Original Article

Effect of a Local Food–Based Nutrition Intervention Using Moringa oleifera and Arachis hypogaea on Mid–Upper Arm Circumference among Pregnant Women with Chronic Energy Deficiency: A Quasi-Experimental Study

Erni Hernawati[1], Novita Yulianti[2], Sofa Nurul Hidayati[2]

[1] Midwifery Professional Program, Faculty of Midwifery, Rajawali Institute of Health, Bandung, West Java, Indonesia
[2] Bachelor of Midwifery Program, Faculty of Midwifery, Rajawali Institute of Health, Bandung, West Java, Indonesia

ARTICLE INFO

Article History
Submit : December 22, 2025
Accepted : February 19, 2026
Published : March 21, 2026

Correspondence
Erni Hernawati; Profesi Bidan, Fakultas Kebidanan, Institut Kesehatan Rajawali, Bandung, Jawa Barat, Indonesia

Email:
ernihernawatie@gmail.com

Citation:
Hernawati, E. ., Yulianti, N. ., & Hidayati, S. N. . (2026). Effect of a Local Food–Based Nutrition Intervention Using Moringa oleifera and Arachis hypogaea on Mid–Upper Arm Circumference among Pregnant Women with Chronic Energy Deficiency: A Quasi-Experimental Study. Journal of Applied Nursing and Health, 8(1), 163–174. https://doi.org/10.55018/janh.v8i1.526

ABSTRACT

Background: Chronic energy deficiency (CED) among pregnant women remains a persistent public health problem in low- and middle-income countries, including Indonesia. Various nutrition programs have been implemented; however, evidence on practical, locally based food interventions—particularly those combining moringa leaves and peanuts in ready-to-consume cookie form—remains limited. This study addresses this gap by evaluating a combined local food–based intervention aimed at improving maternal nutritional status.

Methods: his study used a quasi-experimental design with a non-randomized control group and a pretest–posttest approach, reported according to the TREND guideline. The sample consisted of 100 pregnant women with chronic energy deficiency recruited through consecutive sampling at a primary healthcare center. Inclusion criteria were gestational age 12–28 weeks and MUAC < 23.5 cm, while women with pregnancy complications, chronic diseases, food allergies, or multiple pregnancies were excluded. MUAC was measured using a standard non-stretchable tape by trained midwives. The intervention group received moringa leaf and peanut cookies daily for two weeks in addition to standard antenatal care, while the control group received standard care only. Data were analyzed using paired and independent t-tests, and effect size was calculated using Cohen's d.

Results: Both groups showed significant improvements in MUAC after the intervention period ($p < 0.001$). However, the intervention group demonstrated a greater mean increase in MUAC compared with the control group, with a moderate-to-large effect size (Cohen's d), indicating not only statistical significance but also meaningful clinical improvement. The effect size was moderate-to-large (Cohen's d = 0.65).

Conclusion: The findings indicate that a combined local food–based cookie intervention using moringa leaves and peanuts is more effective than standard antenatal care alone in improving MUAC among pregnant women with CED. This approach supports the integration of culturally appropriate, locally available food interventions into primary healthcare nutrition programs, particularly in low-resource settings.

***Keywords*:** Pregnant women; Chronic energy deficiency; Mid-upper arm circumference; Moringa oleifera; Arachis hypogaea; Local food intervention.

Implications for Practice:

- Nursing- and midwife-led delivery of locally formulated nutrition interventions can effectively improve maternal nutritional status within routine antenatal care services.
- The use of culturally familiar, locally available food ingredients enhances acceptability and feasibility, particularly in low-resource and rural primary healthcare settings.
- This intervention model is adaptable and scalable for community-based maternal nutrition programs in low- and middle-income countries, supporting sustainable strategies to address chronic energy deficiency.

Introduction

Chronic energy deficiency (CED) among pregnant women remains a major public health problem with significant implications for maternal and fetal health, particularly in low- and middle-income countries (LMICs), including Indonesia (Akbarini & Siswina, 2022; Novelia et al., 2021; Prameswari et al., 2020). Globally, the prevalence of undernutrition among women of reproductive age in LMICs has been reported to range from 35% to 75%, contributing to increased risks of pregnancy complications, low birth weight, and impaired fetal growth (WHO, 2024). In Indonesia, national data indicate that 17.3% of pregnant women experience CED, while provincial and district-level reports from West Java show prevalence ranging from 8% to 24%, depending on regional socioeconomic conditions (Kemenkes RI, 2022). Notably, local surveillance data from Rongga Primary Healthcare Center revealed that 31.18% of pregnant women were affected by CED within three months, highlighting the urgency of addressing maternal undernutrition at the primary healthcare level (Dinkes Jabar, 2023; Dinkes KBB, 2021).

