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(Review Article)

Impact of prenatal nutritional interventions on low birth weight in low- and middle-income countries: A systematic review

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Abstract

Introduction: Undernutrition during pregnancy is an indicator of intrauterine growth restriction, a critical factor in low birth weight. This review aimed to summarize evidence of nutritional interventions targeting pregnant women to reduce low birth weight in low- and middle-income countries (LMICs).

Method: A total of 15 systematic reviews were included for the narrative synthesis after an exhaustive literature search on the search engines Pubmed, google scholar, and the Cochrane database. Systematic reviews of randomized controlled trials evaluating the effect of nutritional interventions during pregnancy on the risk of low birth weight were included. The methodological quality of the included studies was assessed using the AMSTAR assessment tool by two authors.

Results: The interventions identified were nutrition education, protein supplementation, lipid supplementation, and multiple or single micronutrients such as vitamin D, iron, zinc, calcium, folic acid, and iodine. Except for vitamin A, iodine, and calcium supplementation, all interventions were useful and could be considered to reduce low birth weight. The effect of zinc supplementation needed to be clarified.

Conclusion: Except for vitamin A, iodine, and calcium, all interventions could impact the child's birth weight. Nutritional education interventions should be combined with other strategies, such as supplementation.

Keywords: Impact; Nutritional intervention; Low birth weight; Pregnant women

1. Introduction

A woman's nutritional status during pregnancy influences her child's growth. Undernutrition during pregnancy, mainly when exposure occurs during the third trimester, is associated with reduced birth weight, which is an indicator of intrauterine growth restriction [1]. During pregnancy, extra energy is required to grow the fetus, the placenta, and various maternal tissues, such as uterus, breast, and fat reserves. The ideal situation for a woman is to start pregnancy at an average weight and in good nutritional condition. The rate of low body mass index (BMI), indicative of maternal undernutrition, has declined somewhat over the past two decades but continues to be widespread in low- and middle-income countries (LMIC), particularly in Africa. The effect of nutritional interventions during pregnancy on child growth may depend on whether the mother enters pregnancy adequately nourished or malnourished. The latter circumstance is common in LMIC [2]. However, underweight women from high-income countries are more likely to suffer from acute malnutrition due to a sudden reduction in food intake, which can lead to reduced weight in both the mother and the offspring [3]. The main determinants of low birth weight (LBW) in LMIC are poor maternal nutritional status (low BMI)

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at the pregnancy conception, insufficient gestational weight gain due to inadequate dietary intake, and maternal short stature inherent in the mother's undernutrition during childhood [4]. Low-birth-weight babies have a significantly increased risk of stunting at 24 months [5], leading to irreversible results after 36 months, including shorter adult height [6], lowered immune function subsequent malnutrition, reduced cognitive function [7], increased risk of chronic disease and maternal complications later in life [6]. Longer-term implications include reduced educational achievement and low adult income [6, 8].

Several macro/micronutrient nutritional interventions for maternal needs during pregnancy have been proposed and evaluated [9]. Some of the macronutrient supplementation interventions include dietary counseling for pregnant women, balanced energy supplementation, high-protein and isocaloric protein supplementation, and prescription of a low-calorie diet for pregnant women who are overweight or have high weight gain earlier in gestation [10, 11]. Energy supplementation is considered one of the most promising macronutrient interventions for preventing adverse perinatal outcomes, including intrauterine growth retardation [10].

A five-year controlled intervention in pregnant African women involved offering high-energy peanut cookies (4.3MJ/day) for around 20 weeks before delivery (intervention) or after delivery (control). The intervention effectively increased weight gain during pregnancy and pregnant women's birth weight [12]. According to a Cochrane review, providing pregnant women with balanced protein energy supplement can reduce the risk of small-for-gestational-age infants, particularly in underweight pregnant women [13]. Studies in Bangladesh [14], Gambia [12], and Taiwan [15] reported higher birth weights when maternal supplementation coincided with the months immediately after the lean season [14]. These results suggest that balanced protein supplement is most effective in bridging an energy deficit and improving intrauterine growth. To verify these findings, we conducted a global systematic review to summarize the evidence from systematic reviews of nutritional interventions on pregnant women to reduce the risk of low birth weight.

