Rapid Response Brief



Improving maternal nutrition in the first trimester

Undernutrition generally, and maternal undernutrition specifically, is more common in low- and middle-income countries than in highincome countries.^{1,2} This leads to increased risk of a variety of poor birth outcomes, including neonatal mortality and low birthweight.¹ As infants exposed to *in utero* undernutrition grow into adults, they continue to experience increased risk of disease and mortality. **Exposure to first trimester undernutrition appears to have the longest lasting effects.**^{3–5}

Given the far-reaching consequences of maternal nutrition during pregnancy, we need to know what works to improve maternal nutrition early in and throughout pregnancy. Nutrition education and counselling are common approaches to improving maternal undernutrition in low- and middle-income countries because they can be implemented effectively at scale. However, the effectiveness of nutrition education and counselling during pregnancy, and ways to make these interventions more effective, remains unclear. This brief reviews the available information and highlights gaps in the evidence base.

Key findings

- In utero exposure to malnutrition affects health not only in infancy but also later in life and across generations.
- The evidence on the effectiveness of nutrition education and counseling interventions to improve birthweight is limited and outdated.
- Evidence that does exist finds mixed, context-specific effects.

Key recommendations

- Commission updated evaluations of the effectiveness of nutrition education and counseling interventions during pregnancy.
- Ensure the implementation of ethical nutrition education and counseling interventions, which respect the autonomy of mothers and ensure optimal outcomes for women and their children.
- Consider the suitability of nutrition education and counseling interventions within local contexts and ensure locally relevant design.



3 International Initiative for Impact Evaluation



Background

The lifechanging importance of maternal nutrition during the first trimester was incontrovertibly proven through a series of studies on the Dutch Hunger Winter, an extraordinarily acute and short famine resulting from World War II.³⁻⁵ These studies showed that effects of late term exposure to famine dissipated over time, but **first trimester exposure to famine was associated with a variety of long-term, negative health and well-being outcomes.** This revolutionary finding led to the creation of the Developmental Origins of Health and Disease hypothesis which claims that adult obesity, cardiovascular disease, and other health outcomes are driven by intra-uterine nutrition and related exposures.³ The intra-uterine environment changes how organs develop and which genes are expressed in adulthood.⁸ Although the effects of maternal diet on fatal and infant health are obvious and intuitive, the disproportionate importance of maternal diet in the first trimester relative to later in foetal and infant life is not as apparent.

Intrauterine socio-nutritional shocks affect infant long-term health in low- and middle-income countries as well; however, co-occurrence with other negative exposures makes causal attribution in these contexts more challenging. Nonetheless, *in utero* exposure to the Chinese famine caused by the Great Leap Forward (1959-1962) increased the risk of fatty liver disease in adulthood in women.⁹ There was an inconsistent relationship between famine exposure and both BMI and waist circumference later in life depending on the timing of exposure, severity of exposure, and age at which the measurement occurred, demonstrating **the existence of unique periods of sensitivity**.¹⁰ As another demonstration of these sensitive periods, across contexts, famine exposure affects risk of negative mental health outcomes, with risk for specific mental health disorders varying by trimester of famine exposure.¹¹ Adults conceived during the Bengal Famine of 1974 were shorter than those conceived two decades earlier.⁷ The children of these famine-exposure to undernutrition can be passed down across generations, perpetuating cycles of undernutrition and poor health.^{6,7}

While these contexts represent extreme shocks, less extreme negative exposures are expected to have similar, but less severe negative effects. For example, *in utero* exposure to the Great Depression (USA, 1930s) was associated with more rapid aging.¹² However, **research on the effects of maternal nutrition in the first trimester in the contexts of less extreme negative exposures is less common because defining the exposure is challenging.¹³ Women often do not know they are pregnant in the first trimester, making it difficult to measure subtle changes in their diet.**

Background

Nonetheless, **specific micronutrients are known to have disproportionate effects in the first trimester.** The effect of folic acid in the first weeks of pregnancy on the prevalence of neural tube defects is well established.¹⁴ Folic acid supplementation in the first trimester can also reduce the risk of congenital heart diseases.¹⁵ Maternal iron deficiency in the first trimester is more damaging to fetal growth than iron deficiency in later pregnancy.¹³ Vitamin B12 deficiency in the first and second trimesters is associated with increased risk of poor pregnancy outcomes, particularly low birthweight¹⁶.

