

# Uncovering the Determinants of Birth Weight: An Investigation on Pregnant Women in Makassar City

Memahami Faktor Penentu Berat Badan Lahir Bayi: Studi pada Ibu Hamil di Kota Makassar

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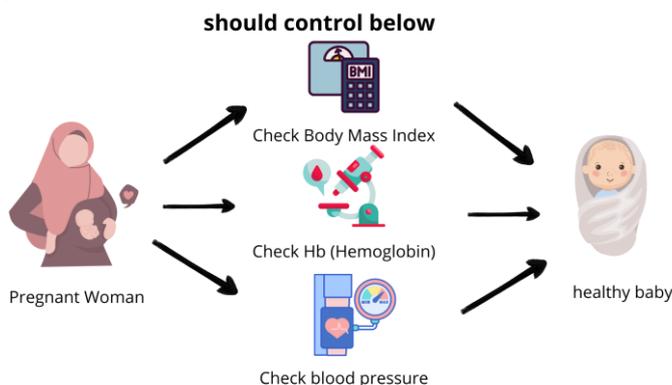
## Abstract

Birth weight is an essential indicator in assessing a baby's health and a factor that affects the baby's long-term health. This study aimed to determine the relationship between the Body Mass Index (BMI), Hemoglobin levels, and Blood Pressure of mothers during pregnancy and to birth weight of the baby. The study used a cross-sectional survey of a group of mothers who gave birth in Makassar. The data on mothers during pregnancy was the maternal history recorded in the mother and Child Health Book (KIA). And the data on the birth weight of the baby was also from the KIA book with the support of secondary data from the Community Health Center and Midwife. The results showed that 41.7% of the low-birth-weight babies had mothers who experienced underweight during pregnancy, 83.3% of the low-birth-weight babies had mothers who experienced Anemia during pregnancy, and 66.7% of the low-birth-weight babies had mothers who experienced hypertension during pregnancy. There was a significant and close relationship between the mother's BMI, Hemoglobin levels, and Blood Pressure to the baby's birth weight. There was a meaningful relationship between the mother's Body Mass Index, Anemia, and Hypertension during pregnancy to low birth weight. Therefore, it is important to maintain a good quality of nutrition for mothers both before and during pregnancy, following Islamic teachings that Allah SWT has decreed for every pregnant woman a thousand good deeds every day and erases a thousand misdeeds as motivation to remain strong throughout the pregnancy process.

## Abstrak

Berat badan lahir merupakan indikator penting dalam menilai kesehatan bayi dan faktor yang mempengaruhi kesehatan jangka panjang bayi. Penelitian ini bertujuan untuk mengetahui hubungan Indeks Massa Tubuh (IMT), Kadar Hb, dan Tekanan Darah ibu selama masa kehamilan terhadap berat badan lahir bayi. Penelitian ini menggunakan metode crosssectional study pada kelompok ibu yang telah melahirkan di Kota Makassar, data ibu saat hamil merupakan data riwayat kehamilan ibu yang tercatat dalam buku KIA (Kesehatan Ibu dan Anak). Dan data berat badan lahir anak juga dari buku KIA dengan dukungan data sekunder dari Puskesmas dan Bidan. Hasilnya menunjukkan sebesar 41,7% bayi yang BBLR memiliki ibu yang mengalami underweight saat masa kehamilan berlangsung, sebesar 83,3% bayi yang BBLR memiliki ibu yang mengalami Anemia saat masa kehamilan, dan sebesar 66,7% bayi yang BBLR memiliki ibu yang mengalami hipertensi saat masa kehamilan berlangsung. Dan adanya hubungan erat yang signifikan terhadap masing-masing IMT, kadar Hb, dan tekanan darah ibu terhadap berat badan lahir bayi. kaitan yang signifikan antara IMT, kondisi anemia, dan hipertensi ibu hamil dengan Berat Badan Lahir Rendah (BBLR). Oleh karena itu, penting untuk menjaga kualitas gizi ibu baik sebelum maupun selama hamil, sesuai dengan anjuran islam untuk wanita hamil bahwa Allah SWT menetapkan baginya setiap hari seribu kebaikan dan menghapuskan seribu kejelekannya sebagai motivasi untuk tetap kuat dalam menjalani proses kehamilannya.