2. Working methods

2.1. Study selection

Searches were carried out on the search engines Pubmed, Google Scholar, and the Cochrane database. A broad combination of keywords (nutritional interventions, birth weight, pregnant women, maternal nutrition) forming search strategies in He-Top, was used to identify studies, regardless of the publication date, to make the search exhaustive. Systematic reviews were identified to assess the effects of interventions to prevent low birth weight. Some reviews were searched manually using conventional search engines such as Google.

Studies focusing on specific nutrition-sensitive interventions during pregnancy were all included. Indeed, systematic reviews of randomized controlled trials (RCTs) aimed at reducing the risk of low birth weight were eligible for inclusion. Reviews whose study design was not a randomized controlled trial or quasi-randomized controlled trial were not eligible for inclusion, nor were reviews that did not report birth weight.

2.2. Data extraction

Titles and abstracts identified by the search were independently reviewed for inclusion by two journal reviewers. Two others also independently assessed the eligibility of full texts against the predefined inclusion criteria. Methods, study population, and results were examined to identify all relevant systematic reviews focusing on nutritional interventions to reduce the risk of low birth weight. A third reviewer resolved discrepancies. Review data were extracted independently by two authors using a predefined data extraction form.

2.3. Methodological quality assessment

Two reviewers independently assessed the reviews' methodological quality using a measurement tool for evaluating reviews (AMSTAR) [16]. The instrument is an 11-item questionnaire that asks reviewers to answer yes, no, can't answer, or don't apply. Each "yes" answer corresponded to one point, and the total number of points was added per line. Scores of 8 to 11 points were considered high quality, 4 to 7 moderate quality, and less than three low methodological quality reviews

3. Results

After searching the selected databases and search engines, we identified 457 relevant studies. We excluded 23 duplicates and examined 434 studies by reading their titles and abstracts. A total of 90 journals were eligible for inclusion. After excluding 75 journals, in line with the inclusion criteria, 15 systematic reviews were finally selected for analysis and narrative synthesis in the present study (figure 1).