However, maternal health and nutrition should not be prioritized for the sake of the child alone. **Maternal nutrition has important implications for women themselves**. Maternal supplementation during pregnancy improves outcomes for the woman. For example, calcium supplementation reduces risk of mortality and severe complications due to pre-eclampsia. Maternal vitamin A supplementation reduces risk of maternal anemia, infection, and night blindness, but not mortality among otherwise healthy women.¹⁷ Iron-folic acid supplementation also reduced the risk of obstetric complications in Nepal.¹⁸

Occasionally, the interests of pregnant women and their fetuses come into conflict.¹⁹ Therefore, **careful and respectful communication with pregnant women, which encourages and empowers them to eat in a way that benefits both mom and her baby, is necessary to ensure the best possible, ethical outcomes.** Outcomes which reflect the overall health of the mother-infant dyad, such as birthweight, can be prioritized to optimize outcomes for both.²⁰ Low birthweight is a sign of long-term maternal malnutrition and poor health during pregnancy and leads to increased risk of neonatal morbidity, poor growth, delayed cognitive development, and disease at all life stages.²⁰



What is maternal nutrition education and counselling?

Given the established importance of maternal nutrition, **governments and institutions use maternal nutrition education and counselling to improve maternal and neonatal outcomes through respectful communication, empowerment, and practical advice.** The primary ethical values that underly effective nutrition counseling focus on providing accurate information, respecting autonomy, avoiding harm, being fair, and ensuring confidentiality when applicable.²¹ In general, nutrition education and counselling during pregnancy promotes healthy, diversified diets.²² These interventions may also include the provision of other health messages, stress and anxiety support, or the provision of supplements or fortified foods.²²

Although definitions vary, **nutrition counseling is defined as two-way interactive educational sessions** which promote specific nutrition behaviors in individual or group settings.²³ **Nutrition education can**, **therefore, be conceptualized as didactic and non-interactive educational sessions** which promote similar nutrition behaviors and can also occur in individual or group settings. However, the boundary between education and counselling is not always clear and terminology is sometimes used interchangeably. Therefore, these two interventions are considered jointly for this work, but the terms are not used interchangeably.

Theory of change

Early-pregnancy nutrition education and counseling is assumed to affect maternal behaviors in the short-term leading to improved neonatal and maternal health in the medium term and improved outcomes for the infant into adulthood (Figure 2). This causal chain can be examined through a variety of indicators. We focus on low birthweight as a measure of both neonatal and maternal health and discuss other outcomes only when considered by studies that also evaluate low birthweight.

Figure 2: Theory of change underlying nutrition education and counseling interventions during pregnancy.



* Birthweight is a proxy measure for this intermediate outcome.



Sources of evidence on maternal nutrition counselling and education

The most comprehensive consideration of the relationship between nutrition counseling and infant birthweight comes from a **2023 systematic review on nutrition counselling during pregnancy, with 42 completed studies**^{23, i}. Studies compared two-way interactive nutrition counselling, sometimes combined with the provision of food and supplements, to standard antenatal care. Participants were low risk pregnant women between 18-49 years old in low- and middle-income countries. They were mostly recruited in their first and second trimester.ⁱⁱ In addition to information on nutrition during pregnancy, interventions provided information on support and exercise during pregnancy, gestational weight gain, healthy eating, breastfeeding, the importance of iron and folic acid supplements, and knowledge of pregnancy complications. Most interventions took place in community settings (n = 25) and used a mixture of one-on-one and group activities (n = 23), sometimes with written guidance documents. The frequency of sessions varied between 1-15 sessions.

A 2022 systematic review on interventions before or during early pregnancy to reduce low birthweight **in sub-Saharan Africa** found only two evaluations of nutrition counseling interventions in early pregnancy.²⁴

Before 2017, only one systematic review had been published on randomized controlled trials evaluating the effects of nutrition education during pregnancy on low birthweight.²⁵ That 2015 review considered interventions to increase energy and protein intake during pregnancy, including nutrition education interventions.²⁶

A 2012 systematic review found 34 studies on nutrition education and counseling interventions.²² These were mostly *quasi-experimental* (n = 18), largely took place in high-income countries (n = 23), and sometimes provided food or supplements (n = 13).



Effects of maternal nutrition counselling and education on neonatal birth outcomes in low- and middle-income countries.

The effects of nutrition counseling interventions in low- and middle-income countries were largely restricted to behavioral changes, such as improved caloric, protein, and fat intake, according to the 2023 review. **Evidence from four studies found no effect on risk of low birthweight**.^{III} In addition, there was no evidence of effect or low-quality evidence on post-partum hemorrhage, stillbirths, and anemia. However, interventions increased the probability of gestational weight gain within recommended parameters.^{23, iv}

Interventions in Ethiopia and Kenya that provided monthly individual counseling both resulted in a **reduction in the prevalence of low birthweight**, as reported in the 2022 systematic review.

