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Sanitation and Multiple Micronutrient Supplementation in Pregnancy Outcomes: Literature Review

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Abstract

BACKGROUND: Around 2.6 billion people lack proper sanitation. In addition, nutritional problems such as multiple micronutrient (MMN) deficiency can increase morbidity, mortality, and impaired neurocognitive growth at later stages of life. In addition to the need for a sanitary approach, a globally applicable strategy to prevent micronutrient deficiencies in pregnant women, UNICEF recommends the use of MMN for prenatal supplementation as an initial program in developing countries, to reduce the risk of poor birth outcomes.

AIM: The aim of this literature study was to analyze the relationship between sanitation and the multimicronutrient (MMN) approach in pregnancy and birth outcomes.

METHODS: This research was conducted using literature review method. Various references were collected from online database including reports, journals, and books. The journals were mostly from the scholarly journals. The articles were screened according to the research objectives. The keywords used are sanitation, pregnancy, and multiple micronutrient approach.

RESULTS: Several studies have shown that sanitation and the multi micronutrient (MMN) approach play a role in determining pregnancy outcomes. We conclude that the importance of sanitation on pregnancy outcome is to reduce the chance of infection. The importance of MMN in pregnancy outcomes is that mothers who consume MMN during pregnancy can reduce the risk of poor birth output. The role of stakeholders is needed in the future.

CONCLUSIONS: Several studies have shown that sanitation and multi micronutrient (MMN) play a role in determining pregnancy outcome.

Introduction

The growth and development of a child are very much determined by the conditions of the womb and when the life of first 2 years. Chronic nutritional deficiencies when in this period can lead for less outcomes later, about disorders in cognitive development, immune function, growth, and an increase developing chronic disease later, which has consequences to human health [1]. Develop of the immune system is very important [2]. The WHO notes around 830 women worldwide died every day because the complications about pregnancy and 99% are in developing countries. In developing countries, in 2015, MMR reached 239 per 100,000, compared to developed country which only reached 12 per 100,000 [3]. Sanitation is one of the crucial facets for women who are either planning to have a baby [4].

There is a consensus that pregnant women need more supplements than just folic acid. Required supplements containing vitamins and minerals are considered to be a more efficient approach to the problem of micronutrient deficiency. Based on this, multivitamin and mineral supplements were designed for pregnant women in developing countries. Then, this MMN is tested in various countries to see its benefits [5]. A meta-analysis study also found that MMN supplementation significantly reduced the incidence of low birth weight (LBW) and small infants for gestational age [6].

Sanitation is one of the crucial facets for women who are either planning to have a baby. Exposure to unsafe water, poor sanitation, and poor waste management during pregnancy have a significant relationship with an increased risk of infection in the mother, which can lead to LBW and premature birth [7].

The aim of this literature study was to analyze the relationship between sanitation and the multimicronutrient (MMN) approach in pregnancy and birth outcomes.

Methods

This research was conducted using literature review method. Various references were collected from online database including reports, journals, and books. The journals were mostly from the scholarly journals. The articles were screened according to the research objectives. The keywords used are sanitation, pregnancy, and multiple micronutrient approach. The data are selected from Google Scholar journals and the literature of the past 10 years. Screened data and selected based on adequate criteria and keywords based on research objectives. Inclusion criteria are journal about sanitation, pregnancy, and multiple micronutrient approach. The number of papers in the initial search is 100 articles. The number of papers that selected for the specific scope of this review is 23 articles. We follow Prisma for reporting in systematic reviews (Figure 1).