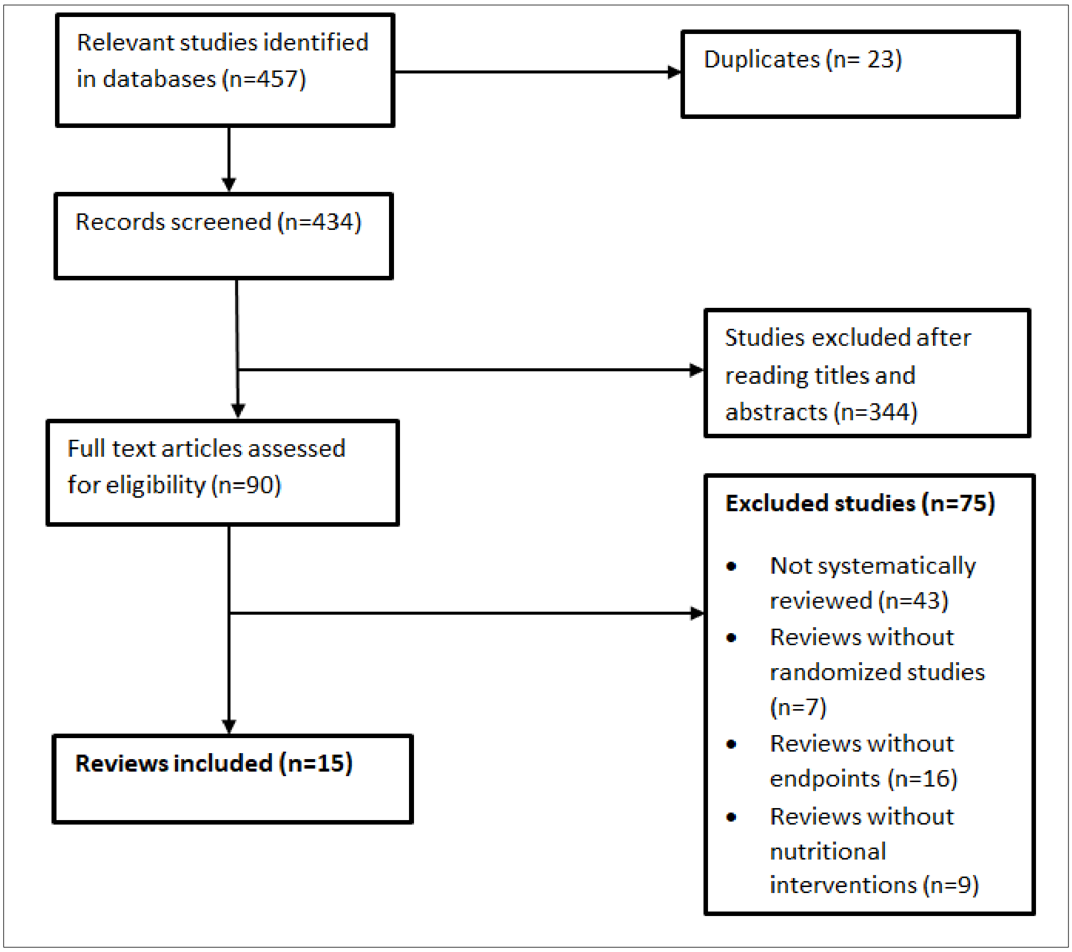

Figure 1 Study selection flow chart

3.1. Scientific quality of systematic reviews included

AMSTAR methodological quality scores for systematic reviews ranged from 5 to 11. Of the reviews, 9 had a score between 8 and 11 and were therefore considered to be of high quality. On the other hand, six reviews had a score between 5 and 7 and were assumed to be of moderate quality. No reviews were considered to be of low quality (Table1).

3.2. Characteristics of included reviews

A total of 15 systematic reviews were included. They all studied the effectiveness of nutritional interventions during pregnancy in pregnant women on maternal, fetal, and neonatal health. All reported results on birth weight. The randomized controlled trials included in these systematic reviews varied from 4 to 24 trials, with sample sizes ranging from 941 to 451723 pregnant women. The nutritional interventions identified in the systematic reviews were as follows: 5 systematic reviews focused on energy protein supplementation, five reviews on multiple micronutrient supplementation, and three reviews evaluated the efficacy of vitamin D on birth weight. The effects of zinc, iron, calcium, and nutritional education were reported in two reviews. Folic acid and iodine were identified in one review each (Table 2).

Table 1 Quality assessment of included systematic reviews

Questions	Has an "a priori" diagram or model been provided?	Were duplicate studies selected and data extracted?	Has an exhaustive literature search been carried out?	Was publication status (i.e. grey literature) used as an inclusion criterion?	Was a list of studies (included and excluded) provided?	Have the characteristics of the included studies been provided?	Was the scientific quality of the included studies assessed and documented?	Was the scientific quality of the included studies used appropriately to reach conclusions?	Were the methods used to combine the findings of studies appropriate?	Was the risk of publication bias assessed?	Was the conflict of interest disclosed?	Total
[20]De-Regil et al	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	10
[17]Oh et al	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes	Yes	8
[22]Keats et al.	Yes	Yes	Yes	Yes	No	Yes	No	No	Yes	Yes	Yes	8
[25]Keats et al.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	11
[26]Haider et al.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	10
[18]Jonker et al.	No	Yes	Yes	No	No	Yes	No	No	Yes	Yes	Yes	6
[27]Das et al.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	11
[23]Harding et al.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	11
[24]Park et al.	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	No	Yes	7
[30]Kramer et al.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	11
[28]Pimpin et al.	Yes	No	Yes	Yes	No	Yes	No	No	Yes	No	Yes	6
[13]Imdad et al.	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	No	Yes	7
[19]Bi et al.	No	Yes	Yes	Yes	No	No	Yes	No	Yes	No	No	5

Questions	Has an "a priori" diagram or model been provided?	Were duplicate studies selected and data extracted?	Has an exhaustive literature search been carried out?	Was publication status (i.e. grey literature) used as an inclusion criterion?	Was a list of studies (included and excluded) provided?	Have the characteristics of the included studies been provided?	Was the scientific quality of the included studies assessed and documented?	Was the scientific quality of the included studies used appropriately to reach conclusions?	Were the methods used to combine the findings of studies appropriate?	Was the risk of publication bias assessed?	Was the conflict of interest disclosed?	Total
[29]Ota et al.	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	9
[21]Soltani et al.	No	Yes	Yes	Yes	No	Yes	Yes	No	Yes	No	No	6

