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Vitamins and minerals, education, and self-care need during preconception to 1000 days of life in Southeast Asia: An expert panel opinion

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Abstract

Addressing maternal malnutrition and its drivers is paramount in Southeast Asia. This article summarizes the key clinical learnings and evidence-based opinions from the experts to understand the need for vitamins and minerals supplementation, education, and self-care from preconception to the first 1000 days of life, which warranted further attention since COVID-19 pandemic. Evidence describing the importance of vitamins and minerals during preconception, pregnancy, and lactation stages was identified using literature databases. A pre-meeting survey was conducted to determine the current practices and challenges in Southeast Asia. Based on the literature review and clinical experience, experts defined the topics, and an online meeting was held on 13th July 2021. During the meeting, nine experts from Southeast Asia provided evidence-based opinion on the vitamins and minerals supplementation, education, and self-care need during preconception, pregnancy, and lactation stages. The expert opinions underpin maternal malnutrition as a prevalent issue and discuss appropriate interventions and prevention strategies for women in Southeast Asia. The recent pandemic further impacted nutrition status, pregnancy, and neonatal health outcomes. The expert panel emphasized a need to improve existing inadequacies in education, self-care, and social support, and discussed the role of policymakers in addressing the barriers to dietary changes. As inadequacies in regular vitamins and minerals supplementation, education, and self-care for women of reproductive age implicate maternal and child health outcomes, there is an urgent need for addressing malnutrition concerns in this population. Thus, a strong partnership between policymakers, healthcare professionals, and other relevant sectors is required.

Keywords

Preconception, pregnancy, postpartum, vitamins and minerals supplementation, Southeast Asia

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Introduction

The Developmental Origins of Health and Disease hypothesis states that maternal nutrition during critical periods of development and growth can have short- and long-term health-related consequences on the individual.[1] This critical period, coined as the "first 1000 days" of life, spans roughly from conception to one's second birthday. It is a unique period for fetal programming where foundations of optimum health, growth, and development across the lifespan are established. During this time, insufficient nutrition can result in irreversible tissue structure and physiological changes.[1] A healthy woman, at the time of conception, has a better chance

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of having a healthy pregnancy and a healthy child.[2] Improving women's nutritional status before pregnancy enhances long-term outcomes for mothers and babies.[3] However, while intake of micronutrients such as vitamins and minerals starting only at gestation may help correct critical maternal nutrient deficiencies, it may be too late to improve the child's health fundamentally.[4] The studies suggest that women's health should be assessed not only during pregnancy but also as early as adolescence.[2–4]

Advances in public health and economic development have markedly improved diet and nutrition in the past decades in many parts of Asia.[5] Yet, inadequate maternal micronutrient intake continues to be a substantial contributor to poor mother and fetal health. As per the International Federation of Gynecology and Obstetrics (FIGO), an adequate diet in the correct amounts and proportions of all essential micronutrients is the basis of optimal nutrition required during preconception and pregnancy.[6] Therefore, understanding potential trajectories in nutrition during preconception, pregnancy, and breastfeeding is crucial for guiding long-term investments and policy implementation.

Addressing maternal malnutrition and its drivers through healthcare interventions is thus paramount in Southeast Asia. However, nationally representative data on micronutrient intake, status, and associated health outcomes appear limited to date. Despite global and national recommendations on supplementation during preconception, pregnancy, and lactation, it is unclear how these are implemented in terms of programs or initiatives in individual locations.

This expert opinion article thus summarizes the key clinical learnings. It provides evidence-based opinions to reinforce the importance of micronutrient supplementation, education, and self-care and reduce the risk of malnutrition-related complications in women of Southeast Asia during preconception, pregnancy, and lactation stages. Inadequate nutritional and self-care information is a significant challenge to maternal nutrition and pregnancy-related health outcomes and its importance was further witnessed during the recent COVID-19 pandemic. Thus, best practices for preventing and managing pandemic-related impacts on maternal nutritional status, pregnancy, and neonatal outcomes will be shared based on the experiences of the experts. The scope of this article will be limited to micronutrients and enteral nutrition and will not include a discussion on macronutrient and parenteral nutrition.

Methods

Nine experts from Southeast Asia representing different areas of specialties, including obstetrics and gynecology (7), dietetics (1), and epidemiology (1), convened virtually to evaluate the available published literature and provide evidence-based opinions on the importance of vitamins and mineral supplementation during preconception, pregnancy, and lactation stages.

Literature review

A systematic literature search was carried out using PubMed, MEDLINE, Embase, and Scopus databases using the following key search terms: "preconception," "periconception," "pre-pregnancy," "pregnancy," "pregnant women," "gestation," "prenatal," "antenatal," "postpartum," "perinatal," "postnatal," "lactation," "maternal nutrition," "micronutrient supplements," "micronutrient supplementation," "nutrient supplementation," "maternal undernutrition," "maternal overnutrition," "maternal malnutrition," "COVID-19," "vitamins," and "minerals." Non-English literature was excluded.

Expert panel meeting

An expert panel meeting was conducted virtually on 13th July 2021. The multidisciplinary expert panel consisted of nine experts across specialties, including obstetrics and gynecology, dietetics, and epidemiology from the Philippines, Malaysia, and Thailand.

Pre-meeting survey and expert discussion

A pre-meeting survey (Supplemental Appendix 1) completed by the experts provided insights on current practices and challenges in nutrition (micronutrients) management during preconception, pregnancy, and lactation. In addition, each expert evaluated relevant published literature to inform their opinion on each topic. During the meeting, the expert panel discussed published evidence, their clinical experiences, and learnings to identify and address nutritional gaps and critical areas of concern in the preconception, pregnant, and lactating population of the Southeast Asian region. This meeting also sought to understand the impact of the COVID-19 pandemic on nutritional status, pregnancy, and neonatal health outcomes, as well as the rising importance of education and self-care in this population. The views here do not represent the opinion of any national or international societies.

Grading of the recommendations

The grading method was adapted from National Collaborating Centre for Mental Health.[7] Opinions were graded from A to C based on the level of associated evidence, or as a good practice point (GPP) (Table 1).