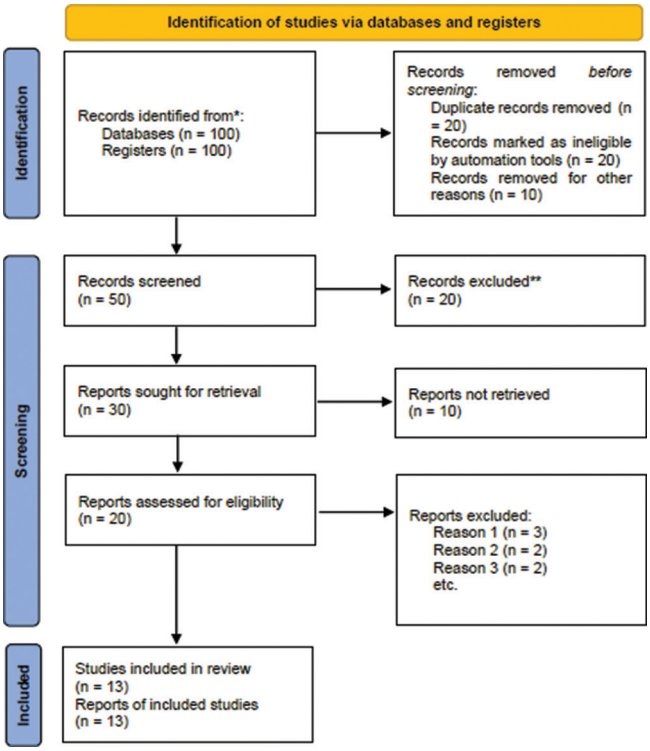

Figure 1: PRISMA for reporting in systematic reviews

Results

Various studies showed that MMN reduced infant mortality, premature birth, and LBW, but some studies showed different results. Some studies found no different in birth weight, mortality, and premature delivery by MMN supplementation. Several studies have shown that poor sanitation carries a greater risk of pregnancy outcome (Table 1). They connect between three variables described. The results of the studies show the determining pregnancy outcome.

Discussion

Sanitation in pregnancy

The WHO was reported that 4.0% of all deaths and 5.7% of total lives could associated with water, sanitation, and hygiene. Water quality are related to environmental chemicals add a quite a heavy load of disease. Water quality associated with environmental chemicals adds to the considerable burden of disease and is exacerbated by inadequate water supply, sanitation and hygiene, and no quantification of improvements in water supply and sanitation [8]. Adverse conditions can originate not only from contaminated water sources but also from poor hand hygiene, which can made worse by limited access to water [9]. Poor water or environmental sanitation factors (health facilities and housing conditions) contribute to maternal mortality [8].

MMN in pregnancy

Micronutrient deficiency is more common, especially in low pregnant women to countries has middle income. Risk of pregnant women by multiple micronutrient deficiencies caused by an increased need for fetal and placental development. The inability to meet the increased needs can be bad for the mother and fetus [6]. Deficiency of vitamin and mineral extends widely iron deficiency in reproductive age women can negatively impact pregnancy. The outcome of such deficiency includes LBW. This can be done by an efficient approach of combining different kinds of vitamin and mineral into a supplement. Based on this approach, multivitamin and mineral supplementation designed to be consumed by pregnant women was developed and made available through UNICEF. These multivitamins and mineral supplements were tested in efficacy and effectiveness series tests that included some countries and continents. The aim of this trial is found that multivitamin and mineral using pregnancy supplements can increase important results such as birth weight and improve supplement consumption adherence to pregnancy and micronutrient status in addition to reduce infant and neonatal mortality rate [10].

Although this provision is part of a national program that has been running for the past several

Table 1: Collection of Journal Literature that explains the relationship in the topic of sanitation and multiple micronutrient supplementation in pregnancy outcomes