*The numbers in front of the authors represent the reference numbers in the list

Table 2 Characteristics of included reviews

Studies	Intervention	Comparator	Population	Dosage (Mean range)	Frequency	Start of the intervention
[20]De-Regil et al	Vitamin D (9 trials) Vitamin D and calcium (6 trials)	No supplementation or placebo	Pregnant women of any gestational or chronological age (2833)	Daily dose: 200-2000 IU (14 trials) Single dose: 35,000-600,000 IU (1 trial)	Daily Weekly	20 weeks or more of gestation
[17]Oh et al	Vitamin A (9 trials)	No supplementation	Healthy pregnant women of all ages and parities (451,723)	800 µg	Weekly	Approximately 20 weeks gestational age ((<13 weeks gestation) to <37 weeks gestation)
	Lipid-based nutrient supplementation	MNM supplementation		Not specified		
	Vitamin D (11 trials)	Placebo		200 IU		
	Zinc (13 trials)	Placebo		15 mg		
	Ion (7 trials)	Folic acid		30 mg		
	Ion (13 trials)	Placebo		30 mg		
	Calcium (5 trials)	Placebo				
	MNM (34 trials)	Folic acid Ion				

Studies	Intervention	Comparator	Population	Dosage (Mean range)	Frequency	Start of the intervention
[22]Keats et al.	MNM* supplementation or Lipid-based nutrient supplementation (13 trials)	Ion and Folic acid supplementation	Adolescents (15,283) and pregnant adults (44,499)	Recommended daily intake of Vitamin A, Vitamin B1, Vitamin B2, niacin, Vitamin B6, Vitamin B12, zinc, Vitamin C, Vitamin D, Vitamin E, copper, selenium and iodine with 20-60 mg of Ion and Folic acid 400-800�g	Daily	Less than or equal to 37 weeks gestation
[25]Keats et al.	MNM supplémentation with Ion et Folic acid (20 trials)	Ion supplémentation with or without Folic acid and placebo	Pregnant women (141, 849)	120-420mg supplement (recommended intake of Vitamin A, Vitamin B1, Vitamin B2, niacin, Vitamin B6, Vitamin B12, Folic acid, Vitamin C, Vitamin D, Vitamin E, copper, selenium and iodine with 30 mg Ion and 15 mg zinc)	Weekly	Before or after 20 weeks' gestation
[26]Haider et al.	MMN supplémentation (17 trials)	Ion with or without Folic acid and placebo	Pregnant women (137,791)	Recommended intake of Vitamin A, Vitamin B1, Vitamin B2, niacin, Vitamin B6, Vitamin B12, Folic acid, Vitamin C, Vitamin D, Vitamin E, copper, selenium and iodine with 30 mg Ion and 15 mg zinc)	Daily	Start of pregnancy at 36 weeks gestation
[18]Jonker et al.	Maternal supplementation	No dietary supplementation of folic acid	Pregnant women and their infants (275,421)	Not specified	Not specified	Not specified

Studies	Intervention	Comparator	Population	Dosage (Mean range)	Frequency	Start of the intervention
	with folic acid (17 trials)					
[27]Das et al.	Supply of lipid-based nutritional supplements for point-of-use enrichment or direct consumption, independently (4 trials)	Placebo Folic acid Ion Oral multiple micronutrient supplements in tablet or capsule form Multiple micronutrient powders (MMP) - for sprinkling on foods Nutritional advice	Pregnant women (8018)	120 to less than 250 kcal/day	Daily	20 weeks gestation or less
[23]Harding et al.	injected or oral iodine supplementation (e.g. tablets, capsules, drops) (14 trials)	No intervention or placebo	Pregnant or post-partum women of all chronological ages and parities (3154)	75 µg to 300 µg	Daily	Not specified
[24]Park et al.	Micronutrient and calcium supplementation for the mother A balanced supply of energy proteins (i.e. food) to the mother Education	Placebo Standard of care (if applicable) No intervention	Pregnant women (206,531)	Not specified	Daily	Majority of women recruited in the second and third quarters
[30]Kramer et al.	Nutritional advice (24 trials)	No intervention	Pregnant women (6786)	Not specified	Not specified	20 weeks gestation or less

