, apnea, cyanosis, and seizures, when not promptly managed. Hyperinsulinism resulting from exposure to gestational diabetes mellitus is one of the most common causes of hypoglycemia among infants born to mothers with gestational diabetes mellitus. Consequently, these infants are classified as a high-risk group requiring blood glucose testing immediately after birth (Eichenwald et al., 2023; Kliegman et al., 2024).

This finding is also consistent with Andrews et al. (2024), who analyzed 8,262 mother–infant pairs and found that infants born to mothers with gestational diabetes mellitus had greater odds of neonatal hypoglycemia than infants born to mothers with normal glucose tolerance (OR = 4.90, 95% CI [3.81, 6.29]). Arimitsu et al. (2023) also reported that among 443 term infants born to mothers with gestational diabetes mellitus, approximately 45% experienced hypoglycemia during the first hours after birth. This finding indicates that hypoglycemia is a

common metabolic complication among infants born to mothers with gestational diabetes mellitus.

The high OR observed in the present study (OR = 21.250) indicates that gestational diabetes mellitus was a clinically important risk factor for neonatal hypoglycemia at Aura Syifa Hospital. However, the wide confidence interval should be considered when interpreting the precision of the estimate. These findings emphasize the need for more intensive blood glucose screening and monitoring among infants born to mothers with gestational diabetes mellitus. Management of gestational diabetes mellitus should begin as early as possible through glucose screening during pregnancy and strict maternal glycemic control. Health facilities should establish specific protocols requiring blood glucose examination for all neonates born to mothers with a history of gestational diabetes mellitus within the first hour of life, followed by standardized management when glucose values fall below the operational threshold.

Analysis of the Relationship Between Maternal Age ≥35 Years and Blood Glucose Levels in Neonates

Based on the study results, among the 36 respondents, most were not included in the maternal age ≥35 years category, namely 23 respondents (63.9%), while 13 respondents (36.1%) were aged ≥35 years. In the maternal age ≥35 years group, 5 respondents (13.9%) had neonates with hypoglycemia, while 8 respondents (22.2%) had neonates with normal blood glucose levels. In the maternal age <35 years group, 13 respondents (36.1%) had neonates with hypoglycemia, while 10 respondents (27.8%) had neonates with normal blood glucose levels.

The Chi-square statistical test showed a p value of .298 ($p > .05$), indicating no significant relationship between maternal age ≥35 years and blood glucose levels in neonates. The OR was 0.481 with a 95% CI of 0.120–1.927, showing a direction opposite to the proposed hypothesis, in which maternal age ≥35 years tended to be associated with lower odds of neonatal hypoglycemia. However, this association was not statistically significant because the confidence interval included 1.

This result is inconsistent with the American Diabetes Association (2022), which identifies maternal age ≥35 years as one of the risk factors for gestational diabetes mellitus. Increasing maternal age is associated with physiological changes affecting glucose metabolism regulation, including decreased insulin sensitivity, reduced muscle mass involved in glucose utilization, and increased fat mass that worsens insulin resistance. Pancreatic β-cell responses to increased glucose concentrations may also become slower and less effective. Thus, mothers aged ≥35 years theoretically have a higher risk of gestational diabetes mellitus, which may subsequently trigger fetal hyperinsulinemia and neonatal hypoglycemia (American Diabetes Association, 2022).

This discrepancy is also evident when the study findings are compared with those of Dong et al. (2017), who reported that the prevalence of gestational diabetes mellitus among mothers aged ≥35 years reached 36.27%, which was higher than the prevalence among mothers aged 20–35 years at 24.93%. In addition, clinical reports on the characteristics of neonatal hypoglycemia found that neonates with hypoglycemia more frequently had mothers aged ≥35 years. This finding was associated with physiological changes at an older maternal age, including a greater risk of metabolic dysfunction and decreased insulin sensitivity (Prayoga et al., 2025).

Based on the study results, maternal age ≥35 years should still be considered a factor requiring clinical attention, although the present study did not support the initial hypothesis. More intensive pregnancy monitoring among older mothers is required, including earlier and more frequent screening for gestational diabetes mellitus. Premarital counseling and optimal pregnancy planning should also be strengthened as part of reproductive health programs to reduce maternal and neonatal complications.

Analysis of the Relationship Between Hypothermia and Blood Glucose Levels in Neonates

Based on the study results, among the 36 respondents, 13 respondents (36.1%) did not experience hypothermia, while 23 respondents (63.9%) experienced hypothermia. In the non-hypothermia group, all respondents had normal blood glucose levels, namely 13 respondents (36.1%), meaning that none of the respondents in this group experienced hypoglycemia. In contrast, in the hypothermia group, most respondents experienced hypoglycemia, namely 18 respondents (50.0%), while 5 respondents (13.9%) had normal blood glucose levels.

