GRADUATE SCHOOL SEMINAR
INSTITUT PERTANIAN BOGOR

Name	:	Kitaka Ashraf
NRP	:	I1504222801
Study Program	:	Nutrition Science
Research Title	:	Maternal Nutrition and Infant Birth Size among Pregnant Mothers in Rural Areas in Bogor District
Supervisors	:	1. Dr. dr. Mira Dewi, M.Si. 2. Prof. Dr. Rimbawan
Group	:	Social Sciences Humanities
Day / Date	:	Thursday, 20 June 2024
Time	:	08:30-09:30
Venue	:	Ruang Seminar Pasca Gd. FEMA Lantai 1

MATERNAL NUTRITION AND INFANT BIRTH SIZE AMONG PREGNANT MOTHERS IN RURAL AREAS IN BOGOR DISTRICT

(*Gizi Ibu Hamil dan Ukuran Bayi Baru Lahir di Pedesaan Kabupaten Bogor* [1)]

Kitaka Ashraf[2], Mira Dewi[3], Rimbawan Rimbawan[4]

Abstrak

Asupan makanan dan status gizi ibu berperan penting pada saat pertumbuhan janin dan setelah kelahiran. Ibu hamil memiliki kebutuhan energi yang lebih tinggi, sehinnga menyebabkan berbagai risiko seperti; kekurangan gizi pada Ibu, berat badan lahir rendah (BBLR), panjang lahir rendah dan kematian bayi. Tujuan penelitian ini adalah untuk mengestimasi hubungan antara status gizi ibu hamil serta kecukupan gizi makro dan mikro dalam kaitannya dengan ukuran bayi lahir di wilayah pedesaan Kabupaten Bogor. Penelitian ini menggunakan desain kohort prospektif yang melibatkan 49 ibu hamil berusia antara 16-54 tahun. Status gizi ibu dengan indikator indeks massa tubuh pra-kehamilan, lingkar lengan atas tengah (LILA), dan pertambahan berat badan saat hamil, diukur menggunakan antropometri. Data berat badan dan panjang badan bayi lahir dikumpulkan dari buku kesehatan ibu dan anak yang dicatat segera setelah kelahiran. Asupan gizi ibu diperoleh melalui diet recall 2x24 jam. Data dianalisis untuk menghitung odds ratio. Hasil penelitian menunjukkan bahwa hanya lemak (57,1%) yang dikonsumsi secara memadai oleh lebih dari separuh ibu hamil. Kurang dari 50% ibu hamil mengonsumsi energi, protein, karbohidrat, zat besi, asam folat, seng, kalsium, vitamin A, C, D, dan B_{12} dalam jumlah yang cukup. Sejumlah 16,9% ibu hamil mengalami kekurangan energi kronis (KEK), 59,1% tidak memenuhi anjuran kenaikan berat badan saat hamil dan hanya 46,9% yang memiliki Indeks Massa Tubuh pra-kehamilan yang normal. Hasil regresi logistik menunjukkan bahwa peningkatan LILA ibu dikaitkan dengan penurunan 0,034 kejadian berat badan lahir rendah (OR 0,034, 95% CI 0,02-0,542) (p=0,017). Bertentangan dengan indeks massa tubuh pra-kehamilan, kenaikan berat badan saat hamil, dan kecukupan gizi makro-mikro, indikator LILA ditemukan sebagai prediktor signifikan untuk berat badan lahir tetapi tidak panjang badan lahir.

Keywords: *BBLR, ibu hamil, kecukupan gizi, panjang badan lahir, status gizi*

INTRODUCTION

Maternal nutrition is critical for promoting the health of both mothers and children, supporting healthy growth for new born infants (Zhang *et al.* 2019). Pregnant women are more susceptible to poor nutritional status because of the elevated demand for nutrients. Maternal undernutrition, which is wide-spread in low-and middle-income countries including Indonesia can lead to negative pregnancy outcomes such as intrauterine growth retardation (IUGR) and low birth weight (Muze *et al.* 2020; Arero 2022). Anthropometric measures of new born infants such as body weight and length

[1] The paper is part of a thesis presented as a seminar at Graduate School IPB
[2] The student is from the Nutrition Science Program, Graduate School IPB
[3] Supervisor 1, Lecturer at the Department of Community Nutrition, FEMA, IPB
[4] Supervisor 2, Lecturer at the Department of Community Nutrition, FEMA, IPB

can be used to identify babies that suffered suboptimal fetal growth (Ezenwa *et al.* 2016).

