KEMAS 21 (4) (2026) 949-956

Jurnal Kesehatan Masyarakat

http://journal.unnes.ac.id/nju/index.php/kemas

Integrating Multiple Micronutrient Supplementation into Antenatal Care in Rural Indonesia

Rosdiana Syakur[1]✉, Ajeng Kurniati [2], Andi Maryam [3], Sutiyono [4]

[1]Department of Public Health , Indonesia Timur University, South Sulawesi, Indonesia
[2]Department of Pharmacy , Indonesia Timur University, South Sulawesi, Indonesia
[3]Department of Midwifery , Kurnia Jaya Persada University, South Sulawesi, Indonesia
[4]Depatment of Nursing, An Nuur University, Central Java, Indonesia

Article Info

Article History:
Submitted December 2025
Accepted April 2026
Published April 2026

Keywords:
Maternal Nutrition; Multiple Micronutrient Supplementation; Iron–Folic Acid; Pregnancy Outcomes;

DOI
https://doi.org/10.15294/kemas.v21i4.35707

Abstract

The This study evaluated the effectiveness of Multiple Micronutrient Supplementation (MMS) compared to Iron–Folic Acid (IFA) in improving maternal nutritional outcomes in Indonesia. Maternal undernutrition and anemia contribute to low birth weight and stunting, while antenatal programs largely rely on IFA. This quasi-experimental pre–post parallel-group study was conducted in 2025 in Grobogan District, Central Java, who involved 60 pregnant women who were randomly assigned to MMS (n = 30) or IFA (n = 30). Maternal nutritional status was assessed through changes in body weight, mid-upper arm circumference (MUAC), and hemoglobin levels. Ethical approval was obtained (No. 48/Kom.etik/VI/2025). Data were analyzed using paired t-tests or Wilcoxon tests for within-group comparisons and independent t-tests or Mann–Whitney tests for between-group differences. Both groups showed significant weight gain (MMS: +2.93 kg; IFA: +3.47 kg; $p < 0.05$), with no significant difference between groups ($p = 0.363$). MUAC increased significantly in the IFA group (+0.96 cm; $p = 0.018$) but not in the MMS group. Hemoglobin increased significantly in the IFA group (+1.02 g/dL; $p = 0.008$), whereas MMS showed a non-significant decline. These findings indicate that although both supplements improved maternal weight, IFA was more effective in increasing hemoglobin.

Introduction

Chronic energy deficiency (CED) remains a critical nutritional issue among pregnant women in Indonesia, posing serious risks to both maternal and fetal health. It is commonly linked to inadequate intake of calories and protein, which can lead to complications such as anemia, preterm birth, and impaired fetal development. According to the 2023 Indonesian Health Survey, approximately 16.9% of pregnant women in the country suffer from CED, underscoring the urgent need for improved maternal nutrition (BKPK, 2023). In addition to poor dietary intake, socioeconomic challenges play a key role in exacerbating nutritional deficiencies. A qualitative study in Yogyakarta highlighted how low maternal education, permissive parenting, and poverty contribute to malnutrition in toddlers, reflecting the broader social determinants of health (Nuzuliana & Ellyda, 2025). Pregnant women with low nutritional status, particularly in environments with industrial pollution, face increased risks of adverse outcomes. Recent findings from industrial areas in Indonesia show that factors, such as maternal age, parity, anemia, and preeclampsia, are strongly associated with low birth weight (Khayati *et al.*, 2025). Furthermore, stunting continues to affect a large proportion of children in various regions, including Gorontalo, where prevalence rates exceed 35%. These cases are often linked to

✉ Correspondence Address:
Department of Public Health , Indonesia Timur University, South Sulawesi, Indonesia
Email: rosdiana@unan.ac.id

pISSN 1858-1196
eISSN 2355-3596

suboptimal birth weight, limited breastfeeding practices, and poor dietary diversity during early childhood (Nurlaily *et al*., 2025).