Title	Characteristics		Finding
	Subject	Method	
Multiple micronutrient supplementation during pregnancy in low-income countries: A meta-analysis of effects on stillbirths and on early and late neonatal mortality (Carine Ronsmans *et al.*, 2009)	22,396 children whose mothers received several micronutrient supplements 22,003 children in the control group	Case control	Supplementation provides about RDA from various micronutrients does not reduce risk stillbirth (OR = 1.01; 95% CI, 0.88–1.16), early neonatal death (OR = 1.23; 95% CI, 0.95–1.59), late neonatal mortality (OR = 0.94; 95% CI, 0.73–1.23), or perinatal death (OR = 1.11; 95% CI, 0.93–1.33)
Multi-micronutrient supplementation during pregnancy for prevention of maternal anaemia and adverse birth outcomes in a high-altitude area: a prospective cohort study in rural Tibet of China (Yi Jun Kang *et al*., 2017)	A total of 1,149 pregnant women are eligible allocating daily supplementation with FA in one area and MMN containing recommended allowances for twenty-three vitamins and minerals in other countries from ≤ 24 weeks of gestation and continuing until delivery	Cohort	Antenatal MMN supplementation in rural Tibet is associated with a reduction in maternal anemia in third trimester, and potentially reduce the risk of preterm birth and LBW infants
The Effect of Intermittent Antenatal Iron Supplementation on Maternal and Infant Outcomes in Rural Viet Nam: A Cluster Randomised Trial (Hanieh, *et al.*)	1258 pregnant women with UK <16 weeks. The treatment group was divided into three groups (Group 1 was given regular iron and folic acid supplements, Group 2 was given iron and folic acid 2 times a week, Group 3 was given multiple micronutrients	Cohort, randomized trial	There were no significant differences between the three treatment groups for infant birth weight, the highest ferritin levels were found in mothers who received regular iron supplements, there was no significant effect on Hb levels in the three treatment groups. Babies born to mothers who get iron supplements twice a week have higher cognitive scores compared to those who get regular iron supplement
Systematic review and meta-analysis: Association between water and sanitation environment and maternal mortality (Lenka Benova *et al*., 2014)	Literature in Medline, Embase, Popline and Africa Wide EBSCO since 1980	Cohort	Caught the relationship between poor and high level sanitation maternal mortality and the relationship between inadequate water access and high maternal mortality. households with poor sanitation have a 3.14-fold chance dying compared to better sanitation. That sensitivity analysis after issuing only studies adjusted for age yields the same estimate of 3.07. That Collecting estimates of the relationship between water and maternal mortality shows that women with poor water supplies have an estimated 1.75 chance of maternal death compared to those who have enough water, but only one study adjusted for confounders (adjusted OR 1.5)
Water, sanitation, hygiene and enteric infections in children, Joe Brown *et al*., 2015	Using evidence from the past 150 years of the WSH-related illness burden followed by a general review of water, sanitation and hygiene transmission route and control steps	Case control	Infections related to excreta through a variety of route from one host to the next, both as a results of direct transmission through contaminated ones hand, or indirect transmission through contamination drinking water, soil, equipment, food, and flies. A study of several countries found that 25% stunting in children aged 24 months could be caused by five or more episodes of diarrhea experienced in the first 2 years of life. More than 780 million people now do not have access to “improved” water source, and one study estimates the number of people which rely on water microbiologically or chemically is not safe 1.8 billion, or about 28% of the global population