Results

Prevalence of maternal undernutrition and overnutrition during childbearing years are underaddressed issues in Southeast Asia

Maternal malnutrition in Asian countries is often considered a double burden, encompassing both undernutrition and a growing problem of the overweight population.[8] Biswas et

Table 1. Hierarchy of evidence and recommendations grading structure.

Level	Type of evidence	Grade	Evidence
I	Evidence obtained from a single randomized controlled trial (RCT) or a meta-analysis of RCTs	A	At least one RCT as part of a body of literature of overall good quality and consistency addressing the specific opinion (*evidence level I*) without extrapolation
IIa	Evidence obtained from at least one well-designed controlled study without randomization	B	Well-conducted clinical studies but no randomized clinical trials on the topic of opinion (*evidence levels II or III*); or extrapolated from level-I evidence
IIb	Evidence obtained from at least one other well-designed quasi-experimental study		
III	Evidence obtained from well-designed nonexperimental descriptive studies, such as comparative studies, correlation studies, and case studies		
IV	Evidence obtained from expert committee reports or opinions and/or clinical experiences of respected authorities	C	Expert committee reports or opinions and/or clinical experiences of respected authorities (*evidence level IV*). This grading indicates that directly applicable clinical studies of good quality are absent or not readily available
		GPP	Recommended GPPs based on the clinical experience of the experts

Expert opinions were graded as AI, BIIa, BIIb, BIII, CIV, or GPP.

al.[9] reported a pooled prevalence of 20% for underweight and overweight in Southeast Asian women.[9] As per Food and Nutrition Research Institute, 14% of women of reproductive age were underweight, while 27% of women were overweight or obese in the Philippines.[10] In 2019, a Vietnamese study found that 32.7% of women were underweight before pregnancy.[11] At 26–29 weeks of gestation, two-thirds of the women did not meet the recommended weight gain, and one in two women had concurrent inadequacies for more than 10 nutrients.

Consequently, maternal body mass index (BMI) is commonly associated with the risk of childhood wasting in Southeast Asia. The risk of being wasted was 69% higher for a child whose mother has a low BMI ($<18.5\,kg/m^2$) than a normal BMI.[12] The burden of low birthweight (LBW) in Southeast Asia is also among the highest in the world.[13,14] A child whose pregnant mother is short, thin, or anemic is more likely to experience in utero growth restriction, preterm delivery, and LBW.[15,16] In 2018, a PRECONCEPT trial from Vietnam reported that maternal preconception nutrition also influences both offspring linear growth and risk of stunting across the first 1000 days.[17] Overnutrition can also lead to various health risks, including pregnancy-induced hypertension, gestational diabetes mellitus (GDM), increased risk of macrosomia, and obstructed delivery.[9,18,19] In women who were overweight or obese during preconception or early pregnancy, the meta-analysis estimating the risk for adverse perinatal and maternal health outcomes by maternal BMI categories in low- and middle-income countries demonstrated a significantly higher risk of adverse health outcomes, including gestational diabetes, pregnancy-induced hypertension, preeclampsia, cesarean delivery, and postpartum hemorrhage.[20] In addition, a higher prevalence of GDM was found among Asians (9.9%) and Filipinas (8.5%), and the occurrence of GDM was at relatively lower BMI thresholds ($22.0–24.9\,kg/m^2$).[21] A population-representative cross-sectional data from eight South and Southeast Asian countries (between 1996 and 2016) also reported a 1.3% regional average annual rate of reduction for underweight women and an 8.4% average annual rate of increase for overweight/obese women of reproductive age. At this rate, the proportion of underweight and overweight/obese women of reproductive age will be 6.6% and 76.6% in 2030, respectively.[18]

Nutritional gaps and strategies to address micronutrient insufficiency/deficiency-related complications

Appropriate interventions promoting adherence to a healthy diet and supplementation should start as early as preconception and continue through the "first 1000 days" of life. As the rates of maternal malnutrition, obesity, and weight gain continue to remain high, adequate knowledge of dietary recommendations can help pregnant women to achieve a healthy weight gain.[22] In Myanmar, 86% of pregnant women had a low to moderate level of knowledge of nutritional needs during pregnancy.[23] Nutritional advice has improved pregnant women's knowledge and understanding and reduced the risk of maternal (reduced preterm birth by 54%, the risk of maternal anemia by 30%, and improved gestational weight gain by 0.45 kg) and fetal complications.[24,25] However, studies from Indonesia reported that only a few women visited primary health centers for receiving nutrition counseling. Most pregnant women did not actively seek nutrition information. The

findings suggest an improvement in antenatal nutrition education and related services for pregnant women.[26,27]

A cross-sectional survey reported that most of the pregnant respondents (87.9%) from Malaysia were aware of the role of dietary supplements during pregnancy, but only half of them claimed to take essential supplements during pregnancy (49.1%).[28] The consumption of micronutrients such as vitamin B12, either through diet or supplements, was found to be inadequate in seven regions of Asia (Hong Kong, Indonesia, the Philippines, Singapore, Taiwan, Thailand, and Vietnam).[4] Inadequate concentrations of key nutrients during crucial periods of fetal development may lead to reprogramming within fetal tissues, predisposing the infant to chronic conditions in later life.[29,30]

Interventions to control micronutrient deficiencies in women of reproductive age, including during pregnancy and lactation, can be broadly divided into a healthy diet and supplementation. A healthy diet includes macronutrients (i.e. carbohydrates, proteins, and fats) that provide the energy necessary for the cellular processes required for daily functioning as well as micronutrients (i.e. vitamins and minerals) in comparatively small amounts for normal growth, development, metabolism, and physiologic functioning.[31] Adherence to a healthy diet favorably influences body composition, BMI, body fat, heart rate, and glycemic control.[32] The Asian continent is large thus the composition of its diet can vary based on different countries and its region. Cena and Calder[31] has described different diet options from various parts of the world including Asia that have been shown to influence health. Diet-based approaches are less suitable for treating existing deficiencies but are more suited to prevent deficiencies. These approaches include fortifying foods with micronutrients and dietary interventions to improve micronutrient intake and bioavailability. In the Philippines, mandatory rice fortification has been implemented in food outlets, and campaigns to improve the acceptability of iron-fortified rice have been conducted.[33] Supplementation refers to the direct provision of vitamins and minerals in the form of liquid, pill, tablet, or dispersible formulations.