Nutritional education and supplementary feeding programs are widely promoted to improve maternal nutritional status and reduce the risk of adverse pregnancy outcomes. Despite this, adherence to iron and folic acid (IFA) supplementation, the standard antenatal intervention, remains a challenge. Adherence to antenatal supplementation is also influenced by socioeconomic conditions, maternal education, and the utilization of antenatal care services. A systematic review reported that adherence to IFA among pregnant women in Ethiopia was only 41.38%, underscoring the need for enhanced and targeted educational strategies (Bekele, 2025). Beyond conventional education, digital-based interventions are gaining attention. A recent meta-analysis found that digital psychotherapy could reduce maternal stress and anxiety, thereby supporting better adherence to antenatal health practices (Audina *et al*., 2025).

Beyond adherence challenges, concerns have also been raised about the limited effectiveness of IFA in preventing low birth weight (LBW) and neonatal complications. Evidence from multiple meta-analyses of randomized controlled trials (RCTs) consistently demonstrates that multiple micronutrient supplementation (MMS) offers superior benefits compared to IFA, particularly in reducing the incidence of LBW and small-for-gestational-age (SGA) births. One meta-analysis reported a 19% reduction in LBW risk with MMS use (RR 0.81; 95% CI: 0.74–0.89) (Bourassa *et al*., 2019). The enhanced outcomes are attributed to the synergistic effects of various essential vitamins and minerals that support maternal metabolic demands and fetal development. Although MMS involves higher upfront costs than IFA, studies have shown it to be a cost-effective strategy in improving pregnancy outcomes, especially in low- and middle-income countries such as Indonesia (Keats *et al*., 2021).

Multiple micronutrient supplementation (MMS), particularly the UNIMMAP formulation, has shown substantial benefits for both maternal and neonatal health. Systematic reviews and meta-analyses consistently report that MMS outperforms iron and folic acid (IFA) in reducing the incidence of low birth weight (LBW) and small-for-gestational-age (SGA) births, while improving overall birth weight outcomes (Keats *et al*., 2021). An individual participant data meta-analysis from 17 randomized controlled trials further confirmed that MMS reduced LBW risk by 19% compared to IFA alone. Beyond birth outcomes, MMS has also been associated with improved postnatal growth. Longitudinal studies have documented better length-for-age and weight-for-length scores among infants whose mothers received MMS during pregnancy (Taneja *et al*., 2022). These positive effects are attributed to the synergistic functions of micronutrients, including enhanced iron absorption via ascorbic acid and the combined metabolic support provided by other essential vitamins and minerals (Bourassa *et al*., 2019).

Despite substantial global evidence supporting the benefits of MMS, its implementation in Indonesia remains limited, as iron–folic acid (IFA) continues to be the standard supplementation in antenatal care. Nevertheless, several Indonesian studies have demonstrated that integrating MMS into routine maternal health services could meaningfully reduce the risks of low birth weight (LBW), small-for-gestational-age (SGA) infants, and preterm birth—outcomes that persist as significant public health concerns (Gomes *et al*., 2019). Nonetheless, MMS implementation faces several challenges. Reported barriers include poor adherence, logistical difficulties in supplement distribution, and the need for additional healthcare provider training (Ajello *et al*., 2024). Socioeconomic status and maternal education also play important roles in affecting the uptake of MMS, underscoring the necessity of culturally tailored interventions (Ba *et al*., 2024). The *Consolidated Framework for Implementation Research (CFIR)* has been proposed as a useful tool in identifying contextual facilitators and barriers for integrating MMS into maternal health programs in Indonesia (Damschroder *et al*., 2022). This study aimed to evaluate the effectiveness of multiple micronutrient supplementation (MMS) compared to iron–

folic acid (IFA) in improving maternal nutritional outcomes among pregnant women in Indonesia, in line with emerging global evidence supporting broader benefits of MMS in antenatal care.

Methods

This study employed a randomized controlled trial (RCT) with a pre–post parallel group design, conducted in Pulokulon Village, Grobogan District, Central Java, Indonesia. A total of 60 pregnant women in their first or second trimester were randomly assigned to receive either multiple micronutrient supplementation (MMS, n = 30) using the UNIMMAP formulation or standard iron–folic acid (IFA, n = 30) based on national guidelines. Inclusion criteria included age 18–40 years, absence of chronic disease, and willingness to complete the study. Women with obstetric complications or severe comorbidities were excluded. Baseline data included maternal age, gestational age, parity, education level, nutritional status (BMI and MUAC), and hemoglobin concentration. Supplementation was administered daily for 8 weeks, with adherence monitored by community health workers and midwives. Both groups also received basic nutrition counseling in accordance with national antenatal care guidelines.