Various factors are known to influence the growth and development of the fetus including; maternal age and socioeconomic status (Patil *et al.* 2018) as well as maternal nutritional status and nutrient intake (Retni *et al.* 2016; Mulianingsih and Nurmayani 2021). Women in low-and-middle income nations, such as Indonesia, are more likely to consume insufficient amounts of food because their diets are undiversified and consist primarily of a few staple foods. This imbalance between intake and requirements increases the probability of unfavourable birth outcomes, such as intrauterine growth retardation and low birth weight (Tyagi 2023).

The dietary intake of pregnant and lactating mothers in Indonesia has been reported to be insufficient for both macro-and-micro nutrients (Agustina *et al.* 2023). Among Indonesian women, pre-pregnancy body mass index (PP-BMI), and mid-upper arm circumference (MUAC), as indicators of maternal nutritional status, have been associated with low-birth weight (Maryani *et al.* 2019; Dewi and Sari 2023). Gestational weight gain (GWG) and dietary intake are among other maternal characteristics that have been reported to affect birth size among pregnant Indonesian women (Ratnasari *et al.* 2017). Family characteristics and socioeconomic status are also important determinants of maternal nutritional status and by extension birth size of new born infants (Laksono *et al.* 2023).

Previous studies have shown that rural residence among pregnant women can influence the birth size of their children (Alemayehu *et al.* 2020). Considering that studies which have investigated the effect of maternal nutritional status and nutrient intake during pregnancy on the birth size of their babies are still limited and far in between, especially among rural families, a prospective study involving pregnant women from rural families in Bogor regency was conducted, aiming to estimate the relationship between the nutritional status and nutrient intake of third-trimester pregnant women with the birth size of their newborn infants.

METHODOLOGY

Design, Time, and Location

This study was analytical and observational in nature with a prospective cohort design that followed up pregnant mothers through out the third-trimester until delivery. The study was conducted at three local community health centres in the villages of Karyamekar and Bojong as well as the regional hospital of Cileungsi in Bogor district between October 2023 to March 2024. Ethical approval was obtained through the Health Research Ethics Commission, Faculty of Medicine, IPB University.

Sampling

Samples were selected using a consecutive sampling technique. The inclusion criteria comprised third-trimester pregnant women with a singleton pregnancy between 29 to 34 weeks' gestation, who were willing to participate in the study and signed consent forms. Pregnant mothers with chronic diseases such as diabetes mellitus, congenital anomalies and cancer before pregnancy were excluded from the study. The sample size was calculated using a relative risk value reported between maternal

nutrient intake and birth weight (Retni *et al.* 2016). The formula based on Lwanga dan Lemeshow (1991) was employed.

$$n = \frac{\left(z_{1-\alpha/2}\sqrt{2\bar{P}(1-\bar{P})} + z_{1-\beta}\sqrt{P_1(1-P_1)+P_2(1-P_2)}\right)^2}{(P_1-P_2)^2}$$

The sample size computation obtained from the above formula using a significance level of 0.05 with the addition of 10% for possible dropouts produced a total of 50 respondents.

Data Collection

Data collected included; maternal nutrient intake assessed at any two points of the third trimester depending on the gestational age, and maternal anthropometric measures along with socio-demograhic characteristics taken at the first contact with the mothers. Maternal dietary intake was assessed by trained nutritionists using a two non-consecutive 24-hour diet recall through face-to-face interviews on a weekday and one weekend day. Respondents were encouraged to estimate portion sizes of the foods they consumed, shown to them from the Indonesian food photo book. The amount of food consumed in grams was recorded based on the house hold size presented in the food photo book.

Maternal pre-pregnancy body weight was extracted from the maternal and child health book. In case the mother's weight was not available in the book, self-reported weight was considered. The mother's current weight and height were also measured during the first contact. Weight was measured using a scale with the shoes off. Height was measured to the nearest 1 mm, standing straight and without shoes using a stadiometer. Maternal body mass index was calculated by dividing mother's weight in kilograms with mother's height in meters squared. Gestational weight gain was obtained by subtracting maternal pre-pregnancy weight from current weight. Assessment of weight gain sufficiency was based on Institute of Medicine (IOM) recommendations (Aji *et al.* 2022). Mid-upper arm circumference was measured using a color-coded MUAC tape specific for pregnant and lactating mothers. Mothers with a score of <23cm were deemed to have chronic energy deficiency based on the Indonesian cut-off (Nurahmawati *et al.* 2017). Data on neonatal anthropometric measurements including birth weight and length was collected from the maternal and child health book. Information on maternal characteristics (age, education, occupation, household income) was gathered through a validated questionnaire.