Chronic energy deficiency is defined as a prolonged state of energy and protein inadequacy, commonly identified using a mid–upper arm circumference (MUAC) measurement of less than 23.5 cm (Jeukendrup et al., 2024; Legesse et al., 2019; Wiyono et al., 2020). MUAC is widely used in community and primary healthcare settings due to its simplicity, low cost, and feasibility for routine application by nurses and midwives. (Aiman et al., 2025; Nasaru et al., 2024; Wati et al., 2024). Low MUAC values reflect reduced maternal energy–protein reserves and are associated with increased risks of anemia, preeclampsia, preterm birth, and impaired fetal growth, underscoring the importance of interventions aimed at improving MUAC among pregnant women with CED (Al Maeka et al., 2025; Harna et al., 2024; Nukpezah et al., 2024).

Various governmental efforts have been implemented to address CED among pregnant women, including supplementary feeding programs, iron supplementation, nutrition education, and strengthened antenatal care services (Alfina et al., 2024; Berti et al., 2018; Nguyen et al., 2021). However, the effectiveness of these programs remains constrained by challenges related to food availability, sustainability of distribution, production costs, and acceptability of industrially produced supplementary foods. In addition, food forms that are not aligned with local dietary habits may reduce adherence among pregnant women, limiting the short-term impact of standard nutritional counseling alone (Chaman-Ara et al., 2018; Habtu et al., 2023). These challenges highlight the need for alternative nutrition interventions that are affordable, culturally acceptable, and feasible within routine primary healthcare services (Alaba, 2025; Jhaveri et al., 2023).

Local food–based nutrition interventions have been increasingly recognized as sustainable strategies for improving maternal nutritional status in LMICs. Previous studies have demonstrated

the nutritional potential of moringa leaves (*Moringa oleifera*) and peanuts (*Arachis hypogaea*) for pregnant women and other nutritionally vulnerable groups. Moringa leaves are rich in protein, iron, vitamin A, and vitamin C, while peanuts provide high energy density and healthy fats essential for meeting increased energy–protein requirements during pregnancy. Sudaryati et al. (2023) reported that biscuits made from moringa leaves and legumes increased hemoglobin levels by 0.82 g/dL, MUAC by 1.0 cm, and reduced anemia prevalence by up to 60%. Similarly, studies by Frianti et al. (2022) and Nur et al. (2022) showed that moringa-based interventions in capsule or biscuit form significantly improved hemoglobin levels and MUAC among pregnant women with CED. In addition, Utami et al. (2017) found that peanut-based formulations produced greater improvements in nutritional status among pregnant women with CED compared with other legume-based formulas.

Despite these promising findings, most previous studies have focused on single food ingredients or specific processed products, such as capsules or commercially produced biscuits, with limited evidence on combined local food formulations designed for routine daily consumption as snacks among pregnant women (Setyawati et al., 2024; Shah & Bhargava, 2020). Furthermore, evidence from rural areas of West Java, including the working area of Rongga Primary Healthcare Center, remains scarce. This gap limits the translation of local food–based nutrition interventions into scalable and midwife-led practices within primary healthcare settings.

From a conceptual perspective, this study is grounded in a behavior-oriented nutrition intervention framework, in which the provision of locally sourced, energy- and protein-dense foods in a ready-to-consume form is expected to support dietary intake by reducing barriers such as food availability, preparation time, and adherence challenges. Conceptually, increased intake of locally–based snacks is hypothesized to improve energy–protein adequacy, which subsequently enhances maternal nutritional reserves as reflected by improvements in MUAC. This framework aligns with the role of nurses and midwives in delivering practical, acceptable, and sustainable nutrition interventions within community and primary healthcare services. Therefore, this study aimed to analyze the effect of consuming cookies formulated from moringa leaves (*Moringa oleifera*) and peanuts (*Arachis hypogaea*) on changes in mid–upper arm circumference among pregnant women with chronic energy deficiency in the working area of Rongga Primary Healthcare Center, West Bandung Regency. Specifically, this study examined differences in MUAC changes between intervention and control groups following a two-week intervention period. The findings are expected to contribute to maternal nursing practice and community health nutrition by providing evidence to support the integration of culturally appropriate, local food–based nutrition interventions into routine antenatal care services.