## Graphical Abstract



## Keyword

anemia; birth weight; body mass index; child; pregnant women

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## INTRODUCTION

An infant's birth weight is an important indicator of their health and well-being. It is a critical factor in determining the infant's future growth and development and overall survival. In recent years, increasing attention has been directed toward various factors that influence birth weight, including pregnant mothers' health and nutritional status (Vargas-Terrones et al., 2019). In Asian populations, infants with Low Birth Weight (LBW), particularly those with a birth weight less than 2,000 grams, have a higher predisposition to neuro-motor and cognitive problems than infants with average birth weight. Therefore, it is important to implement early developmental interventions to help minimize the negative impact of LBW and help achieve the maximum potential of the infant. Preventive and early intervention measures are crucial to ensure optimal development for LBW infants in Asia (Upadhyay et al., 2019).

The health status of mothers and children has shown a moderate improvement over the past decade (Requejo et al., 2015; Victora et al., 2021). However, most women still experience health issues, and young mothers remain vulnerable to giving birth to infants with LBW. It is imperative to integrate maternal and child health programs with existing health policies to improve conditions and provide additional attention to the health and nutrition of young pregnant women (Banerjee et al., 2022).

According to a report by the Directorate of Community Nutrition from 25 provinces in 2019, there were 111,827 infants (about 3.4%) who experienced Low Birth Weight (LBW) out of the total reported neonates. The results of the 2018 Riskesdas study also showed that 6.2% of the total 56.6% of toddlers with birth weight records were born with LBW. Furthermore, the study revealed that the rate of LBW in South Sulawesi Province reached 7.1% in 2018. (Kementerian Kesehatan RI, 2018).

Body Mass Index (BMI), anemia, and hypertension in pregnant women are factors considered when understanding their relationship with Low Birth Weight (LBW). While there is suspicion that these factors may influence LBW, further research is needed to establish the exact relationship between BMI, anemia, hypertension, and LBW in pregnant women. Additional information on these factors will help in understanding the factors that influence LBW and develop strategies to address this issue (Banerjee et al., 2022; Bauserman et al., 2021; Gueye et al., 2023; Wagata et al., 2020).

Therefore, it is crucial to understand the various evidence-based findings that indicate that maternal body mass index (BMI), anemia, and hypertension can significantly impact birth weight. Pregnant women with high BMI are at risk of having larger babies, which can increase the risk of complications during delivery for both the mother and baby. Anemia during pregnancy can also affect a baby's birth weight, as the baby may not receive enough oxygen or nutrients through the placenta. Hypertension during pregnancy can also increase the risk of low birth weight and premature birth. This study aimed to further understand the determinants of birth weight in Makassar City while considering the influence of maternal BMI, anemia, and hypertension. The gaining a deeper understanding of these factors, it is hoped that steps can be taken to improve the health and well-being of mothers and babies in the region.

## METHODS

The type of research conducted was an analytical observational study using a cross-sectional approach. This study was conducted in the city of Makassar in the working area of Malimongan Baru Health Center in July 2022. The choice of this health center was based on the diversity of its population in terms of education level, culture, and socioeconomic status, providing a general representation of the diversity in the area. Additionally, based on our monitoring, the health center had the highest number of registered new mothers in the past six months. The study obtained a total of 109 respondents who had given birth, selected through purposive sampling technique, with inclusion criteria being mothers with infants under six months old residing in the health center's working area. Respondent data was collected through door-to-door visits based on initial observation data gathered from the health center and Posyandu cadres.