Primary outcomes were changes in body weight, MUAC, and hemoglobin levels. Data were collected using standardized tools: digital scales, microtoise, non-elastic tape, and digital hemoglobinometers. Data collection was conducted in August 2025 through structured questionnaires and direct measurements. Data analysis was performed using SPSS. The Shapiro–Wilk test assessed the normality of the data. Within-group comparisons were analyzed using paired t-tests or Wilcoxon signed-rank tests. Between-group differences were evaluated using independent t-tests or Mann–Whitney U tests, while categorical data were analyzed using Chi-square or Fisher's exact tests. Statistical significance was set at $p < 0.05$. Ethical approval was obtained from the Health Research Ethics Committee of the Grobogan District Health Office, Central Java, Indonesia (No. 48/Kom. etik/VI/2025).

Results and Discussion

The baseline characteristics of the participants showed that most pregnant women were in the reproductive age range of 20–35 years, with only a small proportion classified as adolescents or advanced maternal age. A majority were multiparous and recruited during the second trimester. Nutritional status assessment indicated a relatively high prevalence of overweight and obesity, while MUAC values above 23.5 cm were common, suggesting that severe undernutrition was rare. Baseline anemia prevalence was low, and most women had completed secondary education. No significant differences were identified between groups, confirming balanced distribution for comparison.

Maternal body weight increased significantly in both groups after eight weeks of intervention. The MMS group gained an average of 2.93 kg, while the IFA group showed a mean increase of 3.47 kg, with both demonstrating statistically significant improvements ($p = 0.000$). However, between-group comparisons revealed no significant differences ($p = 0.363$). MUAC also increased in both groups; however, only the IFA group showed a statistically significant change ($p = 0.018$). Mean MUAC gain was higher in the IFA group (0.96 cm) than in the MMS group (0.46 cm), although between-group differences remained non-significant ($p = 0.086$). Hemoglobin levels exhibited distinct patterns: the MMS group experienced a slight non-significant decline ($p = 0.131$), whereas the IFA group showed a significant increase of 1.02 g/dL ($p = 0.008$), resulting in significant between-group differences ($p = 0.049$).

These findings are consistent with national evidence reporting that most Indonesian pregnant women fall within the 20–35-year age range but continue to experience a double burden of malnutrition (BKPK, 2023). Maternal age is strongly associated with pregnancy outcomes, with adolescents facing elevated risks of preeclampsia and low birth weight, while older mothers (≥35 years) have higher risks of gestational diabetes and hypertension (Keats *et al.*, 2021). Parity also influences outcomes, as multiparity is associated with complications such as preterm birth and low birth weight. Nutritional status plays an

Table 1. Baseline Characteristics of Pregnant Women in the Intervention and Control Groups (n = 60)

Variables	Intervention Group (n=30)		Control Group (n=30)		Total (n=60)		P-value
	n	%	n	%	n	%	
Mother's Age (years)							
< 20	3	10	1	3,3	4	6,60	0,634
20-35	26	86,6	25	83,3	51	85,00	
>35	1	3,3	4	13,3	5	3,30	
Parity							
Primigravida	7	23,3	7	23,3	14	23,30	0,503
Multigravida	23	76,6	23	76,6	46	76,60	
Gestational Age							
TM 1	10	33,3	4	13,3	14	23,3	0,163
TM 2	20	66,6	26	86,7	46	76,6	
BMI							
Underweight	1	3,33	1	3,3	2	3,33	0,283
Normal	12	40	9	30	21	35,00	
Overweight	12	40	11	36,7	23	38,33	
Obese	5	16,7	9	30	14	23,33	
MUAC							
≤23,5 cm	5	16,6	3	10	7	11,60	0,414
> 23,5 cm	25	83,3	27	90	53	88,30	
Anemia Status							
Yes	1	3,3	3	10	4	6,67	0,735
No	29	96,6	27	90	56	93,33	
Education							
Elementary School	7	23,3	6	20	13	21,60	0,763
Primary School	7	23,3	4	13,3	11	18,30	
High School	15	50	13	43,3	28	46,60	
Bachelor	1	3,3	7	23,3	8	13,30	

Source: Primary Data 2025.

important role as well; underweight women face increased risks of stunting and low birth weight, while overweight and obese women experience heightened risks of gestational hypertension and macrosomia (Keats *et al*., 2021).