At the beginning of pregnancy, the focus should be on eating a macronutrient-balanced diet, rather than eating more, as nutrient requirements differ little from prepregnancy (Figure 1).[34] The concept of "eating for two" is a myth which should be dismissed. However, the supplementation/fortification is needed at the beginning if prepregnancy nutrition is suboptimal. During pregnancy, the requirement of energy intake increases by about 85 kcal per day in the first trimester, 285 kcal per day in the second trimester, and 475 kcal per day in the third trimester.[35] Factors like adolescent pregnancy, high physical activity, multiple pregnancies, and infections or malabsorption disorders might increase energy requirement.[34] In 2021, a systematic review and meta-analysis evaluating different supplementation interventions on maternal, birth, child health, and developmental outcomes in low- and middle-income countries highlighted that micronutrient-specific supplementation should be tailored according to unique health and development needs of pregnant adolescent population for maximum benefit as improvements were noted in only a few outcomes for single micronutrient supplementation. These include preeclampsia/eclampsia (calcium), maternal anemia (iron), preterm births (vitamin D), and maternal serum zinc concentration (zinc).[36] Currently, supplementation efforts are focused on providing iron, folic acid, calcium, iodine, vitamin B12, and vitamin D in the Southeast Asian region.

Multi-micronutrient supplementation may lead to better maternal and child-related health outcomes. Calcium, iron, folic acid, iodine, and vitamins D and B12 are the most relevant nutrients during preconception, pregnancy, and lactation stages.

Data for multiple-micronutrient (MMN) supplementation from a few controlled trials show a persistent lowering of congenital anomalies and preeclampsia cases.[39] In 2021, a systematic review and meta-analysis evaluating different supplementation interventions on maternal, birth, child health, and developmental outcomes in low- and middle-income countries found notable improvement in maternal anemia and the reduction in LBW with iron–folic acid (IFA) supplementation. MMN showed improvement not only in several key birth outcomes, such as preterm birth, small for gestational age (SGA), and LBW but also in child outcomes, including diarrhea incidence and retinol concentration.[36] A greater risk reduction of LBW and SGA births was observed with MMN supplements than iron–folate supplements.[40] One of the RCTs from Vietnam reported that preconception supplementation with MMN or IFA resulted in modest rise in maternal and infant iron stores but without impacting anemia.[41] However, another RCT comparing the impact of preconception MMN or IFA supplementation or folic acid alone on child growth and development reported a significant improvement in linear growth and fine motor development (0.41; 95% confidence interval (CI): 0.05, 0.77) at 2 years of age with IFA. Similar trends were found for the offspring in the MMN group compared with the FA group for linear growth.[42] One Indonesian trial has also reported that among undernourished or anemic pregnant women, the provision of MMN supplements may improve their children's motor and cognitive abilities for up to 3.5 years.[43] Replacing iron–folate supplements with MMN supplements in pregnant women can reduce preterm birth cases, costs associated with adverse outcomes, and infant mortality.[44] These findings support MMN supplement's use beyond iron and folate, especially in settings where MMN deficiencies are common. However, providing women with weekly IFA supplements before pregnancy, together with regular deworming, is still associated with a reduced prevalence of LBW.[45]

Another promising micronutrient intervention is the SMILING (Sustainable Micronutrient Interventions to control deficiencies and Improve Nutritional status and General