Studies	Intervention	Comparator	Population	Dosage (Mean range)	Frequency	Start of the intervention
[28]Pimpin et al.	Animal protein supplementation (14 trials)	No intervention	Pregnant women (8132)	1000 kcal	Daily	19.3 weeks for pregnant women
[13]Imdad et al.	Balanced energy protein supplementation (11 trials)	No intervention	Undernourished pregnant women	Not specified	Not specified	Not specified
[19]Bi et al.	Vitamin D supplementation (24 trials)	No intervention low-dose supplementation	Pregnant women in good health (5405)	800-5000 IU/day	Daily	0-32 weeks of gestation
[29]Ota et al.	Nutritional education (17 trials)	No nutritional education	Pregnant women without systemic disease (9030)	Not specified	Not specified	Not specified
[21]Soltani et al.	Calcium and zinc supplementation Dairy product supplementation (5 trials)	Placebo Micronutrient-fortified orange juice	Pregnant teenagers (941)	1200-2000 mg calcium 20-40 mg zinc Four servings of orange juice a day, To provide 1200 mg Ca	Daily	Not specified

MNM : multiple micronutrients ; MMP : multiple micronutrient powders ; IU : international unit

3.3. Effects of interventions

3.3.1. Vitamin supplementation

Five systematic reviews studied the effect of three vitamins on infant birth weight. Three reviews evaluated the impact of vitamin D, one assessed the effect of folic acid, and one reported data on the impact of vitamin A during pregnancy on birth weight.

Vitamin A: Vitamin A supplementation versus placebo was studied in a high-quality review synthesized from nine randomized controlled trials. This strategy reported no efficacy on birth weight, maternal mortality, stillbirth risk, or maternal hemoglobin concentration). Though, it appears to have improved maternal serum retinol concentration [17].

Folic acid: A review randomizing 275425 pregnant women in 17 randomized controlled trials focused on evaluating folic acid supplementation on pregnancy outcome. It showed that folic acid supplementation increased birth weight by 0.35kg compared with the control group, reducing the incidence of low birth weight. The same review showed a slight improvement in gestational age. However, postconceptional folic acid supplementation later in pregnancy had an odds ratio greater than 1, favoring no supplementation [18].

Vitamin D: Three systematic reviews, including 459661 pregnant women, have studied the effect of vitamin D supplementation during pregnancy. In one review of 5405 pregnant women, women who received prenatal vitamin D supplementation of 2000 IU/d or less had newborns with significantly higher birth weights and also reduced the risk of infants being small for gestational age and improved growth during infancy without increased risk of fetal or neonatal mortality or congenital anomaly [19]. These results are similar to those of another review, including 493 pregnant women. Indeed, women receiving vitamin D supplements during pregnancy were less likely to have a baby with a birth weight below 2500 g than women receiving no intervention or placebo [20]. However, a review of randomized trials showed no association between vitamin D and birth weight but suggested that vitamin D supplementation may have reduced the risk of preterm birth by 36% [17].

3.3.2. Mineral supplementation

Four systematic reviews evaluated the impact of oral mineral supplementation during pregnancy on maternal and infant health. The minerals studied by the reviews were zinc [17, 21], iron [17, 22], iodine [23], and calcium [20, 24, 21].

Zinc: Two systematic reviews, one of which was of high quality, including 3774 pregnant women, evaluated the effect of zinc during pregnancy on maternal and infant outcomes. One of the reviews, including 13 trials, showed that zinc supplementation, compared with a placebo, had no impact on the risk of having a low-birth-weight baby, premature birth, and small size for gestational age. On the other hand, zinc supplementation may improve maternal serum/plasma zinc concentrations [17]. However, the second review of moderate quality, evaluating the results of two trials, showed that zinc supplementation reduced the probability of low birth weight compared with the control group [21].

Iron: a review of thirteen trials examined the effects of iron supplementation during pregnancy on maternal and infant health, compared with a placebo. Versus the control group, iron supplementation reduced the risk of having a low-birth-weight baby by 12% and the risk of maternal anemia by 47% in mothers [17]. Similarly, iron supplementation combined with folic acid and multiple micronutrient supplementation versus iron supplementation (with or without folic acid) showed an additional 8% reduction in the risk of small-for-gestational-age births and a 12% reduction in the risk of low birth weight. However, micronutrient supplementation alone versus iron supplementation had no significant difference in the risk of low birth weight [22].