Haider, B. A., and Bhutta, Z. A. (2017). Multiple-micronutrient supplementation for women during pregnancy. Cochrane Database of Systematic Reviews	Cochrane Pregnancy and Childbirth Trial Register (March 11, 2015) and reference list of articles taken and the main review. We also contact experts in the field for additional and ongoing trials	Cohort	Nineteen trials (involving 138,538 women) were identified as eligible for inclusion in this review but only 17 trials (involving 137,791 woman) contributes data for review. Fifteen of the 17 trials were conducted in low- and middle-income countries and compared MMN supplements with iron and folic acid versus iron with or without folic acid. Two trials conducted in the UK compared MMN with a placebo
Micronutrient Deficiency in Women Living in Industrialized Countries During the Reproductive Years: Is there a Basis for Supplementation with Multiple Micronutrients? Ella Schaefer (2016)	Women of childbearing age in industrialized countries, too those who are pregnant, to determine whether there are gaps in the level of micronutrients	Cohort	Evidence shows that the proportion of high-income women countries that have the potential to have children or who are already pregnant lower than the currently recommended nutritional or blood intake concentration of micronutrients, specifically folate, Vitamin B12, Vitamin D, calcium, iodine, iron, and selenium. All these women will benefit from supplementation with several micronutrients, not just folate and iron. Studies have confirmed the MMN
Multiple micronutrient supplementation during pregnancy in low-income countries A meta-analysis of effects on birth size and length of gestation Caroline H. D. Fall *et al.* (2013)	Original data from 12 randomized controlled trials in Bangladesh, Burkina Faso, China, Guinea-Bissau, Indonesia, Mexico, Nepal, Niger, Pakistan and Zimbabwe all provide about 1 dietary allowance (RDA) recommendation of several micronutrients to be considered HIV-negative women, included	Cohort	Compared with control supplementation (especially with iron-folic acid), multiple Micronutrient supplementation is associated with an increase in average birth weight (pooled estimates: +22.4 g [95% CI, 8.3–36.4 g]; p = 0.002), decreased prevalence of LBW (pooled OR = 0.89 [95% CI, 0.81–0.97]; p = 0.01) and SGA birth (combined OR = 0.90 [95% CI, 0.82 to 0,99]; p = 0.03), and an increase in the prevalence of LGA births (combined OR = 1.13 [95% CI, 1.00])
Risk of Adverse Pregnancy Outcomes among Women Practicing Poor Sanitation in Rural India (Padhi, B. K. *et al.*, 2015)	670 pregnant women	Prospective Cohort Study	This study provides the first evidence, to the best of our knowledge, regarding poor sanitation with a higher risk of adverse pregnancy results
Modifiers of the effect of maternal multiple micronutrient supplementation on stillbirth, birth outcomes, and infant mortality: a meta-analysis of individual patient data from 17 randomised trials in low-income and middle-income countries Emily R Smith, Anuraj H Shankar *et al.* (2017)	Data from 17 randomized and controlled trials were performed in 14 low- and middle-income countries	Cohort	Some micronutrient supplements that contain iron-folic acid provide a significantly greater reduction neonatal mortality for female neonates compared with male neonates rather than iron folic acid supplementation alone (RR 0.85, 95% CI 0.75–0.96 vs. 1.06, 0.95–1.17; p value for interactions 0.007). Some micronutrient supplements resulting in a greater reduction in LBW (RR 0.81, 95% CI 0.74–0.89; p value for interactions 0.049), small births for gestational age (0.92, 0.87–0.97; p = 0.03), and 6 months mortality (0.71, 0.60–0.86; p = 0.04) in anemia pregnant women (Hb < 110 g/L) compared to pregnant women who are not anemic. Multiple micronutrients supplements also have a greater effect on preterm birth among underweight pregnant women (BMI < 18.5 kg/m²; RR 0.84, 95% CI 0.78–0.91; p = 0.01). Initiation of several micronutrient supplements before 20 weeks’ gestation gave a greater reduction in preterm birth (RR 0.89, 95% CI 0.85–0.93; p = 0.03). Generally, survival and birth the effect of the results from multiple micronutrient supplementation is greater with high adherence (≥ 95%) supplementation. Some micronutrient supplements do not significantly increase the risk of stillbirth or neonatal, 6 months, or infant mortality, not in whole or in any of the 26 subgroups examined

