Preconception Care and Nutrition Interventions in Low- and Middle-Income Countries

Zulfiqar A. Bhutta\textsuperscript{a, b} · Zohra S. Lassi\textsuperscript{a, c}

\textsuperscript{a} Division of Women and Child Health, the Aga Khan University Karachi, Karachi, Pakistan; \textsuperscript{b} Program for Global Pediatric Research, Hospital for Sick Children, Toronto, ON, Canada; \textsuperscript{c} Australian Research Centre for Health of Women and Babies, Robinson Research Institute, School of Paediatrics and Reproductive Health, The University of Adelaide, Australia

Abstract

Maternal nutrition plays an important role in pregnancy outcomes and in the health of the newborn, and providing simple nutritional interventions before pregnancy can prevent a significant proportion of maternal and neonatal mortality and morbidity. Evidence suggests that maternal prepregnancy overweight and obesity increase the propensity for gestational hypertension and diabetes, and the risk of stillbirths and congenital heart defects; underweight women have a higher incidence of stillbirths, and preterm birth, low birthweight and small-for-gestational-age babies. While it is important to maintain normal body weight, preconception micronutrient status of women is also crucial. Substantial evidence exists for the potential of preconception folic acid supplementation to more than halve the risk of neural tube defects. Multivitamin supplementation lowers the rates of preeclampsia and multiple congenital anomalies. On the other hand, iron deficiency anemia is significantly associated with increased risk of fetal growth restriction and low birthweight. It is therefore important to scale up these interventions particularly in low- and middle-income countries, where the scenario is grave. Healthcare providers should be encouraged to provide preconception care to all adolescent girls, women and couples of reproductive age.

Preconception or prepregnancy care is no longer a new concept. Health research since the 1960s has made it clear that since prenatal care improves maternal, newborn and child outcomes, preconception care is simply a logical extension. It was realized that while prenatal care remains important, intervening at this time is too late to prevent harmful exposures from affecting the developing fetus.
and that earlier measures to optimize the health of potential mothers (and fathers) would benefit both parents and the newborn. The range of potential interventions extends from the obvious, taking a vitamin supplement for a few months before conception, to birth spacing and preventing adolescent pregnancy. What was remarkable was the difference that resulted just from optimizing women’s health before pregnancy. Ensuring folic acid supplementation, for example, could reduce the occurrence of neonatal morbidity from neural tube defects (NTDs). As significant progress has been made towards reducing child deaths worldwide, preconception care and nutrition is a promising means to improve the lives of women and newborns.

The role of nutrition in promoting health is well defined. What women eat determines more than just their own health, it is also vital to healthy pregnancies and newborns, and in fact research now shows that nutritional status in early childhood affects health throughout life. Pregnancy, or planning for pregnancy, provides an impetus for women to change nonhealthful behaviors. Many women are still unaware of how much their nutritional status impacts their pregnancy outcomes, and improving women’s eating behaviors should therefore begin during their earlier reproductive years. Preconception care allows the time needed for behavioral changes to occur and for interventions to have the maximum impact on optimizing the health of the mother-to-be. In developing countries, particularly, where there is the highest burden of maternal and newborn deaths, preconception care provides opportunities both in the community and healthcare settings to deliver basic interventions such as nutrition, to improve the health of women and their babies.

**Preconception Care – The Definition**

Preconception care may be defined as ‘any intervention provided to women of childbearing age, regardless of pregnancy status or desire, before pregnancy, to improve health outcomes for women, newborns and children’ [1]. Preconception care proposes a process of delivering direct or indirect health care interventions that have a potential to identify or modify the biomedical, behavioral and social risk factors attached to prepregnancy, pregnancy, intrapartum, neonatal and childhood mortality and morbidity [2]. Preconception care encompasses broader initiatives such as women’s education and empowerment and more targeted healthcare interventions such as vaccination and micronutrient supplementation. Preconception care may begin in adolescence, and also overlap with care in early pregnancy, which may be referred to as ‘periconception care’.
Nutritional Interventions: From Prenatal to Preconception

Nutritional supplementation during pregnancy is widely used and has been recommended for decades as a strategy to improve the health of the mother and the infant. However, a limitation of this approach is that it is difficult to predict exactly when a pregnancy is conceived, and many women do not have contact with health services until the second or third trimester, and therefore do not receive supplementation during the critical early weeks of pregnancy. It is therefore recommended that preconception care be provided to all women of reproductive age. Maternal nutrition determines the fetal growth and birthweight, and poor nutrition is the source of long-term, irreversible and detrimental consequences for the fetus. Provision of healthy nutrition and supplementation during the preconception period ensures that risk is minimized and that women are in the best health possible at the start of pregnancy before the crucial time of fetal development and before health problems can lead to adverse maternal outcomes (fig. 1).