Differences in the determinants of anemia between rural and urban populations have been linked to disparities in food intake, nutritional knowledge, and household expenditure (Wulandari *et al*., 2025). Broader contextual factors—including maternal education, socioeconomic barriers, and limited access to health services—further exacerbate nutritional vulnerability and impact maternal–child health outcomes (Nuzuliana & Ellyda, 2025). Parenting style and food access also shape child nutrition; unresponsive parenting and poverty have been shown to contribute to malnutrition among toddlers in Yogyakarta (Wulandari *et al*., 2025). Overall, these results highlight the importance of integrating

Table 2. Effects of MMS and IFA on Maternal Weight, MUAC, and Hemoglobin Levels

Variables	Pre	Post	P-Values	Change	P-Values
Maternal Weight					
MMS Group	61.32±14.85	64.32±14.17	0.000	2.93±3.297	0.363
IFA Group	63.99±10.35	67.47±9.78	0.000	3.47±2.58	
MUAC					
MMS Group	27.68±4.97	28.15±4.60	0.393	0.46±2.94	0.086
IFA Group	26.992±3.01	28.45±4.09	0.018	0.96±2.11	
Hb					
MMS Group	13.61±1.267	13.26±0.93	0.131	0,35 ±1.24	0.049
IFA Group	11.80±1.173	12.82±1.78	0.008	1.02±1.95	

Source: Primary Data 2025.

nutritional counseling, supplementation, and tailored antenatal strategies that consider maternal age, parity, anemia, and broader social determinants to improve maternal nutrition and support optimal fetal development.

Mid-upper arm circumference (MUAC) is an important indicator of maternal nutritional status, particularly in low-resource settings where BMI may be less practical to measure. MUAC remains relatively stable during pregnancy and is a reliable marker of undernutrition (Hasan, 2025).

A MUAC below 23 cm has been consistently associated with increased risks of low birth weight (LBW), impaired fetal growth, and pregnancy complications (Ghosh *et al*., 2019). Meta-analyses have demonstrated that women with low MUAC face up to 1.6 times higher risk of delivering LBW infants, emphasizing its strong predictive value in antenatal care (Cardinal *et al*., 2024). MMS has been shown to improve maternal nutritional reserves, including increases in MUAC and reductions in the LBW prevalence (Susiloretni *et al*., 2020).

Although our study did not find statistically significant differences in MUAC changes between the MMS and IFA groups, global evidence highlights the value of integrating MUAC monitoring with MMS in antenatal programs due to its simplicity, low cost, and strong predictive capacity. Hemoglobin concentration serves as another crucial indicator of maternal nutritional status. Anemia during pregnancy is associated with maternal complications, preterm birth, and LBW. Iron supplementation consistently increases hemoglobin levels, with prior studies reporting improvements of approximately 3.7 g/dL among anemic pregnant women (Donel *et al*., 2021). When combined with nutrition education, iron supplementation yields even better outcomes due to improved adherence and dietary practices (Sunuwar *et al*., 2019).

Although IFA remains the standard intervention for anemia prevention, growing evidence indicates that MMS offers comparable benefits. A meta-analysis comparing MMS containing 30 mg iron with IFA containing 60 mg iron found no significant difference in anemia prevalence (Gomes *et al*., 2023). MMS may also offer additional benefits beyond anemia prevention, including improved fetal growth outcomes. Nevertheless, adherence plays a critical role in supplementing success. Higher adherence to MMS has been linked to greater reductions in LBW risk (Smith *et al*., 2025) . However, concerns persist regarding excessive iron intake, which may increase the risk of gestational diabetes in women with adequate iron stores (Sun *et al*., 2023). In this study, IFA supplementation significantly improved hemoglobin levels, whereas MMS did not demonstrate a comparable increase. Nonetheless, global evidence affirms its nutritional comprehensiveness, suggesting that supplementation strategies should incorporate nutrition education and context-specific monitoring.