Evidence from Bangladesh and the USA showed that nutrition education interventions aiming to increase energy and protein intake during pregnancy improved the birthweight of infants born to undernourished mothers, as reported in the 2015 review. However, a study in Greece^v found no effect on the birthweight of infants born to adequately nourished mothers. Nonetheless, the intervention increased head circumference at birth of the infants in the study in Greece. The studies in the USA and Greece also found reductions in preterm births, with this outcome being unevaluated in Bangladesh.

Of the studies in the 2012 review, 12 (including in India, China, and Latin America^{vi}) considered risk of low birthweight and found no average effect. Furthermore, when considering only studies from **lowand middle-income countries (Egypt, India, and China), the nutrition education and counseling interventions were found to have no effect on birthweight** as measured by the continuous variable. Nonetheless, interventions reduced risk of maternal anemia in the third trimester, based on 8 interventions in low- and middle-income countries and 3 interventions in high-income countries.

Value of additional research

Although nutrition education and counseling interventions are widely implemented, **their effectiveness** in reducing the prevalence of low birthweight remains unknown. Recent systematic reviews recycle old studies, which sometimes took place 35 years ago^{vii}. The reason for such an outdated evidence base is unclear but may be due to the recent movement to combine these interventions with other sources of support. This could have resulted in an absence of recent evidence on the effectiveness of nutrition education and counseling interventions themselves. Reflecting this new trend in nutrition interventions, additional research is needed to understand the value-add of nutrition education and counseling interventions of care, research should establish the additional impacts of nutrition education and counseling to determine if it contributes to the overall effects of such programs and improves the efficiency of these new, multi-sectoral programs.

This Rapid Response brief is primarily based on the following studies

¹ Undernourished and Overlooked | UNICEF. https://www.unicef.org/reports/undernourished-overlooked-nutrition-crisis (accessed 2024-03-12).
² Digital, S. Global Nutrition Report 2020: Action on equity to end malnutrition. Save the Children's Resource Centre. https://resourcecentre.savethechildren.net/document/global-nutrition-report-2020-action-equity-end-malnutrition/ (accessed 2024-03-12).

³ Schulz, L. C. The Dutch Hunger Winter and the Developmental Origins of Health and Disease. *Proc Natl Acad Sci U S A* 2010, 107 (39), 16757–16758. https://doi.org/10.1073/pnas.1012911107.

⁴ De Rooij, S. R.; Bleker, L. S.; Painter, R. C.; Ravelli, A. C.; Roseboom, T. J. Lessons Learned from 25 Years of Research into Long Term Consequences of Prenatal Exposure to the Dutch Famine 1944-45: The Dutch Famine Birth Cohort. *Int J Environ Health Res* 2022, 32 (7), 1432–1446. https://doi.org/10.1080/09603123.2021.1888894.

⁵ Scholte, R. S.; van den Berg, G. J.; Lindeboom, M. Long-Run Effects of Gestation during the Dutch Hunger Winter Famine on Labor Market and Hospitalization Outcomes. *J Health Econ* 2015, *39*, 17–30. https://doi.org/10.1016/j.jhealeco.2014.10.002.

⁶ Painter, R. C.; Osmond, C.; Gluckman, P.; Hanson, M.; Phillips, D. I. W.; Roseboom, T. J. Transgenerational Effects of Prenatal Exposure to the Dutch Famine on Neonatal Adiposity and Health in Later Life. *BJOG* 2008, *115* (10), 1243–1249. https://doi.org/10.1111/j.1471-0528.2008.01822.x.

⁷ Fakir, A. Footprints of War and Famine: Intrauterine and Inter-Generational Effects of the 1971 Bangladesh Liberation War and the 1974 Bengal Famine. Rochester, NY 2019. https://papers.ssrn.com/abstract=3369726 (accessed 2024-03-12).

⁸ Santurtún, A.; Riancho, J.; Riancho, J. The Influence of Maternal and Social Factors During Intrauterine Life; 2019; pp 129–149. https://doi. org/10.1007/978-981-13-7256-8_8.

⁹ Wei, R.; Wang, W.; Pan, Q.; Guo, L. Effect of Fetal Exposure to Famine on the Risk of Metabolic Associated Fatty Liver Disease in Adulthood: A Systematic Review and Meta-Analysis. Rochester, NY March 1, 2022. https://doi.org/10.2139/ssrn.4046672.