Iodine: The effect of iodine supplementation during pregnancy was assessed by a review of 14 randomized trials involving 3154 pregnant women. It reported that iodine supplementation showed no difference between intervention groups on low birth weight and preterm birth. However, iodine supplementation did have a positive impact on the child's mental and motor development. Indeed, the review showed a higher intelligence quotient (IQ) score in mothers who had received iodine than those who had not. The mean difference was 11.21 points [23].

Calcium: Three systematic reviews, two of which were of high quality, involving 209685 pregnant women, assessed the effect of calcium supplementation during pregnancy. According to the synthesis of three studies involving 798 participants, calcium supplementation combined with vitamin D is a risk for premature birth and has no benefit for uterine growth [20]. Another review of 67 trials, with 84,675 randomized patients, demonstrated a trend toward reduced risk of low birthweight and preterm birth [24]. In a moderate-quality study with 507 pregnant women, calcium did not impact the risk of low birth weight. A comparison of the effects of calcium supplementation with calcium-rich dairy products in the two studies showed no significant difference. On the other hand, a significantly higher average birth weight was observed in one study in the group using dairy products compared with the control group [21].

3.3.3. Multiple micronutrient supplementation

Micronutrients are essential for tissue function in the developing fetus. The effect of micronutrients on maternal and infant outcomes has been assessed by four systematic reviews, three of which were of high quality [17, 22, 25] and one of moderate quality [24]. In a review of thirty-four studies, multiple micronutrient supplementation showed a 15% reduction in the risk of delivering a low-birth-weight baby compared with placebo. The risk reduction was more significant in studies containing more than four micronutrients than those between 3 and 4 micronutrients. No maternal outcomes were observed, but a 9% and 7% reduction in the risk of morbidity and small-for-gestational-age stature, respectively, were observed [17]. Another review of 81 trials involving 130,315 pregnant women demonstrated an improvement in mean weight and reduced the risk of preterm birth [24]. According to a study of 21 trials involving 142,496 women, MNM supplementation with iron and folic acid versus iron supplementation (with or without folic acid) showed an 8% reduction in the risk of small-for-gestational-age births, a 12% reduction in the risk of low birth weight and a slight decrease in the risk of preterm births [22]. The results of a similar intervention, analyzed by another review, showed a significant reduction in newborns with low birth weight. However, MNM supplementation versus placebo found no clear difference between groups for preterm birth, low birth weight, and small-for-gestational-age [26].

3.3.4. Lipid-based supplementation

Lipid-based nutrient supplementation is one of the nutritional interventions being considered to improve undernutrition in pregnant women. Lipids are a group of foods rich in essential fatty acids. Two high-quality systematic reviews have addressed the effect of lipid-based supplementation. A review comparing lipid-based nutrient supplementation with multiple micronutrient supplementation showed no effect on the risk of having a low-birth-weight baby and a preterm baby [17]. The same comparison was made in another review with similar results. The risk of having a low-birth-weight baby and premature birth in mothers consuming lipid-based supplements was no different from that in mothers consuming multiple micronutrients [27]. Lipid-based supplementation and multiple micronutrient supplementation would similarly affect infant birth weight.

3.3.5. Energy protein supplementation

Energy protein supplementation has been evaluated in three systematic reviews, one of high quality [24] and two of moderate quality [28, 13]. In a review of 84,675 randomized pregnant women from eleven trials, local high-calorie dietary intervention (1500 kcal per day) reduced the risk of low birth weight and preterm birth [24]. Similarly, energetic protein supplementation during pregnancy significantly increased birth weight and reduced the risk of small for gestational age in a review of twelve trials involving 8132 pregnant women [28]. Another study showed that children in the balanced protein-supplemented women's group gained more weight and had a reduced risk of neonatal death than the control group. However, the difference in danger of death between the two groups was insignificant [13]. High protein supplementation is not beneficial and may harm the fetus [29].