Data Processing and Anlaysis

Food consumption data was analysed to determine nutrient content for energy, protein, fat, iron, calcium, folic acid, along with vitamins A, C, D and B_{12} using the Nutrisurvey application and Indonesian food composition tables. The nutrition adequacy level i.e. >70% of the recommended dietary allowance (RDA) and >77% of the RDA Gibson (2005) was used for adequacy of macro and micro nutrients respectively. Statistical analysis was done using SPSS version 27 IBM, Chicago. Percentages were calculated for maternal characteristics. The Pearson chi-square test was employed to

determine the association between PP-BMI, MUAC, GWG as well as adequacy of nutrients with birth weight and length. Variables that were found significantly associated with birth weight and length were put into a logistic regression model to assess the risk of low birth weight and short birth length using odds ratios and confidence intervals (CI). The chi-square test and odds ratios were considered significant at $p< 0.05$.

RESULTS AND DISCUSSION

Maternal socioeconomic and demographic characteristics are presented in table 1. The mothers' average age was 29.41±7.34 years ranging between 16-54 years old. Most of the mothers were aged 18-35 years, housewives who attended school up to the level of junior high. More than three quarters of mothers came from households with sufficient income and almost two thirds of respondents originated from families whose main source of livelihood was farming.

Tabel 1 Distribution of maternal socioeconomic and demographic characteristics

Characteristic	n	%
Mother's Age:		
<18	3	6.1
18-35	40	81.6
>35	6	12.2
Mother's Education:		
Elementary school<3 years	6	12.2
Elementary school graduate	8	16.3
Junior high school	15	30.6
Senior high school/Vocational	13	26.5
Tertiary education	7	14.3
Mother's employment status		
Employed	6	12.2
Unemployed/Housewife	43	87.8
Farming family		
Farming	31	63.2
Non farming	18	36.8
Household income		
Low	1	2
Sufficient	48	98

The relationship between maternal nutritional status and birth size is shown in table 2. Majority of mothers with a normal PP-BMI gave birth to LBW babies. However, the association between PP-BMI and birth weight was statistically insignificant, as was in the case of GWG. Similarly, more than half of the mothers who gained insufficient weight during pregnancy delivered LBW babies. Mid-upper arm circumference was found to be significantly associated with birth weight ($p<0.05$). Sixteen percent of mothers had chronic energy deficiency. More than three quarters of mothers who suffered chronic energy deficiency delivered LBW babies. Consistent with this study, Alemu dan Gashu (2020) also observed a positive correlation between MUAC of third-trimester pregnant mothers and birth weight. Aditionally, the results of an analytic observational study reported a significant association between maternal MUAC and birth weight. Low maternal MUAC is a manifestation of CED characterized

by inadequate energy and protein availability resulting into poor nutrient delivery to the fetus (Yosefinata *et al.* 2022).

Table 2 Relationship between maternal nutritional status and birth size

Nutritional Status	Birth Weight		p	Birth Length		p
	NBL	LBW		NBL	SBL	
PP-BMI						
Normal	15	8	0.019**	13	10	0.168
Overweight	10	0		9	1	
Obese	15	1		11	5	
MUAC						
Normal	38	3	<0.001**	30	11	0.049**
CED	2	6		3	5	
GWG						
Sufficient	16	4	0.806	15	5	0.343
Insufficient	24	5		18	11	

Note: **Significant (p<0.05), analysed using Pearson chi-square test.
Abbreviations: NBL; normal birth length, LBW; low birth weight, NBL; normal birth length, SBL; short birth length, PP-BMI; pre-pregnancy body mass index; MUAC; mid-upper arm circumference CED; chronic energy deficiency; GWG; gestational weight gain.

Findings of the current study portray a 68.8% prevalence of shortness at birth among mothers who gained insufficient body weight. The prevalence of short birth length among mothers with normal PP-BMI was also high, amounting to 62.5%. Both GWG and PP-BMI were not associated with birth length. Consistent with the results of the current study, Papazian *et al.* (2017) reported GWG to have no significant influence on birth length. Conversely, MUAC was significantly associated with birth length as evidenced in more than half of mothers with CED delivering short babies. These findings resemble those of Rani *et al.* (2017) who also reported a significant relationship between MUAC and birth length.