¹⁰ Jiang, H.; Yu, Y.; Li, L.; Xu, W. Exposure to the Great Famine in Early Life and the Risk of Obesity in Adulthood: A Report Based on the China Health and Nutrition Survey. *Nutrients* **2021**, *13* (4). https://doi.org/10.3390/nu13041285.

¹¹ Dana, K.; Finik, J.; Koenig, S.; Motter, J.; Zhang, W.; Linaris, M.; Brumberg, J. C.; Nomura, Y. Prenatal Exposure to Famine and Risk for Development of Psychopathology in Adulthood: A Meta-Analysis. *J Psychiatry Psychiatr Disord* **2019**, 3 (5), 227–240. https://doi.org/10.26502/jppd.2572-519X0077.

¹² Schmitz, L. L.; Duque, V. In Utero Exposure to the Great Depression Is Reflected in Late-Life Epigenetic Aging Signatures. *Proc Natl Acad Sci U S A* **2022**, 119 (46), e2208530119. https://doi.org/10.1073/pnas.2208530119.

¹³ Abu-Saad, K.; Fraser, D. Maternal Nutrition and Birth Outcomes. *Epidemiologic Reviews* **2010**, *32* (1), 5–25. https://doi.org/10.1093/epirev/mxq001.

¹⁴ CDC. *Folic Acid: The Best Tool to Prevent Neural Tube Defects*. Centers for Disease Control and Prevention. https://www.cdc.gov/ncbddd/ folicacid/features/folic-acid-helps-prevent-some-birth-defects.html (accessed 2024-03-29).

¹⁵ Qu, Y.; Lin, S.; Zhuang, J.; Bloom, M. S.; Smith, M.; Nie, Z.; Mai, J.; Ou, Y.; Wu, Y.; Gao, X.; Tan, H.; Liu, X. First-Trimester Maternal Folic Acid Supplementation Reduced Risks of Severe and Most Congenital Heart Diseases in Offspring: A Large Case-Control Study. *J Am Heart Assoc* 2020, *9* (13), e015652. https://doi.org/10.1161/JAHA.119.015652.

¹⁶ Mishra, J.; Tomar, A.; Puri, M.; Jain, A.; Saraswathy, K. N. Trends of Folate, Vitamin B12, and Homocysteine Levels in Different Trimesters of Pregnancy and Pregnancy Outcomes. *Am J Hum Biol* **2020**, *32* (5), e23388. https://doi.org/10.1002/ajhb.23388.

¹⁷ McCauley, M. E.; van den Broek, N.; Dou, L.; Othman, M. Vitamin A Supplementation during Pregnancy for Maternal and Newborn Outcomes. *Cochrane Database Syst Rev* **2015**, 2015 (10), CD008666. https://doi.org/10.1002/14651858.CD008666.pub3.

¹⁸ Christian, P.; Khatry, S. K.; LeClerq, S. C.; Dali, S. M. Effects of Prenatal Micronutrient Supplementation on Complications of Labor and Delivery and Puerperal Morbidity in Rural Nepal. *International Journal of Gynecology & Obstetrics* **2009**, *106* (1), 3–7. https://doi.org/10.1016/j. ijgo.2009.03.040.

¹⁹ Mahowald, M. B. Maternal-Fetal Conflict: Positions and Principles. *Clin Obstet Gynecol* **1992**, 35 (4), 729–737.

²⁰ Low birth weight. https://www.who.int/data/nutrition/nlis/info/low-birth-weight (accessed 2024-03-12).

²¹ Vasiloglou, M. F.; Fletcher, J.; Poulia, K.-A. Challenges and Perspectives in Nutritional Counselling and Nursing: A Narrative Review. *J Clin Med* **2019**, *8* (9), 1489. https://doi.org/10.3390/jcm8091489.

²² Girard, A. W.; Olude, O. Nutrition Education and Counselling Provided during Pregnancy: Effects on Maternal, Neonatal and Child Health Outcomes. In *Database of Abstracts of Reviews of Effects (DARE): Quality-assessed Reviews [Internet]*; Centre for Reviews and Dissemination (UK), 2012.