Systematic Review on Preconception Risks and Interventions

A systematic review was undertaken to collate the evidence on preconception care and nutrition supplementation interventions [1]. Published and unpublished literature was considered relevant if it was specifically stated that the nu-
trition intervention occurred before conception or in women of reproductive age who were not pregnant, and the outcome assessed impact on the health of the women, mothers (during pregnancy), newborns or children up to age 5. Although preference was given to randomized trials, quasi-randomized trials and observational studies (cohort, case-control) were also included. The advocacy articles were especially useful in understanding the promotion of nutritional supplements in women of reproductive age at a community level which have a major implication for low- and middle-income countries (LMICs). Electronic databases were searched using MeSH terms and keywords relevant to preconception care and nutrition. The articles found were cross-referenced, and bibliographies of reviews were also reviewed to ensure that all relevant sources were identified. Titles and abstracts were screened, and data extracted by 2 independent researchers, and the quality of each study was assessed using standardized criteria. Meta-analyses of quantitative studies were conducted where possible using Review Manager (RevMan) software version 5.1. In total, 131 studies were used in the meta-analyses.

Optimizing Maternal Weight

Maternal overweight and obesity is a growing problem across the world, but women in developing countries and lower socioeconomic strata continue to be at risk of undernourishment and underweight. Prepregnancy overweight approximately doubles the risk for hypertensive disorders of pregnancy (OR 1.99; 95% CI: 1.54–2.58), preeclampsia (OR 2.28; 95% CI: 2.04–2.55) and gestational diabetes mellitus (OR 1.91; 95% CI: 1.58–2.32). Women who are overweight are 1.5 times more likely to deliver by Caesarean section (OR 1.5; 95% CI: 1.34–1.67), give birth to large-for-gestational age infants (OR 1.65; 95% CI: 1.37–2.00) and have higher rates of stillbirths (OR 2.0; 95% CI: 1.05–1.85) versus normal-weight women. There is also some evidence to suggest that birth defects, especially congenital heart defects (OR 1.15; 95% CI: 1.07–1.24), are more common in children born to overweight women, and that this association becomes stronger with increasing maternal body mass index.

Women who are underweight before pregnancy have a 32% increased risk of preterm birth (OR 1.32; 95% CI: 1.22–1.43), and a 64% increased risk of having small-for-gestational-age babies (OR 1.64; 95% CI: 1.35–2.01). Evidence for an effect of prepregnancy underweight on stillbirths, low birthweight, operative delivery including caesarean section, or congenital birth defects was scarce, although intervention studies of balanced energy protein supplementation during pregnancy do indicate significant benefit. The studies on maternal undernutri-
tion largely focus on maternal short stature as a manifestation of the intergenerational effects of undernutrition, and thus indirectly link undernutrition with adverse maternal, newborn and child health (MNCH) outcomes.

**Preconception Nutrition Counselling**

Preconception counseling until now has been provided through two avenues – general physicians who invite women or couples for a prepregnancy visit, and community groups educating women about pregnancy and birth preparedness. In LMICs, preconception counseling through community groups led to a 24% reduction in neonatal mortality (RR 0.76; 95% CI: 0.66–0.88), plausibly through increasing uptake of antenatal care (RR 1.39; 95% CI: 1.00–1.93) and increased supplementation of women with iron/folic acid (RR 1.18; 95% CI: 0.98–1.42). To improve maternal and child health, further trials are imperative to show which MNCH outcomes preconception care affects consistently and positively, and to delineate where and by whom such care should be provided, how long before conception such care should begin, and which interventions are most successful.

**Micronutrient Supplements**

*Periconceptional Folic Acid and Multivitamin Supplementation*

Although major health organizations promote the use of folic acid by women of reproductive age through clinical guidelines and recommendations, and the prevalence of folic acid use is reportedly high in the prenatal period, most women do not use folic acid in the periconceptional period, even if they are aware of its benefits. Increasing the dietary intake of folic acid among women of reproductive age is not sufficient to prevent birth defects; therefore, supplementation is very necessary.