3.3.6. Nutritional education and advice

Nutritional education and counseling interventions during pregnancy aim to increase or reduce energy intake to improve pregnancy outcomes. Three systematic reviews have assessed the effectiveness of nutritional education and counseling interventions during pregnancy on birth weight. According to the results of a review of five trials involving 1134 women, nutritional advice to increase energy and protein intake improved mean birth weight, but no consistent benefit was observed on the risk of low birth weight and preterm birth [30]. These results are similar to a review of 130,315 pregnant women [24]. However, a review of 17 trials involving 9030 women showed that women who received nutritional education during pregnancy had a lower relative risk of preterm birth and low birth weight [29].

4. Discussion

In this global review, we assessed the effect of nutritional interventions on improving women's nutritional status during pregnancy and reducing the risk of low birth weight. A total of 15 systematic reviews were included, nine of high quality and six of moderate quality. However, only reviews in which the interventions were balanced energy protein supplementation, lipid-based nutrient supplementation, vitamin D, iron, folic acid, and multiple micronutrient supplementation showed a reduced risk of low birth weight.

The risks of preterm birth and small-for-gestational-age size were reduced by multiple micronutrient supplementation, vitamin D, and balanced energy protein supplementation. In addition to these interventions, iron and folic acid supplementation improved small-for-gestational-age.

Nutritional education interventions aimed at increasing dietary intake alone had no significant effect on the risk of low birth weight. However, they could be used to improve the average birth weight of newborns. Indeed, the probability of complying with nutritional recommendations and benefiting from adequate health care could be low in populations of women with low socio-economic status. Such interventions may only be helpful in undernourished women [31].

The effects of prenatal zinc supplementation on infant outcomes have yet to be clarified. The results of a review of two moderate-quality trials involving 941 women [21] showed a positive effect on the risk of low birth weight. On the other hand, women with relatively low plasma zinc concentrations in early pregnancy, and a body mass index of less than 26 kg/m2, had children with higher birth weights in other studies [32]. These results may be evidence of a deficient number of included studies, as a review of 13 trials involving 451,723 showed no effect of zinc on low birth weight [17].

In the case of lipid-based supplements, no significant difference was observed compared with multiple micronutrient supplements. However, lipid-based nutritional supplements did improve in-utero growth and mean birth weight [33]. Sub-optimal maternal lipid levels during pregnancy may be involved in the pathophysiological mechanisms leading to low birth weight and small size for gestational age [34]. Lipid supplements would be composed of micronutrients similar to multiple micronutrient supplements.

The scientific quality of the included studies could have been adequately used to formulate conclusions in most reviews. Similarly, most reviews did not list included and excluded studies. Nutritional supplements and education during pregnancy are just one strategy among many to fight or reduce low birth weight. Food hygiene, infections, and chronic disease management can be considered sensitive nutritional interventions against low birth weight [35] [36], but the present analysis does not cover them. The included reviews did not consider women's nutritional status at inclusion, which may make it difficult to generalize the results, as dietary interventions appear more effective in undernourished women [32].

The strength of this review lies in the fact that the majority of the journals included are of high quality. Most of the selected reviews are identified in the Cochrane systematic review database.

The interventions of balanced energy protein supplementation, vitamin D, iron, multiple micronutrients, lipid-based nutrients, and folic acid could reduce the risk of low birth weight. However, they could be accompanied by other interventions to reduce adverse outcomes other than low birth weight. Zinc supplementation should be updated with many systematic reviews to assess its effect on low birth weight better. Other supplementation measures that significantly impact the risk of low birth weight should accompany nutritional education interventions. Calcium supplementation combined with vitamin D, seen as a formula for improving calcium absorption capacity, is reported to pose a risk of prematurity in pregnant women. Health and nutrition care structures in charge of pregnant women are responsible for minimizing this risk.

5. Conclusion

We have summarized the information and results of the individual systematic reviews included in this study in narrative form. All the interventions identified have been effective and could be considered to reduce low birth weight, except vitamin A, iodine, and calcium supplementation. Furthermore, the effect of zinc supplementation needed to be clarified. Therefore, more studies or in-depth studies are required to confirm zinc's impact on birth weight. While effective, nutritional education interventions should not be considered an effective strategy against low birth weight but should be combined with other strategies such as macronutrient and micronutrient supplementation alone.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflict of interest in this work.

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