We used a questionnaire in our data collection technique and validated the data from various relevant sources. We obtained data on the mother's pregnancy and the baby's birth weight from a questionnaire that we previously tested for validity and reliability. We also validated the records of pregnancy and childbirth from each respondent's KIA (Maternal and Child Health) book.

We analyzed the data we collected using data analysis software and performed a chi-square analysis. Since we did not have complete records of

Table 1  
Characteristics of Respondents

Characteristic	Mean $\pm$ SD
Variable	
Mother's age	28 $\pm$ 4
Mother's Weight *	51.82 $\pm$ 9.46
Mother's Height *	158.2 $\pm$ 12.52
BMI	20.94 $\pm$ 3.47
BMI *	
Underweight (< 19 kg/m <sup>2</sup> )	36 (33.1%)
Normal (>19 kg/m <sup>2</sup> )	73 (66.9%)
Hemoglobin	
Low (< 11 g/dL)	67 (61.5%)
Normal (> 11 g/dL)	42 (38.5%)
BP *	
Hight (> 140/90 mmHg)	53 (48.6%)
Normal (< 140/90 mmHg)	56 (51.4%)
LBW *	
Low (< 2500 gr)	48 (44%)
Normal (> 2500 gr)	61 (56%)

Note : \*BMI: body mass index, BP: blood pressure, LBW: Low Birth Weight

weight, height, hemoglobin, and blood pressure measurements, we categorized the data we obtained from the KIA book (Mother and Child Health) for each respondent. We classified Hb data as low for Hb <13 mg/dL and normal for Hb >13 mg/dL to get an overview of the mother's anemia status during pregnancy. We categorized TD data as high for TD >140/90 mmHg and normal for TD <140/90 mmHg to get an overview of hypertension during pregnancy. We obtained IMT (Body Mass Index) data from weight and height measurements in the first trimester of pregnancy. We categorized IMT data as low for IMT <20 kg/m<sup>2</sup> and normal for IMT >20 Kg/m<sup>2</sup> to show the mother's nutritional status during pregnancy. We categorized BBL (Birth Weight) data as Low or having LBW (Low Birth Weight) if the birth weight was <2500g and Normal for birth weight >2500g.

## RESULTS

Based on [table 1](#), the number of participating mothers in this study is 109, with a mean maternal age of 28 years, mean maternal weight of 51.82 Kg, mean maternal height of 158.2 cm, and mean Body Mass Index (BMI) of 20.94 Kg/m<sup>2</sup> of the mothers, 33.1% were underweight (BMI<20 Kg/m<sup>2</sup>), and 66.9% had normal weight (BMI>20 Kg/m<sup>2</sup>). The prevalence of anemia during pregnancy was 61.5%, while 38.5% of the mothers did not have anemia. The prevalence of hypertension during pregnancy based on blood

pressure (BP) data was 51.4% in the normal range, and 48.6% had hypertension. The table also shows that 44% of the newborns had low birth weight.

According to [table 2](#), the relationship between BMI, Anemia, and Hypertension during pregnancy has a significant effect on the occurrence of LBW in their babies. The table shows that 41.7% of LBW babies have mothers who were underweight during pregnancy, 83.3% of LBW babies have mothers who had anemia during pregnancy, and 66.7% of LBW babies have mothers who had hypertension during pregnancy. From these conditions, only 26.2% of underweight mothers had babies with normal birth weight, only 44.3% of anemic mothers had babies with normal birth weight, and only 33.3% of mothers with hypertension during pregnancy had babies with normal birth weight.

## DISCUSSION

This study demonstrates significant and diverse impacts related to maternal nutritional status, anemia, and hypertension during pregnancy resulting in the birth of low birth-weight infants. The research findings highlight the importance of adequate maternal nutrition before and during pregnancy, which contributes to fetal development. One measure of maternal nutritional health is weight gain during pregnancy, and maintaining appropriate weight gain is essential to ensure healthy fetal growth and birth.