Maternal nutrition adequacy for energy, protein, fat, carbohydrate and several micronutrients along with their relationship to birth size is displayed in table 3. A percentage of RDA with a cut-off for adequacy at >70% for macro-nutrients and >77% for micro-nutrients was used.

As clearly displayed in figure 1, The highest percentages of mothers who met the cut-off for adequacy was exhibited by intakes of fat, iron and vitamin A. Notably, nutrition adequacy met by more than half of the mothers was only observed for fat. The overall energy consumption was inadequate for 67.3% of mothers. The percentage of respondents who consumed inadequate carbohydrate, vitamin D, vitamin B_{12}, zinc, and calcium was above 80%. All the mothers did not attain the adequacy level for intake of calcium. Inadequate consumption has previously been reported among pregnant women in Bogor, the site for the current study. Particularly, Madanijah *et al.* (2016) found out that 49% of subjects did not meet the recommendations for energy consumption and up to 85% for iron intake.

Findings of the current study illustrated that nutrition adequacy for vitamins A and D was significantly associated with birth weight. Meanwhile, the birth length did not show association with any of the nutrients studied. A study involving 449 Iranian pregnant women, similarly found out that maternal vitamin D intake was correlated with neonatal birth weight (Sabour *et al.* 2006). In another study on maternal macronutrient consumption and birth weight, 91% of respondents did not fulfill energy intake

recommendations. Nearly three quarters of mothers ate inadequate protein and fat. Nutrient intake greatly impacted birth weight (Ernawati *et al.* 2017).

Tabel 3 Relationship between maternal nutrition adequacy and birth size

Nutrient	Birth Weight		p	Birth Length		p
	NBL	LBW		NBL	SBL	
Energy						
Adequate	13	3	0.962	11	5	0.844
Inadequate	27	6		22	11	
Protein						
Adequate	7	4	0.080	7	4	0.766
Inadequate	33	5		26	12	
Fat						
Adequate	23	5	0.195	19	9	0.930
Inadequate	17	4		14	7	
Carbohydrate						
Adequate	7	2	0.714	6	3	0.962
Inadequate	33	7		27	13	
Vitamin D						
Adequate	3	3	0.033*	3	3	0.33
Inadequate	37	6		30	13	
Iron						
Adequate	18	4	0.976	15	7	0.910
Inadequate	22	5		18	9	
Folic acid						
Adequate	11	4	0.319	15	7	0.165
Inadequate	29	5		18	9	
Vitamin A						
Adequate	14	7	0.019*	11	10	0.053
Inadequate	26	2		22	6	
Vitamin B_{12}						
Adequate	5	2	0.451	5	2	0.804
Inadequate	35	7		28	14	
Zinc						
Adequate	6	2	0.596	5	3	0.749
Inadequate	34	7		28	13	
Calcium						
Adequate	0	0	NA	0	1	0.147
Inadequate	40	9		33	15	
Vitamin C						
Adequate	9	2	0.986	7	4	0.766
Inadequate	31	7		26	12	

Note: *Significant ($p<0.05$), analysed using Pearson chi-square test.
Abbreviations: NBL; normal birth length, LBW; low birth weight, NBL; normal birth length, SBL; short birth length, NA; not applicable

A three-month cohort study in Indonesia involving third-trimester pregnant mothers only found carbohydrate and protein adequacy to be associated with birth weight (Winasandis *et al.* 2020). Consistent results regarding nutrition inadequacy were also found among third -trimester pregnant women in an Indian longitudinal study. It was observed that only half of the respondents met the recommendations for adequate energy. Unlike the current study, this study found birth weight to be significantly correlated with energy, protein and zinc. Birth length also showed a significant correlation with energy adequacy (Tyagi 2023).