(Contd...)

Table 1: ***(Continued)***

Title	Characteristics		Finding
	Subject	Method	
Impact of Periconceptional Multi-micronutrient Supplementation on Gestation: A Population-based Study (Wang dkk, 2013)	60.720 women	Cohort	Providing MMN can benefit LBW, stillbirths, and reduce the risk of anomalous NTD, length of the baby and gestational age
Impact of preconception micronutrient supplementation on anemia and iron status during pregnancy and postpartum: A randomized controlled trial in rural Vietnam (Nguyen dkk, 2016)	5.011 Vietnamese women. 1,813 women who later became pregnant were included in the study	cohort	MMN and IFA supplementation slightly increased maternal and child iron, but did not have an effect on anemia
Maternal antenatal multiple micronutrient supplementation for long-term health benefits in children: A systematic review and meta-analysis. (Devakumar dkk, 2016)	20 follow-up reports of 88,057 women from the previous studies	Meta-analysis	There is no evidence that MMN administration can improve growth survival, body composition, respiratory, and cognitive blood pressure in children
Maternal mupltiple micronutrient supplementation and pregnancy outcome in developing countries: Meta-analysis and meta regression (Kawai dkk, 2011)	17 related studies	Meta-analysis	Giving MMN is more effective than IFA in reducing the risk of LBW, and is small for gestational age, but has no effect on perinatal mortality. Giving MMN decreases perinatal mortality in mothers who have formal education, or starts MMN consumption at 20 weeks' gestation
Effects Of Sanitation Practices On Adverse Pregnancy Outcomes In India: A Conducive Finding From Recent Indian Demographic Health Survey. Patel *et al*., 2019)	To study the relationship between sanitation factors and adverse pregnancy outcomes among mothers aged 15–49, and study the prevalence of sanitation and adverse pregnancy outcomes in India and its states	Cross-Sectional.	Findings from the study show that women who do not have access to a toilet inside the house, do not use a toilet, lack of water and wash their hands near the toilet have a higher risk for adverse pregnancy outcomes
Determinants of risk factors related to the incidence of stunting in the working area of kinovaro sigi health center central Sulawesi. (Miranti *et al*., 2019)	The sample size of this study was 48 children under 5 years	Case control	These risk factors are related to the incidence of stunting and contribute 56.9% ininfluencing the occurrence of stunting
Antenatal multiple micronutrient supplementation: Benefits beyond iron-folic acid alone. *The Lancet Global Health*, *5*(11), e1050–e1051. Baumgartner, J. (2017)	Data for 112,953 pregnant women from 17 randomized trials done in 14 l mics were included	Meta-analysis	Meta-analysis results because they guide researchers and policy makers subgroups that will be targeted by many micronutrients supplements and other potential nutrients intervention strategy. This study provides further information proof of additional multiple benefits micronutrient supplementation (including ironic acid) above iron-folic acid alone in women enter pregnancy with poor nutritional status. Thus, the authors declare that "this new evidence suggested that the WHO should consider re-evaluating balance of multiuniversal benefits and harms micronutrient supplementation in their antenatal care recommendation"
SUMMIT. 2008. Effect of maternal multiple micronutrients supplementation on fetal loss and infant death in Indonesia: A double blind cluster-randomised trial. Lancet	In a double group randomized trial in Lombok, Indonesia, we randomly assigned 262 midwives to distribute IFA supplements (*n* = 15, 86) or MMN (*n* = 15,804) to 31,290 pregnant women	Standard randomised controlled trial	Maternal MMN supplementation, as compared with IFA, can reduce early infant mortality, especially in undernourished and anaemic women. Maternal MMN supplementation might therefore be an important part of overall strengthening of prenatal-care programs
Darnton-hill, I., Schultink, W., Shrimpton, R., Schultink, W., Yan, H., Cheng, Y.,Rosenberg, I. H. (2018). Multiple Micronutrient Supplementation During Pregnancy in Developing Country Settings	The independent Systematic Review Team conducted a meta-analysis of 12 randomized and controlled trials comparing several micronutrients with daily iron folic acid supplementation during pregnancy	Meta-analisis	Replacing iron-folic acid supplements with several micronutrient supplements in the health and nutrition intervention package delivered to the mother during pregnancy will increase the impact of supplementation on birth weight and on the growth and development of children
Chauhan, S., Patel, R. and Bansod, D. W. (2020) "Are we ignoring the Importance of Sanitation while Mourning the Adverse Pregnancy Outcomes?"	This research was conducted using literature review method	Literature review	The results found that sanitation is an important aspect for women planning to have babies or will deliver the baby because the findings show evidence between sanitation and adverse pregnancy outcomes. There is a need to study this aspect more closely because this is still an area that has not been studied. Further study in this matter Dimensions will assist policymakers in designing appropriate interventions to reduce adverse pregnancy results related to poor sanitation
Clement, J., and Mora, J. (1979). pregnancy . supplementation and the outcome II. Visual habituation at 1 5 days 13	One hundred are not supported and 144. Additional babies are tested at 15 days: 2 × 2 boxes are served eight times followed by a 6 × 6 checkered presentation	Longitudinal Study	Infants who are not given supplements show fewer early attention is followed by slower habituation and a higher level of movement than babies born. The observed effect of maternal nutritional supplementation during the latter trimester of pregnancy in the newborn's attention is interpreted as maturity

OR: Odds ratio, CI: Confidence interval, MMN: Multiple micronutrient, LBW: Low birth weight, Hb: Hemoglobin, BMI: Body mass index, SUMMIT: Supplementation with Multiple Micronutrients Intervention Trial, RDA: Recommended Dietary Allowance, FA: Folic acid,,WSH: Water, sanitation and hygiene, RR: Risk ratio, LGA: Large for gestational age, SGA: Small for gestational age, NTD: Neural Tube Defect, IFA: Iron & Folic Acid.

decades, the level of compliance in the consumption of supplements is still low. To overcome the problem of other deficiency of micronutrient, in 1999, the UNICEF, UNU, and WHO approved multi-micronutrient composition tablets or MMN tablets. The composition of this tablet is in accordance with the RDA for all vitamin for pregnant women [6]. MMN supplementation during pregnancy can reduce abortion risk and intrauterine growth restriction. In double blind randomly control trial in the group that received MMN and who only received folic acid and iron showed that there was a 10% [11]. MMN in pregnant women to controls who only received folic acid and iron, it was a decrease incidence stillbirth and premature and mortality [12].