A strong protective effect of folic acid was found on recurrent NTDs (RR 0.28; 95% CI: 0.13–0.58) and occurred NTDs (RR 0.47; 95% CI: 0.34–0.61). Evidence also found a significant protective effect of multivitamin supplementation on preventing NTDs (both occurred RR 0.51, 95% CI: 0.31–0.82, and recurrent RR 0.38; 95% CI: 0.20–0.71). A recent systematic review [3] demonstrated that even in developed countries, only half of all women use folic acid before conception; therefore, protective levels cannot be achieved before the critical period of neural tube closure. When periconceptional folic acid supplementation...
tion was compared with supplementation with multivitamin alone or with folate and multivitamin, it showed a nonsignificant decrease in NTDs with folate alone. A modest benefit of folic acid/multivitamin supplementation was also reported, especially for cleft lip (RR 0.70; 95% CI: 0.47–1.05). Periconceptional folic acid fortification also showed a significant impact on reduction of NTD prevalence by 41% (RR 0.59; 95% CI: 0.52–0.67; fig. 2).

While there is conclusive evidence for the role of folic acid in the preconception period to prevent adverse pregnancy outcomes, very few studies have been conducted to assess the role of other micronutrients. Micronutrients are important in the preconception period since they affect fertility and reproductive function, as well as the early stages of gestation during which fetal development occurs, through various biologic pathways [4]. Evidence supports that women with adequate micronutrient levels had lower risk of miscarriage and NTDs. There is a dearth of evidence to support supplementation of nonfolate micronutrients in the preconception period; therefore, additional evidence is needed to determine whether supplementation with other micronutrients, particularly other B-complex vitamins, might further reduce the rates of adverse pregnancy outcomes and congenital birth defects.

**Iron Supplementation**

Prevalence of anemia has been reported to be higher in pregnant compared to nonpregnant women [5]. Maternal iron deficiency in the first trimester of pregnancy has been linked with significant reductions in infant size at birth [6] and

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**Fig. 2.** Folic acid fortification and prevalence of NTDs.
The relationship between maternal anemia and preterm delivery has been studied in the past few years, with some studies supporting this association [8, 9] but not all [10].

Multiple trials on iron supplementation during early pregnancy have shown significant reductions in the frequency of infants with low birthweights [6, 11, 12]. Various modes of iron supplementation have been studied. The trial in Bangladesh [11] compared supplementation with a powdered form of micronutrients and tablets. It showed greater mean hemoglobin among subjects taking the tablet compared to those taking the powdered form. This was attributed to a higher rate of compliance among tablet users. Another trial [13] with doubly fortified sugar (iron plus vitamin A) showed significant increase in iron stores among women of reproductive age in 2 of the 3 fortified communities. As a complementary strategy to iron supplementation, periconceptional iron plus folic acid supplementation has been suggested by Smitasiri and Solon [14] to treat underlying anemia, build up iron stores and prevent NTDs. This was used in a trial [15] that reported significant improvement in reducing anemia frequency and improving iron stores in nonpregnant women.

Iron deficiency anemia among women of reproductive age is grave, particularly in LMICs. The situation only worsens during pregnancy leading to known adverse outcomes. Even with intrapregnancy iron supplementation to correct the iron status, most improvements take long. Hence, it is only natural to target iron deficiency in women of reproductive age before they conceive and try to have the greatest effect on reducing pregnancy-related consequences.

**Vitamin A Supplementation**

Vitamin A deficiency is pervasive and occurs either when there is a limited intake of dairy products, carotene-rich vegetables and fruits or, occasionally, with malabsorption syndromes. Vitamin A deficiency during pregnancy is known to result in night blindness [16], increased risk of maternal mortality [17] premature birth, intrauterine growth retardation, low birthweight [18], and antepartum hemorrhage [19]. Whereas pregnant women in the West meet their recommended daily need with appropriate consumption during their reproductive years, women in the developing countries need to replenish their stores. Vitamin A is associated with anemia [20], and Suharno [21] reported that supplementing pregnant women in their second trimester with both vitamin A (2,400 mg) and iron daily for 2 months improved hemoglobin concentrations more than when
compared to supplementation with iron or vitamin A alone. A study from Nepal [22] reported no association between small weekly doses of vitamin A or β-carotene given to women before conception, during pregnancy, and through 24 weeks’ postpartum and improvement in fetal or early infant survival. A trial in Ghana also found that once-a-week vitamin A supplementation in women of reproductive age had no favorable effect on their survival or that of their newborns [23]. These findings were in accord with the lack of effect on stillbirth rate and neonatal/infant survival found in Bangladesh [24]. However, another trial from Nepal reported that supplementation of women with either vitamin A or β-carotene at recommended dietary amounts during childbearing years significantly improves pregnancy-related mortality by 44% [17].

Although limited, the current evidence is inconclusive as it failed to show impacts on maternal mortality (OR 0.69; 95% CI: 0.47–1.03) and fetal/neonatal and infant mortality (OR 0.98; 95% CI: 0.96–1.04). However, the potential benefits may still have been overlooked, and larger more focused trials are needed to evaluate any possible relation of vitamin A with reducing pregnancy-related morbidities and mortalities.