Table 2

Correlation of Maternal BMI, Hb, and BP Condition during Pregnancy towards Birth Weight of Infants

Var.		BMI				P	Hemoglobin				P	BP				P
		Underweight		Normal			Low		Normal			Hight		Normal		
		n	%	n	%		n	%	n	%		n	%	n	%	
LBW	Low	20	41.7	28	58.3	0,047*	40	83.3	8	16.7	0,000*	32	66.7	21	34.4	0.001*
	Normal	16	26.2	45	73.8		27	44.3	34	55.7		16	33.3	40	65.6	

Note: \*Significant

Inadequate or excessive nutritional status can have long-term impacts on childhood and subsequent generation development, despite the proven relationship between weight gain during pregnancy and healthy fetal growth.

The influence of pre-conception maternal BMI, rate of maternal weight gain from conception to 12 weeks gestation, and rate of weight gain during pregnancy (between approximately 12 and 32 weeks) are all independently associated with infant length and birth weight. It emphasizes the importance of maternal nutritional status and weight before and during pregnancy. Also, it reinforces the value of maternal nutritional supplementation starting at least three months before conception in populations with limited resources in low- and middle-income countries (Bauserman et al., 2021). In addition to being underweight, excessive weight management is also a problem in this case. Other studies have shown that the likelihood of inappropriate pregnancy weight gain is lower in the intervention group than in the control group. Subgroup analysis also indicates that women in the intervention group have a lower risk of inadequate and excessive pregnancy weight gain than those in the control group. Antenatal care experience scores and women's health literacy are also higher in the intervention group than in the control group (Wang et al., 2023). A high pre-pregnancy body mass index may present a higher risk for suboptimal pregnancy outcomes, particularly regarding cesarean delivery in rural areas. Preconception-focused interventions and programs that include counseling on optimizing pre-conception health and lifestyle modifications for improving pregnancy outcomes in overweight and obese women are greatly needed (Gudipally et al., 2023). Therefore, weight management led by midwives positively impacts maternal and fetal health during pregnancy.

Pregnancy-induced hypertension, which manifests as pre-eclampsia/eclampsia, is associated with chronic hypertension as the most common form

(Drost et al., 2010). Another study showed that about 40% of women with a history of hypertensive disorders during pregnancy still have high blood pressure three months after delivery. To minimize the risk of future cardiovascular complications, innovations in identifying and providing long-term care are needed for women who still have high blood pressure after giving birth (Lugobe et al., 2023).

In a cohort study conducted in the Tohoku Medical Megabank Birth and Three-Generation Cohort Study in Miyagi, Japan, a population of 4810 women was used to explore the relationship between birth weight and the risk of subsequent hypertensive disorders of pregnancy. The results of multivariate logistic regression analysis showed that women with low birth weight <2500 g had a significant risk of developing hypertensive disorders of pregnancy, with an adjusted odds ratio of 1.50 and a 95% confidence interval (CI) of 1.02 to 2.21. Subtype analysis also showed that the odds ratio for pre-eclampsia increased significantly in the low-birth-weight group, with an odds ratio of 3.37 and a 95% confidence interval (CI) of 1.84 to 6.16. The prevalence of hypertensive disorders of pregnancy was higher in the low-birth-weight group in both the underweight and overweight groups. Based on these results, it can be concluded that there is a significant association between low birth weight and subsequent hypertensive disorders of pregnancy in mothers, and maintaining a normal weight may be effective in preventing hypertensive disorders of pregnancy even if a woman was born with low birth weight (Wagata et al., 2020).

Anemia during pregnancy is a condition that can affect pregnancy outcomes and fetal health (Garzon et al., 2020; Patel et al., 2018). Anemia occurs due to a lack of iron in the blood, which reduces the supply of oxygen and nutrients to the fetus. Inadequate oxygen and nutrient deficiency can affect fetal growth and development, leading to low birth weight. They can also increase the risk of other

health problems in pregnant women, such as miscarriage, premature delivery, and complications during childbirth (Shah et al., 2022).