The Chi-square test showed a p value of <.001 ($p \leq .05$), indicating a significant relationship between hypothermia and blood glucose levels in neonates. Thus, the alternative hypothesis was accepted, and the null hypothesis was rejected. Risk analysis showed that respondents who did not experience hypothermia had 4.600 times greater odds of having normal blood glucose levels than respondents who experienced hypothermia (95% CI [2.118, 9.989]). This finding indicates that hypothermia was significantly associated with neonatal hypoglycemia.

This finding is supported by Wodajo et al. (2024), who conducted a case-control study among neonates admitted to neonatal intensive care units at public hospitals in the Wolaita Zone, Ethiopia. The study reported that 84.3% of neonates with hypoglycemia also experienced hypothermia, compared with only 36.7% of neonates without hypoglycemia. Hypothermic neonates had approximately 5.5 times greater odds of developing hypoglycemia than non-hypothermic neonates (AOR = 5.485). These findings indicate that hypothermia is a strong determinant of neonatal hypoglycemia. The increased risk of hypoglycemia among hypothermic neonates is caused by increased glucose requirements to maintain normal body temperature, resulting in rapid depletion of neonatal glucose stores (Wodajo et al., 2024).

This finding is also consistent with Eichenwald et al. (2023), who explain that neonatal hypothermia may cause hypoglycemia through increased energy and glucose requirements to maintain body temperature. Newborns have limited thermoregulatory mechanisms and depend heavily on nonshivering thermogenesis through brown adipose tissue. During hypothermia, this thermogenic process increases substantially and requires glucose as its primary energy source. When this increased glucose demand is not balanced by adequate intake or endogenous glucose production, neonatal blood glucose levels decrease, resulting in hypoglycemia (Eichenwald et al., 2023).

Eichenwald et al. (2023) further explain that hypothermia may increase basal metabolism by two to three times, directly increasing glucose utilization by body tissues. Neonates, particularly premature or low-birth-weight infants, have limited hepatic glycogen stores and immature gluconeogenic mechanisms. This condition reduces the neonate's ability to maintain glucose balance during metabolic stress such as hypothermia. Low glycogen stores among hypothermic neonates are clinically important because hepatic glycogenolysis, which normally constitutes the initial mechanism for maintaining blood glucose levels, cannot function adequately. Gleason and Sawyer (2023) also explain that neonatal hypoglycemia may occur when glucose demand exceeds the infant's capacity to produce or maintain glucose, particularly during metabolic stress.

The results were further strengthened by the finding that none of the non-hypothermic neonates experienced hypoglycemia. However, the available data only indicate that 18 of 23 hypothermic neonates experienced hypoglycemia and do not provide a specific classification of hypothermia severity. Therefore, the findings demonstrate a strong association between hypothermia and neonatal hypoglycemia but do not establish a dose–response relationship based on the severity of hypothermia. The Chi-square test showed a p value of <.001, confirming a statistically significant relationship between hypothermia and neonatal blood glucose levels.

Prevention of hypothermia among newborns should be implemented immediately by drying the infant after birth, using hats and blankets, providing an incubator when indicated, promoting skin-to-skin contact, and initiating early breastfeeding. Early identification of neonates at risk of hypothermia and timely blood glucose testing are necessary to prevent neurological complications resulting from delayed recognition of hypoglycemia. Rapid and appropriate management of hypothermia may reduce excessive energy requirements and help maintain stable neonatal blood glucose levels.

4. CONCLUSION

This study found that most respondents were obese mothers, had no history of pregnancy with diabetes mellitus, were aged under 35 years, and had neonates with hypothermia. Blood glucose levels among neonates at Aura Syifa Hospital showed an equal distribution between hypoglycemia and normal blood glucose. Bivariate analysis showed no significant relationship between maternal obesity or maternal age ≥35 years and neonatal blood glucose levels. However, a significant relationship was found between a history of pregnancy with diabetes mellitus and neonatal blood glucose levels, as well as between hypothermia and neonatal blood glucose levels. These findings indicate the need for regular antenatal care, maternal glucose control during pregnancy, early identification of neonatal hypoglycemia risk factors, routine neonatal blood glucose screening, optimal thermoregulation, and early breastfeeding initiation. Future studies are recommended to include other potential factors such as birth weight, gestational age, prematurity, and mode of delivery.

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