This study has several limitations. The

small sample size and single rural location may limit generalizability. The eight-week duration may not fully capture long-term supplementation effects on maternal or neonatal outcomes. Variations in adherence, despite monitoring, may also have influenced the results. Additionally, hemoglobin outcomes may have been affected by factors not controlled in this study, including baseline nutrition, dietary intake, and socioeconomic status. Therefore, the findings should be viewed as preliminary rather than conclusive guidance for policy.

Future research should include larger randomized controlled trials with longer supplementation periods extending through delivery to more comprehensively evaluate maternal and neonatal outcomes, such as LBW, SGA, and birth length. Further studies should incorporate dietary assessments, socioeconomic analyses, and adherence tracking to better understand the supplementing effects. Implementation research is also needed to identify strategies for integrating MMS into antenatal care in Indonesia, with emphasis on improving adherence, cultural acceptability, and program feasibility.

Conclusion

This study demonstrated that both iron–folic acid (IFA) and multiple micronutrient supplementation (MMS) improve maternal nutritional outcomes, particularly in body weight gain and Mid-Upper Arm Circumference (MUAC), with no significant differences observed between groups. However, hemoglobin levels improved significantly only in the IFA group, while the MMS group showed no comparable increase. Despite this, evidence from global literature underscores the broader benefits of MMS, particularly in improving birth outcomes such as reductions in low birth weight and small-for-gestational-age infants. In addition to clinical effectiveness, MMS has also been shown to be a cost-effective intervention for antenatal care programs in low- and middle-income countries, including Indonesia (Alfiani *et al*., 2025). This is consistent with findings from a follow-up study conducted in Jeneponto District, which revealed that Moringa extract supplementation during pregnancy significantly reduced stunting prevalence among preschool-aged children (Basri *et al*., 2025).

These findings highlight the importance of integrating nutritional supplementation into antenatal care while tailoring strategies to local contexts. IFA remains effective in addressing maternal anemia, whereas MMS offers a more comprehensive nutritional approach that may enhance maternal and neonatal outcomes in the long term. The results reinforce the need for public health policies that incorporate supplementation, nutrition education, and monitoring tools such as MUAC to optimize maternal and infant health. Further large-scale trials and implementation research are recommended to strengthen the evidence base for adopting MMS as part of routine antenatal care in Indonesia and similar low- and middle-income settings.

Acknowledgments

The authors would like to express their sincere gratitude to the Directorate of Research and Community Service, Ministry of Higher Education, Science, and Technology (Kemdiktisaintek) of the Republic of Indonesia, for providing financial support through the 2025 fiscal year research grant. The authors also extend their appreciation to the Grobogan District Health Office, midwives, community health volunteers (cadre), and all individuals who contributed to the successful implementation of this study. Their support and collaboration were invaluable in ensuring the smooth execution of the research.

References

Ajello., Clayton, J.B.A., & Jarno D.L., 2024. Expert Consensus on an Open-Access UNIMMAP MMS Product Specification: 2024 Revision. *Annals of the New York Academy of Sciences*. 1540(1).

Alfiani, F., Auliasari, M.U., Neily, Z., Auliya, A.S., & Irma, M.P., 2025. Cost-Effectiveness Analysis of Multiple Micronutrient Supplementation (MMS) Compared to Iron Folic Acid (IFA) in Pregnancy : A Systematic Review. *Int J Womens Health*, 17, pp.639–649.

Audina, A., Trias, M., Siti, R.N., & Emyr, R.I., 2025. Digital Therapy Versus Traditional Care for Maternal Mental Health: Meta-Analysis of Psychotherapy RCTs. *Jurnal Kesehatan*

Masyarakat, 21(1), pp.214–24.

Ba, A., Monica, F., Adama, M.K., Kristen, H., Shannon, K., Samba, O.S., Kounandji, D., Mahamane, D., Baba, S.K., Moussa, C., Ousmane, D., Lisa, M.N., Pooja, S., & Peter, J.W., 2024. Qualitative Evaluation of a Package of Implementation Strategies Codesigned to Support the Introduction of Multiple Micronutrient Supplementation (MMS) for Pregnant Women in Bamako, Mali. *Maternal and Child Nutrition*, 21(1).