Methods

Study Design

This community-based quasi-experimental study used a non-randomized control group with a pretest–posttest design to evaluate the effect of a local food-based cookie intervention on mid-upper arm circumference (MUAC) in pregnant women with chronic energy deficiency. The study was reported according to the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) guideline.

Participants

The study was conducted at Rongga Primary Healthcare Center, West Bandung Regency, Indonesia, from August to September 2025. Pregnant women attending antenatal care were screened. Consecutive sampling was used to enroll 100 eligible women (50 per group). Inclusion criteria: gestational age 12–28 weeks, MUAC <23.5 cm. Exclusion criteria: pregnancy complications, chronic diseases, food allergies, or multiple pregnancies. Using area-based allocation to minimize contamination, women from the Sukaresmi area were assigned to the intervention group and those from Cinengah to the control group. No participants dropped out.

Instruments

Mid–upper arm circumference (MUAC) was used as the primary outcome measure to assess maternal nutritional status. MUAC was measured using a calibrated, non-stretchable MUAC tape following standardized anthropometric procedures. Measurements were taken at the midpoint between the acromion and olecranon of the upper arm by trained midwives to ensure consistency and accuracy. Before data collection, all measuring tapes were checked against a standardized reference to maintain calibration. Each participant's MUAC was measured at baseline before the intervention and again two weeks after the intervention period to evaluate changes in nutritional status. Standardized recording forms were used to document measurements and minimize data entry errors.

Intervention

Formulation and Rationale: The intervention was a cookie formulated from Moringa oleifera leaf powder and Arachis hypogaea (peanut) flour, selected for their complementary nutrient profiles addressing energy-protein gaps in CED. Nutritional content was calculated using the Indonesian Food Composition Table (TKPI), yielding ~46 kcal and 0.98 g protein per cookie. The specific ratio of 25g moringa leaf powder to 50g peanut flour per batch was determined through preliminary testing to optimize nutrient delivery and palatability. A single production batch was made under standardized conditions to ensure consistency: dry ingredients (including moringa powder) were sifted; peanuts were dry-roasted and ground; dough was made by creaming margarine and sugar, adding egg yolks, incorporating dry ingredients and peanuts, then portioning into 10-gram units. Cookies were baked at 160°C for 15–20 minutes, cooled, and individually packaged.

Delivery and Dosage: The intervention group received a two-week supply (5 cookies/day, providing ~230 kcal and 4.9 g protein additional daily) alongside standard antenatal care. The control group received standard care only. Adherence was monitored via structured follow-up visits (days 3, 7, 10) involving package counts and consumption recall.

Data Collection

Data collection followed a structured workflow integrated into routine antenatal visits in a private examination room. At baseline, sociodemographic data and MUAC were recorded. MUAC was measured using a calibrated, non-stretchable tape. Before data collection, all tapes were checked against a standardized length reference. Regular spot-checks were conducted during data collection as part of ongoing quality control. Measurements were taken at the mid-point between the acromion and olecranon by trained midwives who followed a standardized protocol for landmark identification and tape tension to ensure validity. To ensure reliability, all midwives received comprehensive standardized training and used the same

calibrated instrument. Post-intervention MUAC was measured two weeks (±2 days) later. Data were recorded on standardized forms to minimize errors. Direct supervision and immediate data entry with verification were implemented. Regular cross-checking of recorded MUAC values was performed.

Data Analysis

Data were analyzed using IBM SPSS Statistics for Windows, version 26. Descriptive statistics summarized participant characteristics. The normality of the MUAC data distribution was assessed using the Shapiro-Wilk test, confirming that parametric tests were appropriate. Within-group changes were analyzed using paired samples t-tests, and between-group differences using an independent samples t-test. The magnitude of the intervention effect was quantified using Cohen's d, calculated as the difference between the group mean changes divided by the pooled standard deviation. Statistical significance was set at $p < 0.05$.