Sanitation, MMN, and pregnancy output

There are several factors that affect the baby size, one of which is the nutrition of the mother during pregnancy. There is a clear relationship between maternal protein consumption in the last month of pregnancy and the baby size. Worse the mother's nutrition, the less her birth weight and length of the baby. In addition, mineral deficiency in the mother during pregnancy is also said to have an effect on postnatal development including damage to neurological and immunological functions in infants [13]. In addition, for children under five to not experience poor nutritional status, improvement in environmental hygiene is needed. This can be done by maintaining the water

environment and managing wastewisely especially for those with nutrient deficiency such as deficiency of Vitamin A, B, and C. A clean environment program is very important because sanitation also determines the success of the development paradigm of environmental health and nutritional status, especially in children under five whom we should put more emphasis on preventive measure rather than therapeutic measure. With a good preventive effort, the incidence of diseases related to environmental conditions can be reduced [14]. Very importance to understanding each transmission route is different pathogens [5].The baby's status of health, including diarrhea incidence, acute respiratory infection, and other infectious diseases, has a relationship with status of nutrition [15].

Poor sanitation can result in an adverse pregnancy, most commonly premature birth or stress during pregnancy. Some diseases that can affect the health of the fetus are toxoplasma, other infections, rubella, cytomegalovirus, and herpes infections. This infection can cause disability, abortion, and intrauterine fetal death [16]. Environmental sanitation is one of the factors that affect nutritional status. Poor nutrition and infection start from poverty and an unhealthy environment with poor sanitation. There is a vice versa interaction between nutritional status and infection. Infection can cause malnutrition through various mechanisms. Acute infections can result in lack of appetite and tolerance to food.

Deficiency of vitamins and minerals is far more prominent than iron deficiency, especially pregnant and nursing women, where this deficiency has a LBW. Pregnant women must have supplements more than just folic acid. Supplements containing vitamins and minerals are considered to be a more efficient approach to micronutrient deficiency problems. Then, this MMN were tested in various countries to assess the benefits. Providing MMN supplements to pregnant women provide better pregnancy outcomes for babies whose mothers had anemia and were undernourished [5], [10], [12].

The results showed mixed results from the effects of MMN on perinatal and postnatal mortality rates. Research in China that included 61,000 women from various socioeconomic levels showed a reduction in the incidence of stillbirth by giving MMN supplements given 3 months before pregnancy compared to pregnant women without nutritional intervention [17], [18] According to Baumgartner, consumption of MMN can be beneficial in certain group of pregnant women with certain risks. Giving MMN to pregnant women who have anemia can reduce infant mortality within 6 months of life (−29%) compared to women who are not anemic [19]. Giving MMN supplements significantly reduced the incidence of LBW [6].

MMN administration was found to decrease a small and large incidence for gestational age [20]. A meta-analysis study also found that MMN supplementation significantly reduces incidence of LBW. Different results from several studies did not show changes in infant mortality at birth or after birth with MMN administration, even MMN administration data during pregnancy increased initial risk and perinatal neonatal mortality compared to mothers given folic acid and iron supplements after MMN study exclusion. This finding is surprising but must be carefully criticized [6], [21]. A meta-analysis study by Devakumar *et al.* in general found no anthropometric differences and body composition in children aged 0–9 years [22]. Research data from 12 studies found no significant effect of MMN administration on infant length. The effect on head circumference was generally not significant in 10 studies. The results of arm circumference measurements in three studies also did not show any significant effect [20]. Nguyen's research in Vietnam showed that the administration of preconception MMN in women before pregnancy was related to the increase of height of children at 2 years of age which that only received folic acid, but there was no difference groups that received MMN supplements and groups who received iron-folic acid supplements [22] The results of meta-analysis by Kawai *et al*. showed no difference in perinatal mortality after MMN administration in developing countries. The study showed that maternal education levels and gestational age when first receiving MMN contributed to the heterogeneous effect of perinatal mortality rates [23].

Conclusion

Several studies have shown that sanitation and the multimicronutrient (MMN) approach play a role in determining pregnancy outcomes. We conclude that the importance of sanitation on pregnancy outcome is to reduce the chance of infection. The importance of MMN in pregnancy outcomes is that mothers who consume MMN during pregnancy can reduce the risk of poor birth output. The role of stakeholders is needed in the future.

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