Basri, H., Nur, H., Veni, H., Burhanuddin, B., Andi, Z., & Russeng, S., 2025. Effect Of Moringa Oliefera Supplementation During Pregnancy on Stunting in Children of Pre-School Age Hasan. *Jurnal Kesehatan Masyarakat*, 20(4), pp. 818–24.

Bekele, Y., 2025. Urban–Rural Disparities in Non-Adherence to Iron Supplementation Among Pregnant Women Aged 15 to 49 in Sub-Saharan Africa. *International Journal of Environmental Research and Public Health*, 22(6), pp.964.

BKPK., 2023. *SKI Dalam Angka*. Survei Kesehatan Indonesia.

Bourassa, M.W., Saskia J.M.O., Seth, A.A., Saima, A., Clayton, A., Gilles, B., Robert, B., Parul, C., Simon, C., Saskia, de.P., Kathryn, G.D., Shams, E.A., Reina, Engle-Stone, Alison, F., Alison, D.G., John, H., Rolf, K., Klaus, K., Roland, K., Erin, M.L., Sophie, E.M., Lynnette, M.N., Lars-Åke, P., Kathleen, M.R., Anuraj, H.S., Emily, S., Christopher, R.S., Emorn, U., Stephen, A.V., 2019. Review of the Evidence Regarding the Use of Antenatal Multiple Micronutrient Supplementation in Low- and Middle-Income Countries. *Annals of the New York Academy of Sciences*, 1444(1), pp.6–21.

Bourassa, M.W., Gilles, B., & Filomena, G., 2019. Multiple Micronutrient Supplementation During Pregnancy: Evidence Review (P10-092-19). *Current Developments in Nutrition*, 3.

Cardinal, A.M., Vanessa-Maria, F.T.T., & Ma, E.A.L., 2025. Maternal Mid-Upper Arm Circumference as a Predictor of Low Birth Weight Outcome Among Newborn Deliveries of Adolescents in a Tertiary Level Hospital. *Acta Medica Philippina*, 59(2).

Damschroder, L.J., Caitlin, M.R., Marilla, A.O.W., & Julie, C.L., 2022. The Updated Consolidated Framework for Implementation Research Based on User Feedback. *Implementation Science*, 17(1).

Donel., Dhini, A.N., Ruza, P.R., & Maya, S., 2021. Three-Month Iron Supplementation as Treatment for Microcytic Hypochromic Anemia in Pregnancy. *Majalah Kedokteran Bandung*, 53(2).

Ghosh, S., Kathryn, S., Meghan, K., Kidane, A., Yitbarek, K., Krista, Z., Leslie, W., Ashish, P., Jeffrey, K.G., Tefera, B., & Eileen, K., 2019. Nutrition-Specific and Nutrition-Sensitive Factors Associated With Mid-Upper Arm Circumference as a Measure of Nutritional Status in Pregnant Ethiopian Women: Implications for Programming in the First 1000 Days. *Plos One* 14(3), pp.e0214358.

Gomes, F., Sufia, A., Robert, E.B., Parul, C., Kathryn, G.D., Martin, N.M., Ziaul, H.R., Sarah, R., Anuraj, H.S., Emily, R.S., & Alison, T., 2023. Antenatal Multiple Micronutrient Supplements Versus Iron-folic Acid Supplements and Birth Outcomes: Analysis by Gestational Age Assessment Method. *Maternal and Child Nutrition*, 19(3).

Gomes, F., Megan, W.B., Seth, A.A., Clayton, A., Zulfiqar, A.B., Robert, E.B., Elisabete, C., Ranadip, C., Nita, D., & Pratibha, D., 2019. Setting Research Priorities on Multiple Micronutrient Supplementation in Pregnancy. *Annals of the New York Academy of Sciences*, 1465(1), pp.76–88.

Hasan, R.T., 2025. Mid-Upper Arm Circumference as a Tool to Assess the Nutritional Status of Pregnant Women and Associated Factors. *Journal of Education and Health Promotion*, 14(1).