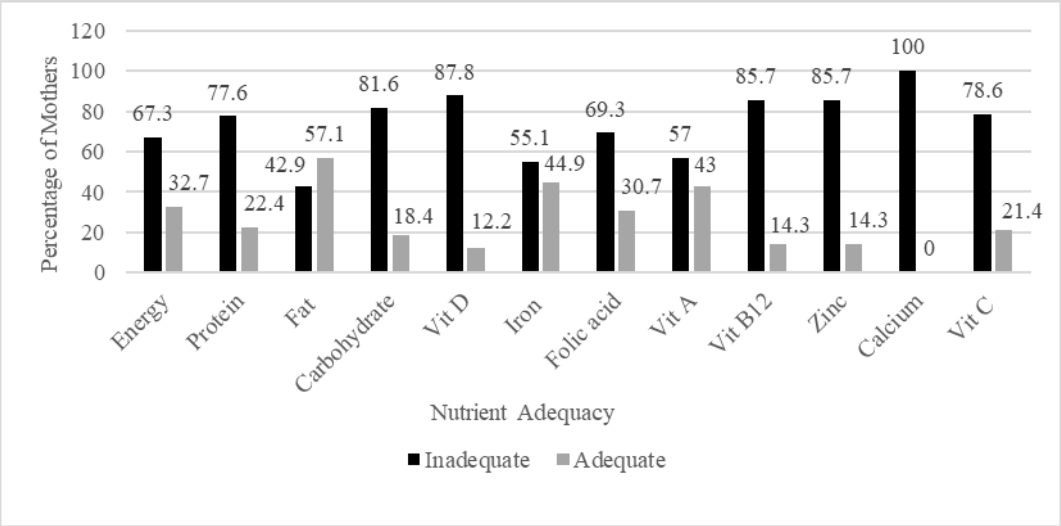

Figure 1 Maternal adequacy of macro-and-micronutrients

In the bivariate analysis, all variables that were significantly associated with birthweight and length were put into a binary logistic model to assess the risk of low birth weight and shortness at birth. Table 4 shows the results of logistic regression.

The model explained 59% of the variation in low birth weight and correctly classified 91.8% of cases. It was found that the odds of a pregnant mother with normal MUAC delivering a low-birth-weight baby were 0.034 the odds of a pregnant mother with CED delivering a low-birth-weight baby (OR-0.034, 95% CI 0.02-0.542) (p=0.017). This implies that increase in maternal MUAC was associated with a decrease of 0.034 in the odds of delivering a low-birth-weight baby.

Tabel 4 Predictors of birth size

Birth Size	Variable	p	OR	95% CI
Birth weight				
	PP-BMI	0.592	2.018	0.155-26.243
	MUAC	0.017*	0.034	0.002-0.542
	Vitamin D	0.816	1.433	0.069-29.746
	Vitamin A	0.453	2.317	0.258-29.746
Birth length				
	MUAC	0.062	0.220	0.045-1.078

* Significant (p<0.05), analysed using binary logistic regression

On the other hand, the regression model involving birth length and MUAC was statistically insignificant and therefore not fit to predict birth length (p>0.05). The model explained only 10% of the variation in birth length and correctly classified just 71.4% of cases. Previous studies have reported MUAC as a good predictor of neonatal birth weight. For instance, an Indian case control study by Shrivastava *et al.* (2016) found maternal MUAC as the best parameter to predict the birth weight of neonates (OR 9.73, CI 6.69-14.14). Unlike the current study, Karimi *et al.* (2022) who analysed maternal dietary adequacy among third-trimester mothers using nutrient adequacy ratios found dietary adequacy to be a significant predictor of birth weight but not length. Contrary to the results of the current study, an Indonesian cohort study revealed inadequate GWG (AOR 9.60, 95% CI 0.88-105.2) (P=0.002) as a predictor of low-

birth-weight (Aji *et al.* 2022). Despite numerous previous studies reporting MUAC as a good predictor of birth weight, a meta-analytic review of 309,419 women paired with their newborns in Africa, Asia, Europe, Latin America, the middle East and Oceania, concluded that maternal anthropometric measurements including MUAC were unsuitable for predicting low birth weight (Goto 2015). Our study aimed to establish whether PP-BMI, MUAC and GWG as well as nutrition adequacy of macro-micro-nutrients were predictors of birth size or not. Results show that only MUAC was found to be a significant predictor of birth weight. None of the studied parameters was able to predict birth length.

The strength of this study lies in its comprehensive follow-up of mothers throughout the entire third-trimester, particularly in low socioeconomic communities prone to low birth sizes. The study had limitations, including inability to establish maternal nutrient status using blood serum, under-reporting as well as over-reporting of dietary intake due to measurement errors and recall bias in the 24-hour recall tool.