Ethical Considerations

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Ethical approval was obtained from the Health Research Ethics Committee of the Faculty of Health Sciences, Universitas Jenderal Achmad Yani (Approval No. 089/KEPK/FITKes-Unjani/V/2025). Written informed consent was obtained from all participants, and confidentiality was maintained throughout the study.

Results

Participant Characteristics

A total of 100 pregnant women with chronic energy deficiency participated in this study, with 50 participants in the control group and 50 in the intervention group. As shown in **Table 1**, the baseline sociodemographic characteristics were comparable between the two groups. Most participants were aged 17–24 years, had a senior high school education, and were unemployed. No participants were lost to follow-up.

Table 1. Baseline sociodemographic characteristics of participants (n=100)

Characteristic	Category	Control (n=50) n (%)	Intervention (n=50) n (%)
Age (years)	17–24	35 (70.0)	38 (76.0)
	25–30	15 (30.0)	12 (24.0)
	31–35	0 (0.0)	0 (0.0)
Education	Primary/Junior High	12 (24.0)	10 (20.0)
	Senior High School	35 (70.0)	29 (58.0)
	Higher Education	3 (6.0)	11 (22.0)
Employment Status	Unemployed	47 (94.0)	45 (90.0)
	Employed	3 (6.0)	5 (10.0)

The baseline MUAC values for both groups are presented in **Table 2**. The mean baseline MUAC was identical between the control and intervention groups (23.10 cm), indicating comparable maternal nutritional status before the intervention. There was no statistically significant difference in baseline MUAC between the two groups ($p > 0.05$).

Table 2. Baseline mid-upper arm circumference (MUAC) values

Group	n	Mean MUAC (cm) ± SD
Control	50	23.10 ± 0.16
Intervention	50	23.10 ± 0.18

Table 3 summarizes the within-group changes in MUAC before and after the two-week study period. Both the control and intervention groups showed statistically significant increases in MUAC ($p < 0.001$). In the control group, the mean MUAC increased by 0.75 ± 0.22 cm. A greater improvement was observed in the intervention group, with a mean increase of 1.00 ± 0.33 cm.

Table 3. Within-group changes in MUAC (paired samples t-test)

Group	n	Mean Change (cm) ± SD	95% CI of Difference	t	df	p-value
Control	50	0.75 ± 0.22	0.69 – 0.81	24.41	49	< 0.001
Intervention	50	1.00 ± 0.33	0.91 – 1.09	21.50	49	< 0.001

The comparison of MUAC changes between groups is presented in **Table 4.** The intervention group showed a significantly greater increase in MUAC compared to the control group (mean difference = 0.25 cm; $t(98) = -3.12$, $p = 0.002$). The 95% confidence interval for the difference (0.09 – 0.41 cm) did not cross zero, consistently favoring the intervention. The magnitude of this effect was moderate, with a Cohen's d of 0.65.

Table 4. Between-group comparison of post-intervention MUAC and effect size

Group	n	Mean Posttest MUAC (cm) ± SD	Mean Difference (cm)	t(98)	p-value	Cohen's d
Control	50	23.85 ± 0.22	-0.25	-3.12	0.002	0.65
Intervention	50	24.10 ± 0.33				

Discussion

This study demonstrated that a combined local food–based nutrition intervention using cookies formulated from *Moringa oleifera* leaves and *Arachis hypogaea* resulted in a greater improvement in mid–upper arm circumference (MUAC) among pregnant women with chronic energy deficiency compared with standard antenatal care alone. Although both the intervention and control groups showed significant improvements, the magnitude of change was consistently higher in the intervention group, indicating that standard antenatal care alone may be insufficient to rapidly restore maternal nutritional reserves among women with established chronic energy deficiency. This finding highlights the added value of direct nutritional supplementation in improving maternal anthropometric outcomes. These findings are consistent with previous studies reporting improvements in MUAC following moringa- and legume-based interventions among pregnant women (Frianti et al., 2022; Nur et al., 2022; Sudaryati et al., 2023; Utami et al., 2017)

From a physiological perspective, the superior effect of the combined intervention can be explained by the complementary nutritional profiles of moringa leaves and peanuts. Moringa leaves contribute protein and micronutrients that support maternal tissue synthesis, while peanuts provide energy-dense fats and additional protein necessary to increase total caloric intake during pregnancy. The simultaneous provision of energy and protein likely facilitated more efficient

replenishment of maternal energy–protein stores, which was reflected in the observed improvement in MUAC. Unlike nutrition counseling alone, which relies on dietary changes at the household level, direct provision of nutrient-dense foods ensures actual intake. It enables measurable anthropometric improvements even within a short intervention period.