Keats, E.C., Nadia, A., Pravheen, T., Simon, C., Zulfiqar, A.B., Hasmot, A., & Shams, E.A., 2021. Multiple-Micronutrient Supplementation in Pregnant Adolescents in Low- And Middle-Income Countries: A Systematic Review and a Meta-Analysis of Individual Participant Data. *Nutrition Reviews*, 80(2), pp.141–56.

Khayati, Y.N., Tandiyo, R., Oktia, W.K.H., Evi, W., & Dina, N.A.N., 2025. Maternal Characteristics, Malnutrition, and Pregnancy Complications with the Incidence of Low Birth Weight in an Industrial Environment. *Jurnal Kesehatan Masyarakat*, 21(1), pp.183–91.

Nurlaily, S., Rahma, D.A., & Nurhidayah., 2025. Stunting Among Children Aged 6-59 Months in Gorontalo, Indonesia. *Jurnal Kesehatan Masyarakat*, 20(3), pp.523–33.

Nuzuliana, R., & Ellyda, R.W., 2025. Socioeconomic Status as a Root Cause of Child Malnutrition Rosmita. *Jurnal Kesehatan Masyarakat*, 20(4), pp.751–58.

Smith, E.R., Filomena, G., Seth, A.A., Victor, M.A.,

Shams, E.A., Zulfiqar, A.B., Ellen, C.C., Parul, C., Delanjathan, D., Kathryn, G.D., Wafaie, W.F., Henrik, F., Exnevia, G., Ousmane, G., Lotta, H., Sheila, I., Pernille, K., Carl, L., Ken, M., Sophie, E.M., Erin, M.O., David, O., Anisur, R., Ziaul, R., Arjumand, R., Dominique, R., Saijuddin, S., Bakary, S., Sajid, B.S., Inan, S., Rahardjo, S., Dongqing, W., Keith, P.W.J., Lee, S.F.W., Noel, Z., Megan, W.B., Christopher, R.S., 2025. Contribution of Maternal Adherence to the Effect of Multiple Micronutrient Supplementation During Pregnancy: A Systematic Review and Individual Participant Data Meta-Analysis. *Advances in Nutrition*, 16(7), pp.100455.

Sun, F., Liyuan, C., Jinfeng, Q., Mengdie, L., Lanting, C., Chunqin, C., Da-Jin, L., Songcun, W., & Meirong, D., 2023. Decidual Stromal Cell Ferroptosis Associated With Abnormal Iron Metabolism Is Implicated in the Pathogenesis of Recurrent Pregnancy Loss. *International Journal of Molecular Sciences*, 24(9), pp.7836.

Sunuwar, D.R., Raj, K.S., Nani, S.S., Renu, Y., Narendra, K.C., & Pranil, M.S.P., 2019. Effect of Nutrition Education on Hemoglobin Level in Pregnant Women: A Quasi-Experimental Study. *Plos One*, 14(3), pp.e0213982.

Susiloretni, K.A., Dyah, N.S., Elisa, U., Trina, A., Sunarto., & Emily, R.S., 2020. Low Cost Local Food Supplements Could Improve Maternal and Birth Outcomes: A Pilot Randomized Controlled Trial. Medrxin, 2020.

Taneja, S., Ranadip, C., Neeta, D., Ravi, P.U., Sarmila, M., Sitanshi, S., Kiran, V.B., Chellani, H., Dewan, R., Mittal, P., Bhan, M.K., Bahl, R., & Bhandari, N., 2022. Impact of a Package of Health, Nutrition, Psychosocial Support, and WaSH Interventions Delivered During Preconception, Pregnancy, and Early Childhood Periods on Birth Outcomes and on Linear Growth at 24 Months of Age: Factorial, Individually Randomised Co. *BMJ*, 379, pp. e072046.

Wulandari, C., Pratiwi, H.P., Anugrah, L.M., Farah, N., Farda, J.H., Farah, N., Laily, M., Jauharotul, L., & Miftakhul, S., 2025. Anemia in Pregnancy Based on Rural and Urban Areas Catur. *Jurnal Kesehatan Masyarakat* 21(1), pp.126–35.