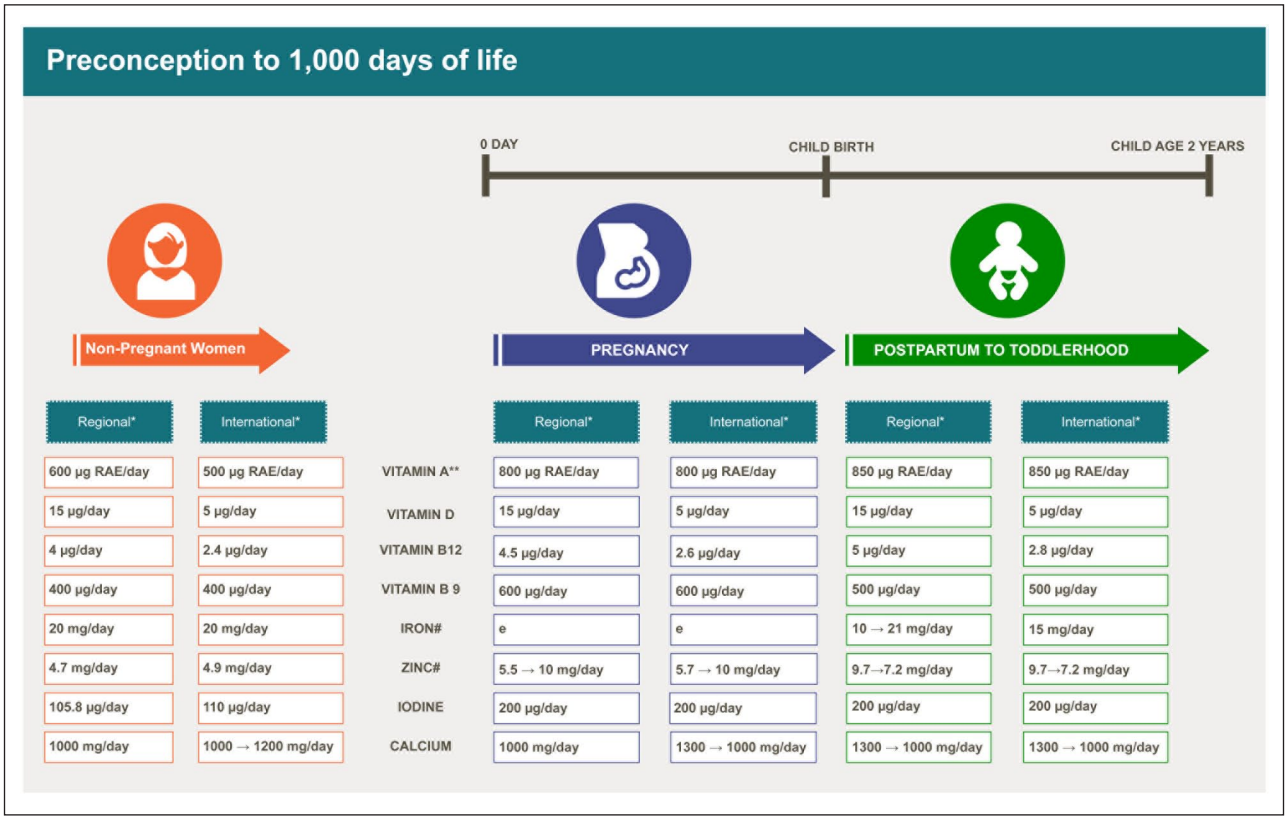

Figure 1. RNI for nonpregnant and women from conception to 1000 days of life. e: Iron recommendation in pregnancy depends on anemic conditions. In the non-anemic pregnant woman, during the second half of pregnancy, daily supplements of 100 mg of iron (e.g., as ferrous sulfate) is adequate; however, higher doses are usually required for anemic women.
RAE: retinol activity equivalent; RNI: recommended nutrient intake; right arrow (→): change in doses with time.
*RNI regional values[37] and international values.[38]
**Safe intake is used in place of RNI for vitamin A (international values).
#Moderate bioavailability values are taken for iron and zinc.

health in Asia) project in five Southeast Asian countries (Vietnam, Laos, Thailand, Cambodia, and Indonesia), funded by the European Union.[46] This biphasic project primarily focused on six micronutrients: vitamin A, iron, zinc, iodine, vitamin B9 (folic acid), and vitamin B12. This project developed strategies to improve awareness regarding micronutrient deficiency in women of reproductive age.[47] The prevalence of micronutrient deficiency and intake among the Southeast Asian population has been provided in Supplemental Appendix 2. Figure 2 depicts the potential risks involved with different nutrient deficiencies during pregnancy and lactation.

Iron–folic acid. Early iron supplementation has been shown to help women with insufficient reserves. One of the RCT from Vietnam reported that preconception supplementation with IFA resulted in modest rise in maternal and infant iron stores but did not impact anemia.[41] Another RCT comparing the impact of preconception IFA supplementation with folic acid alone on child growth and development reported a significant improvement in linear growth and fine motor development (0.41; 95% CI: 0.05, 0.77) at 2 years of age with IFA.[42]

Iron demands in pregnancy cannot be fulfilled by dietary iron intake but require oral iron supplementation. Without iron supplementation during pregnancy, the normal maternal hemoglobin (Hb) range falls from 12.5–13.0 to 11.0–11.5 g/dL.[48] Iron supplementation significantly increased Hb concentration among Vietnamese women in the second and third trimesters by 0.4 and 0.7 g/dL, respectively ($p = 0.017$ and $p < 0.001$).[49] Daily prenatal use of iron can substantially improve birth weight in a linear dose–response fashion, reducing the risk of LBW babies.[50] Wang et al.[51] also found that the risk for preterm birth decreased with high maternal Hb and increased with low maternal Hb. However, they also reported an increased risk of GDM and preeclampsia with the rise in maternal Hb concentration. Thus, understanding the changes in Hb concentration and maintaining an optimum level is very important during pregnancies.

Folic acid is recognized as a necessity before and during pregnancy because of its preventive properties against neural tube defects (NTDs). A study from Thailand reported low

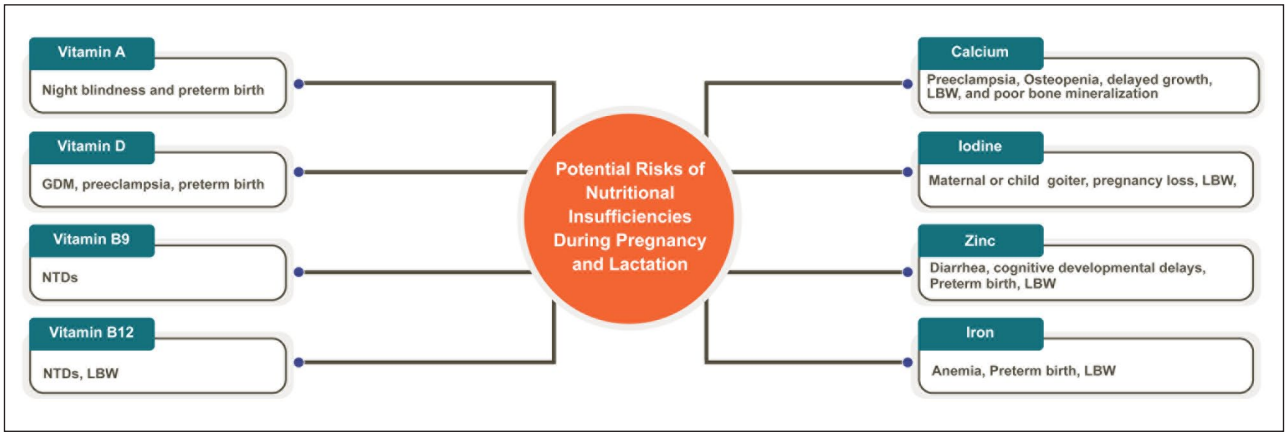

Figure 2. Potential risks of nutritional insufficiencies during pregnancy and lactation.
GDM: gestational diabetes mellitus; NTD: neural tube defect; LBW: low birth weight.

dietary folate intake in 65.5% and low serum folate concentration in 18% of women of childbearing age.[52] Deficiency of folic acid could also compromise oocyte development and early embryogenesis.[53] Thus, its adequate level is very important specially in women of reproductive age.