In addition to physiological mechanisms, behavioral factors play an important role in explaining why the combined intervention outperformed standard care. Pregnant women with chronic energy deficiency often face barriers to adequate dietary intake, including limited food availability, time constraints, fatigue, and reduced appetite. The ready-to-consume cookie format reduced these barriers by eliminating the need for food preparation and simplifying daily consumption. Integration of the intervention into routine antenatal care further supported consistent intake by embedding the behavior within an existing healthcare routine. This behavior-supportive design likely enhanced adherence without requiring complex behavior modification strategies, thereby amplifying the nutritional impact of the intervention (Watson et al., 2023; Wright et al., 2022).

The findings of this study are particularly relevant for low- and middle-income country (LMIC) settings, where maternal undernutrition remains prevalent and access to commercial nutritional supplements is often limited. The use of locally sourced ingredients such as *Moringa oleifera* leaves and *Arachis hypogaea* reflects an approach that is affordable, culturally familiar, and accessible within community settings. By relying on ingredients that are already available at the local level, this intervention demonstrates potential scalability without dependence on complex supply chains or specialized production facilities.

Scalability is further supported by the delivery of the intervention through routine primary healthcare services. Integrating the provision of locally formulated nutritional supplements into existing antenatal care workflows allows the intervention to be implemented without substantial additional infrastructure or workforce demands. This approach strengthens feasibility and sustainability, particularly in primary healthcare settings where nurses and midwives play a central role in maternal nutrition monitoring and support. As such, the intervention aligns with community-based and nursing-led strategies for improving maternal nutritional status in resource-constrained contexts.

Implications and limitations

This study advances the theoretical framework for local food-based interventions by demonstrating that a combined, ready-to-consume formulation of energy-dense and micronutrient-rich ingredients can improve maternal anthropometry in the short term, suggesting that integrating nutrient complementarity with behavioral convenience is a key factor for effectiveness beyond focusing solely on single nutrients or long-term dietary change. However, the findings should be interpreted with several limitations in mind, including the quasi-experimental design that may introduce selection bias despite area-based allocation, the short two-week intervention period, which limits assessment of sustainability and long-term outcomes, and the use of MUAC as a screening measure for CED that does not capture micronutrient status or overall diet quality. Future randomized trials with longer follow-up periods and more comprehensive nutritional assessments are therefore recommended. Despite these limitations, the intervention

demonstrates a feasible nursing-led approach for integrating local food-based supplements into routine antenatal care, and its reliance on locally available ingredients and simple delivery mechanisms indicates strong potential for scalability and sustainability in primary healthcare settings while empowering nurses and midwives as key agents in addressing maternal undernutrition.

Relevance to Practice

The findings of this study have direct relevance for maternal health practice, particularly within primary healthcare services where nurses and midwives play a central role in antenatal care delivery. The demonstrated effectiveness of a local food–based nutrition intervention suggests that practical, culturally appropriate nutritional strategies can be integrated into routine antenatal services to support pregnant women with chronic energy deficiency. Importantly, this intervention is well-suited for nursing- and midwifery-led implementation, as it does not require specialized equipment, complex preparation, or additional clinical procedures. Nurses and midwives can incorporate the distribution, monitoring, and basic counseling related to the consumption of locally formulated nutrition supplements into existing antenatal care workflows. This positions nursing professionals not only as care providers but also as key agents in delivering behavior-supportive nutritional interventions at the community level.

By utilizing locally available ingredients and embedding the intervention within routine services, this approach supports sustainable maternal nutrition practices that can be adapted and scaled across similar primary healthcare settings. The integration of such interventions into nursing-led antenatal care has the potential to strengthen maternal nutrition programs and contribute to improved pregnancy outcomes in resource-limited contexts.