Iodine Supplementation

Iodine deficiency is a universal health problem and is thought to be the most common preventable cause of mental retardation. The iodine requirement during pregnancy is sharply elevated. Progressive pathologic changes goiter and hypothyroidism can occur that can adversely affect maternal and fetal health [25]. Severe iodine deficiency during pregnancy causes maternal and fetal hypothyroxinemia [26] which leads to irreversible brain damage with mental retardation and neurologic abnormalities [27]. In a trial in Papua New Guinea [28], the incidence of cretinism was significantly reduced in the offspring of women given oil-based iodine injections (RR 0.27; 95% CI: 0.12–0.60). Another trial [29] of intrapregnancy iodized oil injections, in a severely iodine-deficient area, showed a lower occurrence of children with low psychomotor scores. Other studies on supplementation of women of childbearing age have also suggested modest cognitive benefits for infants and children of maternal iodine treatment [30, 31]. These studies had their own limitations and possible effect of confounders [32].

Although providing adequate iodine in mid- to late pregnancy improves infant cognitive development, benefits are even greater when iodine is given before or early in pregnancy [32]. Trials of supplementation during pregnancy have led to improved maternal and fetal outcomes. These findings can be extrapolated to
say that preconception supplementation and attainment of a steady state of iodine stores before planning a pregnancy would successfully avert the grave consequences associated with iodine deficiency.

**Discussion and Conclusion**

A woman’s nutritional status affects her health and that of her baby throughout pregnancy. Both prepregnancy overweight and underweight are risk factors for poor maternal and child health outcomes. In the recent past, the urbanization and increasingly sedentary lives in LMICs have evolved a nutrition transition, where population is suffering from double burden. It is therefore important for women to understand the risks associated with being overweight or underweight during pregnancy, and should be encouraged to normalize their BMI before pregnancy since weight loss during pregnancy is not recommended, and weight gain during pregnancy does not sufficiently reduce the risk for pregravid underweight women. Although restricting weight gain might seem an easy solution, there is little evidence for the effect of this as the primary intervention in overweight women. Balanced protein energy supplementation and appropriate micronutrient supplementation could reduce the effect of prepregnancy underweight on adverse perinatal outcomes. Reaffirming that the difficulty in maintaining healthy weight and eating habits is not due to lack of willpower, but also environmental pressures and gender equality – where less importance is given to girls and women in general. It is therefore important to work with communities, particularly with husband and significant others from families such as mother-in-law to improve their support for the women in the reproductive years. Promotion of improved diet and exercise/workload with the help of a support system can help improve weight.

The preconception micronutrient status of women is also crucial. Research has proposed that folic acid prevents birth defects through its influence on the methylation pathway and that women at risk for recurrence of birth defects require higher levels of folic acid (especially a multivitamin containing 400 μg of folic acid and iron) [33]. The main reasons for low prevalence of use in LMICs include: low maternal education and socioeconomic status; young maternal age, and unplanned pregnancy. It is necessary therefore to improve awareness and use of folic acid supplements among all women of reproductive age, so that even women with unplanned pregnancies are protected. Multi-component interventions increase use transiently and do not achieve universal coverage, although those with personal counseling in addition to mass campaigns have been shown to be more effective. It has also been shown that in-
clusion of a specific health claim, such as that folic acid prevents birth defects, is more successful in increasing uptake and use. Fortification has thus been proposed as a means to prevent approximately half of all NTDs occurring annually and 13% of neonatal mortality attributed to NTDs, especially in areas with high prevalence of NTDs. For the same reason, public health policy in some countries now mandates that staple foods, such as flour, be fortified with folic acid.

While there is a dearth of literature on the link between preconception anemia and MNCH outcomes, supplementation and fortification studies show a significant improvement in the iron status among women. Future trials need to focus on how prepregnancy provision of iron, vitamin A and iodine supplements could possibly lower adverse pregnancy-related outcomes and the best way of implementing supplementation programs for the general population, especially targeting women of reproductive age.

A woman’s nutritional status affects her health and that of her baby throughout pregnancy. A growing body of evidence points toward care before pregnancy, or preconception care, as a means to reduce risk and improve the health of women and their children. While dietary habits are established in childhood, nutrition can be improved through intervention in the preconception period. Food fortification with micronutrients, along with intensive promotional campaigns and counseling by healthcare providers could increase coverage of daily multivitamin supplementation.

Disclosure Statement

None.

References