Different trials from Malaysia and Singapore investigating the impact of folic acid supplementation/fortification on NTD risk have reported an increase in blood folate concentrations among women of childbearing age to levels with a low risk of NTD.[54,55] However, weekly IFA supplements containing 2.8 mg folic acid group were seven times (relative risk (RR) 7.3; 95% CI: 3.9, 13.7; $p < 0.0001$) more likely to achieve an RBC folate >748 nmol/L, a concentration associated with a low risk of NTD, compared with the 0.4 mg group.[54]

Vitamin B12. During pregnancy, vitamin B12 is concentrated in the fetus and stored in the liver.[56,57] Consequently, vitamin B12 deficiency rarely occurs in infants up to 4 months of age if the mother has adequate vitamin B12 status during pregnancy. However, infants of vitamin B12-deficient breastfeeding mothers are vulnerable to vitamin B12 deficiency from an early age.[58] Daily maternal vitamin B12 supplementation (50 µg/day) during pregnancy through 6 weeks postpartum can substantially increase breast milk and infant plasma vitamin B12 concentrations.[59] A study reported that the proportion of children born small for gestational age was lower in the vitamin B12 supplementation group than in the placebo group (25% versus 34%).[60] Also, neural tube closure abnormalities may be more common in babies delivered by vitamin B12-deficient mothers.[61,62] In 2015, a meta-analysis assessing the relationship between maternal biomarkers and NTDs detected a significant decrease in maternal vitamin B12 concentration among NTD-affected mothers, with an overall ratio of means of 0.89 (95% CI: 0.84, 0.94, $p = 4.9 \times 10^{-5}$). When stratified by ethnicity, maternal RBC folate levels were significantly lower among Asian ($p = 0.04$) and Caucasian ($p = 0.02$) NTD-affected mothers.[63]

Calcium. Low maternal calcium intake can lead to tetanus, muscle cramps, paresthesia, osteopenia, delayed growth, LBW, and poor bone mineralization in the fetus.[64] Women with low calcium intake are at higher risk of developing hypertensive disorders during pregnancy; one of the leading causes of maternal mortality in Southeast Asia.[65,66] Poor bioavailability of calcium can also contribute to its deficiency, especially in countries like Malaysia, where lactose intolerance is prevalent.[67]

A Cochrane review found that supplementing pregnant women with low doses of calcium (500 mg daily) potentially reduces the risk of hypertension (five trials, 665 women: RR 0.53; 95% CI: 0.38, 0.74).[68] FIGO suggests sufficient calcium intake in women for preventing preeclampsia.[69] In response to the low calcium intake, the Filipino government recommends calcium supplementation (500 mg elemental calcium) in women from 20 weeks of gestation until the end of the pregnancy.[70]

Vitamin D. Lower serum 25-hydroxyvitamin D [25(OH) D] concentrations during pregnancy are associated with the increased risk of GDM, preeclampsia, preterm birth, and small for gestational age.[71,72] Recommendations on the use of vitamin D supplements during pregnancy vary, ranging from 200 to 400 IU/day (5–10 mcg/day). A Cochrane review found that supplementing pregnant women with vitamin D alone reduces the risk of preeclampsia, GDM, LBW, and severe postpartum hemorrhage.[73] Furthermore, multivitamin (including vitamin D) intake by Indonesian women during pregnancy significantly prevented vitamin D deficiency in infants.[74] Multiple studies suggest developing/improving an awareness program on vitamin D supplementation in public and healthcare professionals (HCPs) to reduce vitamin D deficiency in pregnant women.[75–77]

Iodine. During pregnancy, iodine requirement increases because of increased thyroid hormone production and iodine excretion. Similarly, iodine is concentrated in the mammary

gland for excretion in breast milk during breastfeeding.[78] If maternal iodine requirements are not met during pregnancy, the production of thyroid hormones may become inadequate for maternal, fetal, and infant needs.[79] Consequences may include maternal or child hypothyroidism or goiter, pregnancy loss, LBW, infant mortality, and developmental delays ranging from mild intellectual impairment to cretinism. In 1993, World Health Organization (WHO) and United Nations International Children's Emergency Fund (UNICEF) recommended salt iodization as the key strategy to eliminate iodine deficiency disorders.[80] Like other regions around the world, Southeast Asian region also started to implement a salt iodization program after this recommendation.

Supplementation with high-dose or daily iodine during pregnancy and lactation effectively increases breast milk iodine concentration.[81] Iodine supplementation before conception could also increase iodine stores and thyroid hormone production during pregnancy.[82] This may be especially important in iodine-deficient women to allow time for correction of the long-standing deficiency. Thyroid hormones are essential for brain and nervous system development, hence starting iodine intake as early as the seventh week of gestation is essential.[43] On National Micronutrient Day of the Philippines, called Araw ng Sangkap Pinoy, iodine capsules are given to women between the ages of 15 and 40 years.[83]

There is a need to improve existing inadequacies in self-care and healthcare supports, which warranted further attention since COVID-19 pandemic

The expert panel discussed that inadequate nutritional and self-care information is a significant challenge to maternal nutrition and pregnancy-related health outcomes and its importance was further witnessed since the recent pandemic. The lockdown during the pandemic over-burdened healthcare systems leading to decreased access and adherence to prenatal and obstetric care, reducing the quality of care. Reduced maternity healthcare-seeking and healthcare provision due to lockdowns, "stay at home guidance," and fear of contracting COVID-19 has been considered a global cause of worsened pregnancy outcomes observed during the pandemic.[84] A systematic review found a significant decrease in the number of ANC visits ($p < 0.0001$) and unscheduled care visits ($p = 0.0046$) per week, as well as an increase in remote ANC ($p < 0.0001$) and hospitalization of unscheduled attendees ($p < 0.0001$).[84] LMICs have recognized women's inadequate access to communication infrastructure as telehealth was elusive, particularly in rural areas.[85,86] The women also face psychosocial challenges related to social isolation and a lack of information or misinformation concerning self-care. The social isolation also led to increased level of anxiety and stress along with reduced adherence to healthy diet.[87–89]

Education. Education plays a prominent role in the nutritional status of pregnant women and lactating mothers. Higher education positively impacts the health and nutrition of women and their children.[90] Higher education and monthly income significantly influence maternal knowledge on nutrition, with educated pregnant and lactating mothers being more careful about what they eat.[91,92] Maternal malnutrition prevalence has also been reported to be much higher among low-income and illiterate women.[91] In Thailand, children of mothers or caregivers with no formal education (4%) were more likely to be underweight, stunted, or wasted (71%, 61%, and 48%, respectively) than children of those with education beyond secondary school (12%).[93]