CONCLUSION AND RECOMMENDATIONS

Conclusion

1) The present study findings show that PP-BMI, GWG and nutrition adequacy are not predictors of birth birth weight or length, despite the fact that previous studies illustrate an association between the above-mentioned variables and birth size.
2) Mid-upper arm circumference as a predictor of birth weight indicates that mothers with normal MUAC are less likely to give birth to low-birth -weight- babies.

Recommendation

1) Maternal MUAC is a simple tool that can be used to identify mothers at risk of delivering low-birth-weight babies. Maternal health workers should routinely perform MUAC measurements to reduce the incidence of low birth weight.
2) Generally, the dietary adequacy of nutrients consumed by mothers was below recommended standards for pregnancy. Maternal nutrition programs should therefore be prioritized among mothers from the above-mentioned areas to ensure optimal nutritional intake and improved birth size outcomes.
3) In the current study, dietary adequacy of vitamins A and D was significantly associated with birthweight, although it was unable to serve as a predictor. This may imply that sufficient intake of vitamins A and D along with supplementation may improve birth size outcomes.

REFERENCES

Agustina R, Rianda D, Lasepa W, Birahmatika FS, Stajic V, Mufida R. 2023. Nutrient intakes of pregnant and lactating women in Indonesia and Malaysia : Systematic review and meta-analysis. *Front Nutr*. 10(1030343):1–26. doi:doi: 10.3389/fnut.2023.1030343.

Aji AS, Lipoeto NI, Yusrawati Y, Malik SG, Kusmayanti NA, Susanto I, Majidah NM, Nurunniyah S, Alfiana RD. 2022. Association between pre - pregnancy body mass index and gestational weight gain on pregnancy outcomes : a cohort study in Indonesian pregnant women. *BMC Pregnancy Childbirth*. 22(492):1–12.

doi:10.1186/s12884-022-04815-8.
Alemayehu GM, Chernet AG, Dumga KT, Science C, Sciences C, Alemayehu GM, Science C. 2020. Determinants of child size at birth and associated maternal factors in Gurage zone. *J Reprod Infertil*. 21(2):138–145.
Alemu B, Gashu D. 2020. Association of maternal anthropometry, hemoglobin and serum zinc concentration during pregnancy with birth weight. *Early Hum Dev*. 142 December 2019:1–7. doi:10.1016/j.earlhumdev.2019.104949.
Arero G. 2022. Undernutrition and associated factors among pregnant women in East Borena Zone, Liban District, Oromia regional state, Ethiopia. *Front Nutr*. 9 December:1–12. doi:10.3389/fnut.2022.1008701.
Dewi R, Sari P. 2023. Association of body mass index for pre-pregnant mothers and weight gain during Pregnancy with the outcome of baby ' s birth weight. *Sch Int J Obstet Gynecol*. 6(3):92–98. doi:10.36348/sijog.2023.v06i03.002.
Ernawati R, Purwaka BT, Prasetyo B. 2017. Nutritional status of third trimester pregnant women correlates positively with birth weight. *Maj Obstet Ginekol*. 25(2):41–47.
Ezenwa B, Iroha E, Ezeaka V, Egri-Okwaji MC. 2016. Comparative study of clinical assessment of nutritional status score and proportionality indices in the assessment of fetal malnutrition in term newborns. *Niger Med J*. 57(2):124–128. doi:10.4103/0300-1652.182075.
Gibson RS. 2005. *Principles of Nutrition Assesmemt*. Second Edi. New York (USA): Oxford University Press.
Goto E. 2015. Diagnostic value of maternal anthropometric measurements for predicting low birth weight in developing countries: A meta-analysis. *Asia Pac J Clin Nutr*. 24(2):260–272. doi:10.6133/apjcn.2015.24.2.05.
Karimi T, Zinab HE, Rezazadeh A, Moslemi Z. 2022. Maternal dietary diversity and nutritional adequacy in relation with anthropometric measurements of newborns at birth : a cohort study in Tehran city. *BMC Pediatr*. 31(200180):1–11. doi:10.1186/s12887-021-03102-3.
Laksono AD, Wulandari RD, Matahari R. 2023. Socioeconomic disparities in low birth weight in Indonesia's rural areas : a population-based study. *Natl Res Innov Agency Repub Indones Jakarta, Indones*. 1(56):403–413. doi:https://doi.org/10.2991/978-94-6463-112-8_37.
Lwanga SK, Lemeshow S. 1991. *Sample Size Determination in Health Studies*. Geneva: WHO 1991.
Madanijah S, Briawan D, Rimbawan R, Zulaikhah Z, Andarwulan N, Nuraida L, Sundjaya T, Murti L, Shah P, Bindels J. 2016. Nutritional status of pre-pregnant and pregnant women residing in Bogor district, Indonesia: A cross-sectional dietary and nutrient intake study. *Br J Nutr*. 116(1):57–66. doi:10.1017/S000711451600057X.
Maryani F, Budi E, Sumiyarsi I. 2019. Correlation between Nutritional Status of Pregnant Mothers and Low Birth Weight in the Surakarta Hospital. Di dalam: *The 2nd International Meeting of Public Health 2016: Public Health Perspective of Sustainable Development Goals: Challenges and Opportunities in Asia Pacific Region*. KnE Life Sciences. hlm 35–38.
Mulianingsih M, Nurmayani W. 2021. Nutritional status and weight of pregnant women to birth weight (BBL) to early detection of stunting. *J Ilm Kesehat*. 10(1):138–150. doi:10.30994/sjik.v10i1.523.