²³ Dewidar, O.; John, J.; Baqar, A.; Madani, M. T.; Saad, A.; Riddle, A.; Ota, E.; Kung'u, J. K.; Arabi, M.; Raut, M. K.; Klobodu, S. S.; Rowe, S.; Hatchard, J.; Busch-Hallen, J.; Jalal, C.; Wuehler, S.; Welch, V. Effectiveness of Nutrition Counseling for Pregnant Women in Low- and Middle-income Countries to Improve Maternal and Infant Behavioral, Nutritional, and Health Outcomes: A Systematic Review. *Campbell Syst Rev* 2023, 19 (4), e1361. https://doi.org/10.1002/cl2.1361.

²⁴ Kuma, M. N.; Tamiru, D.; Beressa, G.; Belachew, T. Effect of Nutrition Interventions Before and/or During Early Pregnancy on Low Birth Weight in Sub-Saharan Africa: A Systematic Review and Meta-Analysis. *Food Nutr Bull* **2022**, 43 (3), 351–363. https://doi. org/10.1177/03795721221078351.

²⁵ Lopes, K. da S.; Ota, E.; Shakya, P.; Dagvadorj, A.; Balogun, O. O.; Peña-Rosas, J. P.; De-Regil, L. M.; Mori, R. Effects of Nutrition Interventions during Pregnancy on Low Birth Weight: An Overview of Systematic Reviews. *BMJ Global Health* **2017**, *2* (3), e000389. https://doi.org/10.1136/ bmjgh-2017-000389.

²⁶ Ota, E.; Hori, H.; Mori, R.; Tobe-Gai, R.; Farrar, D. Antenatal Dietary Education and Supplementation to Increase Energy and Protein Intake. *Cochrane Database Syst Rev* **2015**, No. 6, CD000032. https://doi.org/10.1002/14651858.CD000032.pub3.

What is the WACIE Helpdesk

The WACIE helpdesk provides rapid synthesis and evidence translation to help policymakers in West Africa understand what evidence exists for specific policy questions. The helpdesk can also connect interested policymakers with further resources to meet additional needs. It is staffed by the WACIE Secretariat with engagement from the wider 3ie technical staff and other experts as needed.

To submit a policy question, or for additional information, contact wacie@3ieimpact.org.

What is WACIE?

The West Africa Capacity Building and Impact Evaluation (WACIE) program, was launched to help build evaluation capacity in the eight countries that comprise the West African Economic and Monetary Union (WAEMU): Benin, Burkina Faso, Cote d'Ivoire, Guinea-Bissau, Mali, Niger, Senegal and Togo. Program goals include increasing evaluation capacity in targeted countries, ensuring that policymakers have access to relevant evidence and promoting take-up of high-quality evidence by relevant stakeholders.

Endnotes

¹ Dewidar et al. (2023) identified studies conducted in Africa (Benin, Egypt, Ethiopia, Kenya, Malawi, multiple countries), Asia (Iran, China, India, Indonesia, Turkey, Malaysia, Bangladesh, Nepal, Jordan), South America (Brazil, Mexico), Europe (Greece when classified as an LMIC).

[®] Except one study (Liu, 2009) that identified healthy pregnant women at their third trimester.

^{III} One study was multi-country, taking place in Argentina, Brazil, Cuba, and Mexico. The others took place in Greece when the country was an LMIC, Kenya, and Mexico. RR: 0.74, 95% CI, 0.40–1.37, three RCTs; I² = 73%. The study in Mexico was quasi-experimental and not included in the meta-analysis of the RCTs.

^{iv} RR: 1.84; 95% CI, 1.10–3.09, three RCTs; I² = 69%, confidence rating not provided.

^v This is the same study that took place in Greece when the country was an LMIC referred to in the 2023 systematic review.

vi This is the same multi-country study in Argentina, Brazil, Cuba, and Mexico referred to in the 2023 systematic review.

^{vii} Dewidar and colleagues (2023), da Silva Lopes (2017), and Ota and colleagues (2015) all use information from the same evaluation that took place in Greece and was published in 1989. Dewidar and colleagues (2023) and Girard and colleagues (2012) reference a trial in Latin America from 1989 to 1991.



The International Initiative for Impact Evaluation (3ie) develops evidence on how to effectively transform the lives of the poor in low- and middle-income countries. Established in 2008, we offer comprehensive support and a diversity of approaches to achieve development goals by producing, synthesizing and promoting the uptake of impact evaluation evidence. We work closely with governments, foundations, NGOs, development institutions and research organizations to address their decision-making needs. With offices in Washington DC, New Delhi and London and a global network of leading researchers, we offer deep expertise across our extensive menu of evaluation services.



alieNews



3ieimpact

in /company/3ieimpact

May 2024