Pregnancy is an ideal time to encourage dietary and personal behavior changes that women might otherwise resist because pregnancy often increases motivation and desire to learn.[94] Nutrition education and diet counseling during pregnancy and lactation shall be supported through routine health contacts, considering the local context and beliefs. Incorporation of maternal nutrition into preservice and in-service curriculums and training of healthcare providers and community level workers is essential.[95]

Social support networks can affect pregnancy-related health behaviors and personal habits, including the use of prenatal and delivery services and dietary habits.[96,97] An appropriate, community-based group health education program can create awareness for childbearing health among Southeast Asian women and improve their childbearing attitudes and behaviors.[98] A randomized clinical trial in Singapore reported that mothers who participated in a postnatal psychoeducation program had significantly higher scores of parental self-efficacy and social support, as well as lower scores of postnatal depression, compared to the control group.[99]

Family-based educational programs should be implemented to improve the nutritional awareness of pregnant women and their families. A study from Tanzania evaluating the family-oriented antenatal group educational program found improvement in Family Support ($p = 0.001$ and $p = 0.000$) and Preparation of Money and Food ($p = 0.000$ and $p = 0.000$) among pregnant women and their families.[100] Cultural belief, taboos, and attitudes of pregnant women, their partners, and their families influence their dietary choices.[101] In 2010, an ethnographic study of nutritional conditions of pregnant women in Indonesia found that there was a strong influence of the sociocultural beliefs in the nutritional intake of pregnant women.[102] Family members, including the husband and mother, or mother-in-law, played an essential role in the selection and preparation of diet as well as eating patterns of pregnant women.[103–105] A study from Singapore reported that informational and instrumental support to mothers was lower than emotional and appraisal support.[106] Their primary source of support came from husbands, parents, and parents-in-law. Therefore, it is crucial to target the family too.

Approximately 777,000 girls under 15 years of age and 12 million girls aged 15–19 years give birth annually in the developing regions.[107] In 2018, the overall adolescent

fertility rate in Southeast Asia was 33%.[37] Pregnancy among adolescents increases the risk of adverse consequences for both sets of children: the young mother and her infant.[108] Preconception health and nutrition care can prevent premature birth, LBW, stunting and wasting, and reduce the risk of developing diabetes and cardiovascular diseases.[8] Preconception care measures can include screening and management of anemia and diabetes, supplementation with iron and folic acid, information, education, and counseling on nutrition issues, monitoring of nutritional status, supplementation with energy- and nutrient-dense foods in case of undernutrition, healthy school meal policies, management of obesity, promotion of exercise, and iodization of salt. Modifying unhealthy eating patterns among pregnant adolescents is critical because of their association with the risk of poor pregnancy and birth outcomes.[109] A community-based cross-sectional study from India also reported adverse pregnancy and birth outcomes among women using low-mixed vegetarian diet.[110] Therefore, providing age- and developmentally appropriate contraceptive and nutrition education is essential.[111] A systematic review of RCTs evaluating the effectiveness of preconception education and counseling on reproductive health and pregnancy outcomes in women (planning a pregnancy) highlighted an improvement in their knowledge and positive health behavior.[112]

Self-care health interventions. A pregnant woman can do much to take care of herself during pregnancy, especially when it comes to diet, the use of nutritional supplements, self-monitoring of blood pressure and glucose concentration, and physical activity under the guidance of her HCP. In 2019, WHO published the first consolidated "living" guidelines on self-care health interventions, including ANC interventions for nausea and vomiting, heartburn, leg cramps, and constipation.[113]

In addition to self-care, remote care which uses information technology to gather and exchange data outside of a facility, can also provide much-needed health information and counseling, as well as guidance on self-care activities. These two concepts can change and improve the way of providing ANC, leading to a fundamental and sustainable positive shift. Healthcare administrators can determine the number and frequency of in-person contacts required during ANC and the type of maternal issues that can be dealt with self-care and remote care.[114] A systematic review has found positive influence of social media interventions or web-based tools on maternal and infant outcomes in adolescent pregnancy.[115]

In COVID-19 context, the WHO suggested the use of telemedicine during the antenatal, intrapartum, and postnatal periods when the technology is available.[116] HCPs in the Philippines were also instructed to maximize teleconsulting and tele-prescription platforms for antenatal and postpartum care.[117] In low-income countries, the most promising and commonly evaluated telehealth intervention for women during pregnancy was SMS support and has been found to be associated with increased utilization of healthcare, improvements in obstetric outcomes, continuation of breast feeding, and monitoring of high-risk pregnancies.[33,118–121] Further, the mHealth application can provide pregnant women with instant access to healthcare facilities and information related to COVID-19 self-care processes.[70] It can also be used to reduce stress and anxiety about COVID-19 in mothers, provide access to reliable information to answer possible questions and identify high-risk locations.

Role of policymakers to address barriers to dietary changes

Successful implementation of national nutrition strategies and action plans requires the involvement of multisectoral stakeholders.[122,123] Nutrition and health sectors should be the leading players in nutrition programs to effectively, efficiently, and sustainably promote nutrition and health in individual countries.[124,125] In 2018, FIGO formed a Pregnancy Obesity and Nutrition Initiative (PONI) to reduce all types of malnutrition before, during, and after pregnancy.[126] The PONI team aimed to guide obstetricians and gynecologists on the importance of adequate nutrition at different stages of pregnancy. This team provided key messages, built strong narratives around the importance of tackling malnutrition and obesity, and disseminated FIGO's evidence-based guidelines and checklists to achieve their goals.

Some interventions that affect maternal and child nutrition-related outcomes include promotion of breastfeeding, strategies to promote complementary feeding—with or without the micronutrient interventions, provision of food supplements, broad supportive techniques to enhance community and family nutrition, and reduce disease burden.[127] Extra interventions such as deworming for pregnant women and children, as well as infectious diseases prevention and treatment, might be needed too.[8,125] Approaches used to facilitate IFA or MMN supplement delivery and adherence among pregnant women focus mostly on continuous educational and promotional activities and delivering clear, standardized, and specific target messages. Systematic and professional motivation and training of community health volunteers and healthcare workers are also essential.[128] Additionally, multipronged strategies to promote breastfeeding have been used in Malaysia since the 1970s.[129] This includes education through mass media, training, counseling courses for HCPs, implementation of baby-friendly health facilities, and establishment of breastfeeding support groups.