Muze M, Yesse M, Kedir S, Mustefa A. 2020. Prevalence and associated factors of undernutrition among pregnant women visiting ANC clinics in Silte zone, Southern Ethiopia. *BMC Pregnancy Childbirth*. 20(1):1–8. doi:10.1186/s12884-020-03404-x.

Nurahmawati D, Salimo H, Dewi YLR. 2017. Effects of maternal education, psychosocial stress, nutritional status at Pregnancy, and family Income, on Birthweight in Nganjuk, East Java. *J Matern Child Heal*. 02(04):327–337. doi:10.26911/thejmch.2017.02.04.04.

Papazian T, Tayeh GA, Sibai D, Hout H, Melki I, Khabbaz LR. 2017. Impact of maternal body mass index and gestational weight gain on neonatal outcomes among healthy Middle-Eastern females. *PLoS One*. 12(7):1–13. doi:10.1371/journal.pone.0181255.

Patil A, Pawar P, Bansal R. 2018. Maternal factors affecting fetal growth : review series 2. *Indian J Matern Neonatal Med*. 5(2):187–193.

Rani N, Phuljhele S, Beck P. 2017. Correlation between maternal mid upper arm circumference and neonatal anthropometry. *Int J Med Res Rev*. 5(07):717–724.

Ratnasari D, Suhartono S, Rahfiludin MZ. 2017. Faktor risiko kejadian berat badan lahir rendah di area pertanian (studi di kabupaten Brebes). *J Gizi dan Pangan*. 12(1):41–48. doi:10.25182/jgp.2017.12.1.41-48.

Retni, Margawati A, Widjanarko B. 2016. Pengaruh status gizi & asupan gizi ibu terhadap berat bayi lahir rendah pada kehamilan usia remaja. *J Gizi Indones*. 5(1):14–19.

Sabour H, Hossein-Nezhad A, Maghbooli Z, Madani F, Mir E, Larijani B. 2006. Relationship between pregnancy outcomes and maternal vitamin D and calcium intake: a cross-sectional study. *Gynecol Endocrinol*. 22(10):585–589. doi:10.1080/09513590601005409.

Shrivastava J, Agrawal A, Giri A. 2016. Maternal anthropometry in relation to birth weight of newborn: A prospective hospital based study. *Indian J Child Health*. 3(1):59–63. doi:10.32677/ijch.2016.v03.i01.013.

Tyagi S. 2023. Assessment of maternal dietary intake during pregnancy and its relation with nutritional status of infants at birth. *Hum Nutr Metab*. 31 May 2022:1–5. doi:10.1016/j.hnm.2022.200180.

Winasandis BF, Tamtomo D, Anantanyu S. 2020. Associations between maternal nutritional status , carbohydrate , fat , and protein intakes , and low birth weight in Jember , East Java. *J Matern Child Heal*. 5(1):1–11. doi:https://doi.org/10.26911/thejmch.2020.05.01.01.

Yosefinata K, Zuhairini Y, Luftimas DE. 2022. Association between maternal mid-upper arm circumference and baby's birth weight. *Maj Kedokt Bandung*. 54(3):172–176. doi:https://doi.org/10.15395/mkb.v54n3.2701.

Zhang P, Wu J, Xun N. 2019. Role of maternal nutrition in the health outcomes of mothers and their children: A retrospective analysis. *Med Sci Monit*. 25:4430–4437. doi:10.12659/MSM.914679.