Conclusion

This study provides evidence that a ready-to-consume cookie combining Moringa oleifera and Arachis hypogaea can enhance short-term nutritional recovery in pregnant women with chronic energy deficiency, offering a practical, locally adaptable complement to standard antenatal care. The findings support integrating such behaviorally convenient, local food-based strategies into primary healthcare programs to address maternal undernutrition. Future research should prioritize randomized controlled trials to confirm efficacy, investigate optimal dosing and duration, and evaluate impacts on key pregnancy outcomes such as birth weight and gestational age.

Funding

This research received no external funding.

CrediT Authorship Contributions Statement

Erni Hernawati: Conceptualization, Methodology, Investigation, Supervision, Data Curation, Writing – Original Draft.

Novita Yulianti: Formal Analysis, Validation, Writing – Review & Editing, Visualization.

Sofa Nurul Hidayati: Drafting the manuscript and submission manuscript

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

The authors would like to express their gratitude to the staff of Rongga Primary

Healthcare Center, West Bandung Regency, for their support and cooperation during data collection. Appreciation is also extended to all pregnant women who participated in this study for their time and willingness to contribute to the research. This study was conducted independently and was not part of any funded research grant.

Supplementary Materials

Supplementary File S1: Research Instrument contains the full questionnaire used for data collection.

References

Aiman, U., Riskika, F., Septiawan, N. A., Syahrani, S., Nurhidaya, I., Fitrasyah, I., Utami Dewi, N., & Hartini, D. A. (2025). A cross-sectional study on determinant factors of Chronic Energy Deficiency (CED) among pregnant women in disaster-prone areas: A case study at Talise Community Health Center, Palu City. *Nutrición Clínica y Dietética Hospitalaria*, *45*(3), 392–401. https://doi.org/10.12873/453aiman

Akbarini, O. F., & Siswina, T. (2022). Factors Affecting the Incidence of Chronic Energy Deficiency (CED) in Pregnant Women. *Science Midwifery*, *10*(5), 3776–3783. https://doi.org/10.35335/midwifery.v10i5.841

Al Maeka, S. M., Kartasurya, M. I., & Pradigdo, S. F. (2025). Impact of maternal chronic energy deficiency on newborns in developing countries: A scoping review. *Journal of Holistic Nursing Science*, *12*(2), 315–325. https://doi.org/10.31603/jhns.v12i2.14001

Alaba, S. K. (2025). Strategies to address food insecurity and improve global nutrition among at-risk populations. *International Journal of Science and Research Archive*, *14*(2), 1657–1680. https://doi.org/10.30574/ijsra.2025.14.2.0564

Alfina, S. T., Setyowati, A. T. W., Wuni, A. A. Z., Andriyanti, A., & Jayanti, R. D. (2024). The Role of Continuity of Care (CoC) in Supporting Pregnant Women at Risk of Chronic Energy Deficiency (CED) in Improving Nutritional Status: A Case Report. *International Journal Of Scientific Advances*, *5*(5), 888–893. https://doi.org/10.51542/ijscia.v5i5.5

Anantasia, G., & Rindrayani, S. R. (2025). Metodologi Penelitian Quasi Eksperimen. *ADIBA: Journal Of Education*, *5*(2), 183–192.

Berti, C., Gaffey, M. F., Bhutta, Z. A., & Cetin, I. (2018). Multiple-micronutrient supplementation: Evidence from large-scale prenatal programmes on coverage, compliance and impact. *Maternal & Child Nutrition*, *14*(S5), 1–11. https://doi.org/10.1111/mcn.12531

Chaman-Ara, K., Sharif, S., Ms, ;, Amin, M., & Phd, B. ; (2018). Challenges and Barriers to Pregnant Women's Nutrition: Policy Recommendations. *Journal of Nutrition and Food Security (JNFS)*, *3*(2), 60–64.

Dinkes Jabar. (2023). *Profil Kesehatan Provinsi Jawa Barat Tahun 2023*. https://diskes.jabarprov.go.id

Dinkes KBB. (2021). *Profil Kesehatan Kabupaten Bandung Barat*.