However, the limitation of past and existing national strategies is that most do not include interventions for the preconception period and teenagers (other than during pregnancy). This limitation is observed globally too.[8,107,124] These populations should focus on nutrition and nonnutrition interventions to ensure that women enter pregnancy when they are physically and psychologically ready, thus improving pregnancy quality, reducing complications, and improving birth outcomes (Table 2).[125]

Table 2. Evidence-based opinions of experts from Southeast Asia.

Published evidences	Expert opinion	Evidence grade and level
• In Myanmar, 86% of pregnant women had low to moderate level of knowledge of nutritional needs during pregnancy[23] • Most Indonesian pregnant women did not actively seek nutrition information. Nutrition information from different sources including HCPs was viewed as inconsistent, with varying levels of trust. There is a need for improvement in nutrition awareness among pregnant women in Indonesia[26] • HCPs expressed concern about the maternal malnutrition that they observed in the Indonesian community and the lack of adequate services to rectify these concerns[27]	Awareness among the Southeast Asian community on understanding how to make healthy choices during this period is needed	BIII
• Efforts to prevent fetal growth faltering must begin early in pregnancy and perhaps even before pregnancy[130] • Maternal preconception nutrition influences both offspring linear growth and risk of stunting across the first 1000 days[17] • Maternal MMN supplementation rapidly stabilized maternal mtDNA-CN in Indonesian pregnant women who participated in SUMMIT, indicating improved mitochondrial efficiency. Mitochondria play a key role during pregnancy by providing maternal metabolic energy for fetal development. The data provide a mechanistic basis for the beneficial effects of MMN on fetal growth and survival and support the transition from routine IFA to MMN supplementation[131]	Women's nutritional status, both before and during pregnancy, impacts fetal growth and development	AI
• If women were entirely unexposed to overweight or obesity during the prepregnancy or early pregnancy period, 14%–35% fewer women would develop gestational diabetes and preeclampsia or pregnancy-induced hypertension[20] • Malnutrition status prior to pregnancy and inadequate or excessive gestational weight gain status during pregnancy were significant risk factors for developing adverse pregnancy outcomes in Indonesian pregnant women[132]	Preconception BMI is an independent predictor of many adverse pregnancy outcomes	BIIa
• A better coordination of efforts to reduce micronutrient deficiency and a focus more inclusive for other micronutrients than iron, vitamin A, and iodine is urgently needed for South-East Asia[30] • Inadequate or borderline dietary intake of micronutrients and low consumption of micronutrient supplements were evident among Asian women of reproductive age, despite existing recommendations, food fortification, and supplementation strategies[4]	Deficiency of micronutrients such as iron, calcium, folic acid, iodine, and vitamins B12 and D are relevant in Southeast Asian women, from preconception to the first 1000 days of life	BII
• Preconception supplementation with IFA or MMN supplements resulted in modest increases in maternal and infant iron stores but did not impact anemia,[41] birth outcomes,[133] or depression[134] but child's improved linear growth and fine motor development at 2 years of age[42] intellectual functioning in at age 6–7 years[135]	Multiple nutrients intake is important during preconception and should be continued through the first 1000 days of life and various approaches are required for addressing common insufficiencies, including a healthy diet and supplementation	AI
• Early iron supplementation with doses approximately 100 mg/day improves the biochemical status of the mother independently of her prepregnancy iron status[136] • Two trials with 841 participants revealed that iron supplementations before and/or during pregnancy had no effect on LBW[137]	Prepregnancy iron supplementation is probably more effective	GPP
• Folic acid, alone or in combination with vitamins and minerals, prevents NTDs[138] • Weekly IFA supplements containing 2.8 mg folic acid group were seven times ($p < 0.0001$) more likely to achieve an RBC folate >748 nmol/L, a concentration associated with a low risk of NTD, compared with the 0.4 mg group[54] • Folic acid fortified milk increased blood folate concentrations in women of childbearing age to levels associated with a reduced risk of an NTD-affected pregnancy[55]	Folic acid is necessary before and during pregnancy because of its preventive properties against NTDs	AI
• Vitamin B12 levels were decreased in mothers and infants in NTD groups compared with control groups[139] • NTD-affected mothers had significantly lower levels of folate ($p = 0.002$), vitamin B12 ($p = 3.6 \times 10^{-5}$), and red blood cell folate ($p = 0.01$)[63] • Women with concurrent high intakes of B6, B12, choline, and methionine and moderate intake of betaine had approximately half the risk of an NTD-affected pregnancy[140]	Low vitamin B12 status at preconception is a significant risk factor for fetal NTDs. Thus, adequate concentration of this vitamin should be achieved and maintained before conception	BIIb

(Continued)

Table 2. (Continued)