Studies have shown that anemia in pregnant women can affect the transport of iron to the fetus, reducing iron and hemoglobin levels. Iron and hemoglobin deficiencies can affect fetal brain development, slow fetal growth, and increase newborns' risk of health problems (Mégier et al., 2022). Agreed, pregnant women must ensure adequate iron levels and monitor their health during pregnancy (Hladunewich & Schatell, 2016). They should consume iron-rich foods, take iron supplements, and consult their doctor to ensure their condition is suitable during pregnancy (Kiss & Vassallo, 2018; Pedlar et al., 2018). They can help ensure that the fetus receives adequate nutrition and minimize the risk of low birth weight in babies (Grzeszczak et al., 2020).

In taking care of the health of mothers during pregnancy, it becomes a top priority to maintain the health of future generations. It is following the Word of Allah SWT in Surah Ar Ra'd Ayat 8, translated:

*"Allah knows what every female carries and what the wombs lose (prematurely) or exceed). And everything with Him is by due measure."*

According to the interpretation of Quraish Shihab, Allah is the source of the great miracles received by Prophet Muhammad. Allah knows everything, including human conditions, from the development stage as a sperm cell to death. Therefore, Allah knows the fetus's condition in every woman's womb, from gender identity to development and changes during pregnancy. All things, big or small, have limitations and a time determined by Allah. In this case, Allah has knowledge of the developing fetus in every woman's womb and the stages of development that occur, starting from when the sperm cell transforms into a fetus ready to be born. All things, big or small, have a proper limit and time in Allah's calculation (Shihab, 2012). In human development from the beginning, it is already determined by Allah SWT. To maintain the fetus's health condition, which is the basis for the next generation, we can do various things according to the laws of nature, starting from controlling the nutritional status of prospective mothers. This way, in its development, the prospective mother is ready to become the basis for the fetus to grow, of course, with the permission of Allah SWT.

## CONCLUSIONS

This study found a significant correlation between Body Mass Index (BMI), anemia, and hypertension in pregnant women with Low Birth Weight (LBW). Therefore, maintaining a healthy BMI, hemoglobin level, and blood pressure before and during pregnancy is crucial to ensure the fetus's health. Maternal health during pregnancy has a significant impact on the health and birth weight of the baby. BMI, anemia, and hypertension in pregnant women are important factors that must be monitored and controlled. The research results prove that poor BMI, high hemoglobin levels, and high blood pressure can affect LBW. Therefore, before and during pregnancy, mothers should maintain their BMI, monitor their hemoglobin levels, and ensure that their blood pressure remains within normal limits. This study used secondary data from KIA books regarding the mother's status during pregnancy, so the measurement bias and interpretation of core variables cannot be fully controlled. The results of this study add to the information on the importance of preparing maternal health before and during pregnancy in improving the baby's birth weight, thus ensuring good growth and development. In this regard, a further critical study is to investigate the potential and role of the placenta in maintaining the fetus during pregnancy. The placenta is vital in providing nutrients and oxygen to the fetus during pregnancy. In addition, the placenta is also responsible for removing waste substances that the fetus does not need. Therefore, researchers need to understand how the placenta can play its role optimally during pregnancy and how this affects the baby's birth weight.

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## AUTHORS' CONTRIBUTIONS

Ria Qadariah Arief wrote the manuscript, acquired the data, revised the manuscript, and read and approved the final manuscript. Karmila Sarih and Nur Ulmy Mahmud analyzed the data. All authors designed the study, formulated the concept, reviewed the manuscript, enrolled participants, collected data, revised the manuscript, and performed the field work.

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**COMPETING INTERESTS**

The author(s) declare no potential conflict of interest with respect to the research, authorship, and/or publication of this article.

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