Frianti, N., Arifuddin, S., Hadju, V., Aminuddin, A., Nontji, W., Bahar, B., & Hariati, M. C. (2022). effect of moringa leaf capsules and fe administration to increase hemoglobin levels, weight, and upper arm circumference (LILA) in trimester II pregnant women with chronic energy deficiency (KEK). *International Journal of Health Sciences*, *6*(S3), 12524–12534.

https://doi.org/10.53730/ijhs.v6nS3.9600

Habtu, M., Agena, A. G., Umugwaneza, M., Mochama, M., & Munyanshongore, C. (2023). Effect and Challenges of an Integrated Nutrition-Intervention Package Utilization among Pregnant Women and Lactating Mothers in Rwanda: An Exploratory Qualitative Study. *Current Developments in Nutrition*, *7*(1), 100018. https://doi.org/10.1016/j.cdnut.2022.100018

Harna, H., Rahmawati, R., Irawan, A. M. A., & Sa'pang, M. (2024). Prevalence and determinant factors of Chronic Energy Deficiency (CED) in pregnant women. *AcTion: Aceh Nutrition Journal*, *9*(1), 65–73. https://doi.org/10.30867/action.v9i1.1443

Jeukendrup, A. E., Areta, J. L., Van Genechten, L., Langan-Evans, C., Pedlar, C. R., Rodas, G., Sale, C., & Walsh, N. P. (2024). Does Relative Energy Deficiency in Sport (REDs) Syndrome Exist? *Sports Medicine*, *54*(11), 2793–2816. https://doi.org/10.1007/s40279-024-02108-y

Jhaveri, N. R., Poveda, N. E., Kachwaha, S., Comeau, D. L., Nguyen, P. H., & Young, M. F. (2023). Opportunities and barriers for maternal nutrition behavior change: an in-depth qualitative analysis of pregnant women and their families in Uttar Pradesh, India. *Frontiers in Nutrition*, *10*(1185696), 1–15. https://doi.org/10.3389/fnut.2023.1185696

Kemenkes RI. (2022, December 13). *Gerakan Ibu Hamil Sehat untuk Turunkan Stunting dan Angka Kematian Ibu*. Kementrian Kesehatan Indonesia. https://kemkes.go.id/id/gerakan-ibu-hamil-sehat-untuk-turunkan-stunting-dan-angka-kematian-ibu

Legesse, M., Abebe, Z., & Woldie, H. (2019). Chronic energy deficiency and associated factors among older population in Ethiopia: A community based study. *PLOS ONE*, *14*(4), e0214861. https://doi.org/10.1371/journal.pone.0214861

Nasaru, J., Sutiningsih, D., Setiani, O., Sakundarno Adi, M., & Agushybana, F. (2024). Factors Associated with Chronic Energy Deficiency (CED) in Pregnant Women: A Study in North Gorontalo Regency, 2023. In M. I. Kartasurya, J.-H. Han, K.-H. Tsai, S. Nursheena, S. Changrob, N. Lisnawati, A. F. Asna, N. Handayani, & D. Z. Nuridzin (Eds.), *BIO Web of Conferences* (p. 00003). EDP Science. https://doi.org/10.1051/bioconf/20242413300003

Nguyen, P. H., Kachwaha, S., Tran, L. M., Avula, R., Young, M. F., Ghosh, S., Sharma, P. K., Escobar-Alegria, J., Forissier, T., Patil, S., Frongillo, E. A., & Menon, P. (2021). Strengthening Nutrition Interventions in Antenatal Care Services Affects Dietary Intake, Micronutrient Intake, Gestational Weight Gain, and Breastfeeding in Uttar Pradesh, India: Results of a Cluster-Randomized Program Evaluation. *The Journal of Nutrition*, *151*(8), 2282–2295. https://doi.org/10.1093/jn/nxab131

Novelia, S., Rukmaini, & Annisa, E. (2021). Factors Related to Chronic Energy Deficiency among Pregnant Women. *Nursing and Health Sciences Journal (NHSJ)*, *1*(3), 237–241. https://doi.org/10.53713/nhs.v1i3.54

Nukpezah, R. N., Abanga, E. A., Adokiya, M. N., Aninanya, G. A., Odiakpa, L. O., Shehu, N., Chukwu, N. M., Mahama, A.