Published evidences	Expert opinion	Evidence grade and level
• The single included study in a Cochrane review suggested that calcium supplementation before and early in pregnancy may reduce the risk of women experiencing the composite outcome, preeclampsia, or pregnancy loss at any gestational age, but the results are inconclusive for all other outcomes for women and babies. Therefore, current evidence neither supports nor refutes the routine use of calcium supplementation before conception and in early pregnancy[141] • Calcium supplementation that commenced before pregnancy until 20 weeks' gestation, compared with placebo, did not show a significant reduction in recurrent preeclampsia[142]	Women with low calcium intake are at higher risk of developing hypertensive disorders during pregnancy	GPP
• Developing an awareness program to promote best practices in pregnant women is essential to prevent vitamin D deficiency[75] • Public health policies should target the awareness for optimal and safe sun exposure and adequate vitamin D dietary intake[76] • Recommending supplements containing vitamin D may be the best strategy at present for improving vitamin D status with a need for increased vitamin D education[77]	Considering the possible adverse maternal and fetal outcomes of vitamin D deficiency during pregnancy, the nutrition education should emphasize vitamin D-fortified foods and supplementation consumption among pregnant women, as needed. Improving public and healthcare professionals' awareness, food fortification, and targeted national programs on vitamin D supplementation are beneficial to reducing the prevalence of vitamin D deficiency in pregnancy	BIII
In Philippines, China, and Croatia, salt iodization at approximately 25 mg/kg that covers a high proportion of the total amount of salt consumed supplies sufficient dietary iodine to ensure adequate iodine nutrition in all population groups (school-age children, nonpregnant nonlactating women of reproductive age, pregnant women, lactating women, 0–6-month-old infants, and 7–24-month-old infants), although intakes may be borderline low during pregnancy[143]	The expert group agreed with the WHO and UNICEF consensus that salt iodization is a key strategy for achieving adequate iodine intake in populations. Supplements should only be the solution when salt iodization fails	BIII
• Thirty percent of the pregnant women felt equal or greater satisfaction with telemedicine than face-to-face consultations in Japan. A stronger demand for telemedicine was exhibited by multiparous women than primiparous women[144] • Personal and organizational factors motivated the implementation of teleconsultation during the pandemic, but maintaining it raises technical, regulatory, and ethical issues[145] • Telemedicine services provided during the lockdown period were effective and acceptable in managing women with obstetrics and gynecological conditions[146]	The patient's healthcare-seeking behavior now inclines more toward telemedicine and detached healthcare facilities. Teleconsultation has replaced face-to-face consultations	BIII
• The mHealth application can be used to reduce anxiety and stress about COVID-19 in mothers, provide access to reliable information to answer possible questions, identify high-risk locations, and provide pregnant women with instant access to healthcare facilities and information related to COVID-19 self-care processes[70] • Lebel et al.[147] showed concerningly elevated symptoms of anxiety and depression among pregnant individuals during the COVID-19 pandemic, that may have long-term impacts on their children. Potential protective factors include increased social support and exercise, as these were associated with lower symptoms and thus may help mitigate long-term negative outcomes • Findings underscore the need to address the high rates of mental health during pregnancy and outline potential targets (cognitive appraisal and social support) to protect pregnant people from experiencing mental health problems during the COVID-19 pandemic[148]	Nutrition education, self-care, and social support have become more important in the time of pandemic, especially when there is a rapid redirection of health services	BIII

(Continued)

Table 2. (Continued)

Published evidences	Expert opinion	Evidence grade and level
• In Indonesia codeveloping locally sensitive and sustainable complex interventions incorporating professional support and building on family and community back-up, enhancing knowledge and demystifying dietary misinformation to improve maternal health and nutrition[104] • The family-oriented antenatal group educational program has the potential to increase knowledge, birth preparedness, and awareness of the need for family support among pregnant women and their families[100] • Participation in the *Becoming a Mom* prenatal health education classes resulted in considerable gains in knowledge areas concerning pregnancy and birth[149]	Family-based educational programs should be implemented to improve the nutritional awareness of pregnant women and their families	BIII
• Women who received preconception education and counseling were more likely to have improved knowledge, self-efficacy, and health locus of control and risk behaviour[112] • Women who received preconception care in either a healthcare center or the community showed improved outcomes, such as smoking cessation, increased use of folic acid, breastfeeding, greater odds of obtaining antenatal care, and lower rates of neonatal mortality[150] • Integrating preconception care strategies and policies that can address all the components of preconception care services with other maternal and child health services will be essential when designing effective implementation strategies to improve preconception care uptake. Besides this, advocating for better education for women, awareness creation, and increasing antenatal care services are essential[151]	Preconception care measures can include screening and management of anemia and diabetes, supplementation with iron and folic acid, information, education, and counseling on nutrition issues, monitoring of nutritional status, supplementation with energy- and nutrient-dense foods in case of undernutrition, healthy school meal policies, management of obesity, promotion of exercise, and iodization of salt	AI
• The youngest and oldest mothers suffer most from adverse pregnancy and birth outcomes[152] • MMN supplementation can improve birth outcomes among pregnant adolescents in low- and middle-income countries. Policy related to antenatal care in these settings should prioritize MMN supplementation over the currently recommended IFA supplementation for all pregnant women, especially adolescents[153]	Modifying unhealthy eating patterns among pregnant adolescents is critical because of their association with the risk of poor pregnancy and birth outcomes	AI
• Development of web-based, text messaging, compact disc read-only memory, electronic prompts, and interactive computer agent interventions is required for promoting and supporting breastfeeding[154] • Social media interventions or web-based tools have the potential to positively influence both maternal and infant outcomes in adolescent pregnancy, but there is a need for more well-conducted studies to demonstrate the effectiveness of these support programs[115] • Post-COVID-19, where technology is continuously developing, there is a compelling need for studies that investigate the role of eHealth and mHealth in self-monitoring pregnancy, and the consequences this has for pregnant women, health professionals and organizations, as well as midwifery curricula[155]	Available technologies such as social media, digital applications, and so on, should be leveraged to facilitate the shift of physical visits to digital platforms and support self-care interventions wherever appropriate	AI

BMI: body mass index; MMN: multiple micronutrient; IFA: iron–folic acid; NTD: neural tube defect; mtDNA-CN: mitochondrial DNA copy number.

Conclusion

During preconception, pregnancy, and lactation, malnutrition remains a prevalent and under-addressed issue in Southeast Asia. Appropriate interventions promoting adherence to a healthy diet and appropriate usage of MMN supplementation could contribute to better health of women of reproductive age and their children. In this journey, HCPs and policymakers are the important torchbearers who must address the barriers to dietary changes and existing inadequacies in education, self-care, and social support. With the COVID-19 pandemic further amplifying these inadequacies, a practical and multipronged strategy involving a strong partnership between multisectoral stakeholders is required to alleviate malnutrition concerns in this population. To increase the touchpoints with women in reproductive age groups, interventions such as community outreach, local government initiatives, active involvement of allied HCPs, including pharmacists and midwives, and focus on family education to improve nutritional awareness should be implemented. Future research should assess the role of additional nutrients, including zinc, selenium, magnesium, and DHA, in offering additional health benefits to the Southeast Asian population.

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Availability of data and material

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Supplemental material

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