B., & Boah, M. (2024). Preterm birth, low birth weight, and their co-occurrence among women with preexisting chronic diseases prior to conception: a cross-sectional analysis of postpartum women in a low-resource setting in Ghana. *Maternal Health, Neonatology and Perinatology*, *10*(18), 1–13. https://doi.org/10.1186/s40748-024-00188-2

Nur, N., Sakung, J., & Bima. (2022). Haemoglobin Levels and Mid-Upper Arm Circumference in Pregnant Women Through The Giving of Moringa Biscuits. *Journal of Health Science and Prevention*, *6*(1), 1–7. https://doi.org/10.29080/jhsp.v6i1.632

Park, K., Kittrell, K., & Ewing, R. (2020). Quasi-Experimental Research. In *Basic Quantitative Research Methods for Urban Planners* (1st ed., pp. 305–318). Routledge.

Prameswari, F. S. P., Marliyati, S. A., & Dewi, M. D. (2020). A Supplementary Protein Food for Pregnant Women with Chronic Energy Deficiency to Improve Fetal Growth. *Jurnal Gizi Dan Pangan*, *15*(1), 1–10. https://doi.org/10.25182/jgp.2020.15.1.1-10

Setyawati, E., Sumarmi, S., Nurasmi, N., Irnawati, I., & Hutagaol, I. O. (2024). Effectiveness of moringa biscuit (Moringa oleifera) and snakehead fish (Channa striata) in improving the nutritional status of pregnant women with chronic energy deficiency. *African Journal of Reproductive Health*, *28*(10s), 41–49. https://doi.org/10.29063/ajrh2024/v28i10s.5

Shah, R., & Bhargava, A. (2020). To Study the Effect of Arachis hypogaea and Cicer arietinum on Serum Calcium Levels of Women between 17-25 years of Age group in Shekhawati region of Rajasthan. *EAS Journal of Nutritions and Food Science*, *2*(4). https://doi.org/https://doi.org/10.36349/easjnfs.2020.v02i04.003

Sudaryati, E., Panjaitan, A. M., Nadeak, T. A. U., Tobing, A. M. L., Masthalina, H., & Keloko, A. B. (2023). The Effect of Pumpkin Biscuits (Cucurbita moschata), Peanut (Arachis hypogaea) andMoringa Leaves (Moringa oleifera) on Hemoglobin Levels and Maternal Upper Arm Circumference (MUAC) of Pregnant Women. *Research Suare*, 1–11. https://doi.org/10.21203/rs.3.rs-2761631/v1

Utami, N. W., Majid, T. H., & Herawati, D. M. D. (2017). Pemberian minuman formula kacang merah, kacang tanah, dan kacang kedelai terhadap status gizi ibu hamil kurang energi kronis (KEK). *Jurnal Gizi Klinik Indonesia*, *14*(1), 1–9. https://doi.org/10.22146/ijcn.22424

Wati, E. K., Murwani, R., Kartasurya, M. I., & Sulistiyani, S. (2024). Determinants of chronic energy deficiency (CED) incidence in pregnant women: A cross-sectional study in Banyumas, Indonesia. *Narra J*, *4*(1), e742. https://doi.org/10.52225/narra.v4i1.742

Watson, D., Mushamiri, P., Beeri, P., Rouamba, T., Jenner, S., Proebstl, S., Kehoe, S. H., Ward, K. A., Barker, M., & Lawrence, W. (2023). Behaviour change interventions improve maternal and child nutrition in sub-Saharan Africa: A systematic review. *PLOS Global Public Health*, *3*(3), e0000401. https://doi.org/10.1371/journal.pgph.0000401

WHO. (2024, April 26). *Maternal mortality*. World Health Organization. https://www.who.int/news-

room/fact-sheets/detail/maternal-mortality

Wiyono, S., Burhani, A., Harjatmo, T. P., Ngadiarti, I., Prayitno, N., . M., Purbaningrum, R. P., . W., Erowati, D., & Fahira, F. (2020). Study causes of chronic energy deficiency of pregnant in the rural areas. *International Journal Of Community Medicine And Public Health*, *7*(2), 443–448. https://doi.org/10.18203/2394-6040.ijcmph20200412

Wright, C., Barnett, A., Campbell, K. L., Kelly, J. T., & Hamilton, K. (2022). Behaviour change theories and techniques used to inform nutrition interventions for adults undergoing bariatric surgery: A systematic review. *Nutrition & Dietetics*, *79*(1), 110–128. https://doi.org/10.1111/1747-0080.12728

