

Drh. Rizal Damanik, MRepSc, PhD
Department of Community Nutrition,
Faculty of Human Ecology,
IPB University, Bogor
Indonesia

EARLY NUTRITION: NUTRITION FOR PREGNANCY WOMAN

Paper is presented at The 2nd International Symposium on Wellness and Healthy Lifestyle,
In Universiti Sains Malaysia, Kelantan Malaysia,
on 8-9 December 2011

INTRODUCTION

Evidence accumulates that food supply and the metabolism of food ingredients in women during pregnancy and lactation and in their children have marked implications on child development and long-term health. Epidemiological evidence and intervention studies performed in pregnant women and in infants have highlighted the fact that maternal and intrauterine influences are of special importance during the development of the infant and child. Early nutrition modulates growth and functional development of the organism and appears to exert lifelong programming effects that modulate health, disease and mortality risks in adulthood, neural function and behavior, and quality of life. The scientific exploration of these relationships and their underlying mechanisms offer new windows of opportunity for preventive health concepts, the provision of sound nutritional advice, and the development of improved food products for mothers and children.

A woman's nutritional status should be assessed preconceptionally with the goal of optimizing maternal, fetal, and infant health. Pregnancy-related dietary changes should begin prior to conception, with appropriate modifications across the pregnancy and during lactation. Most nutritional advice is based upon the Recommended Daily Allowances (RDAs), which are simply the levels believed to prevent disease in the vast majority of otherwise normal individuals. Women who typically eat three meals daily consisting of several servings of vegetables, fruits, whole grains, dairy products, and a few sources of protein (eg, meat, fish, eggs, dried peas or beans) are likely to have adequate nutrition. By comparison, women who skip several meals each week and have a high intake of soft drinks and snack foods (eg, chips, candy, cookies) instead of a more balanced diet can benefit from nutritional counseling. The present paper will discuss the nutritional concerns related to pregnancy.

PRECONCEPTIONAL RECOMMENDATIONS

The fetal environment affects subsequent infant and childhood development and appears to have permanent effects on adult health (Barker hypothesis) [1]. Thus, dietary changes that optimize fetal growth and development may have health benefits across an individual's lifecycle. Dietary modifications should be started early to maximally benefit fetal growth and development.

Folic acid supplementation — Folic acid supplementation to reduce the risk of neural tube defects is a preconceptional recommendation that applies to all fertile women in the childbearing years. The neural tube closes between 18 and 26 days after conception so folic acid supplementation after the diagnosis of pregnancy is usually too late to reduce the risk of neural tube defects.

The Center for Disease Control (CDC) and American College of Obstetricians and Gynecologists (ACOG) recommend that women of childbearing potential take a folic acid supplement of 400 micrograms per day [2]. However, doses well above this amount are necessary to maximally reduce the risk of neural tube defects [3], therefore some experts recommend a supplement of 800 micrograms for women trying to conceive. Higher doses (4 milligrams per day) are recommended for women known to be at increased risk for offspring with neural tube defects [4]. The optimal dose of folic acid to prevent as many neural tube defects (NTDs) as possible is not

precisely known. The CDC and ACOG recommendation is likely too low to maximally reduce the risk of NTDs and was chosen to avoid masking B12 deficiency.

There is also evidence that folic acid supplementation may reduce the risk of other congenital anomalies. A reduction in childhood acute lymphoblastic leukemia may be an additional benefit from folic acid supplementation during pregnancy, but this has not been confirmed in large studies [5]. Use of folic acid supplements may also slightly increase the incidence of twin pregnancy, although this association may have been due to incomplete ascertainment of women who used both folate supplements and drugs to stimulate ovulation [6].

Maternal metabolic disease — Metabolic diseases, such as phenylketonuria (PKU) and diabetes, are associated with a higher risk of congenital anomalies. As an example, high maternal phenylalanine levels during pregnancy in women with PKU cause microcephaly, mental retardation, and congenital heart disease in their offspring [7]. Dietary restrictions that lower levels of maternal phenylalanine preconceptionally and during the earliest stages of gestation appear to reduce the risk of fetal malformation. Health care providers should advise affected women of childbearing age to either stay on a PKU diet or plan their pregnancies to occur after they have reinstated such a diet [8].

Hyperglycemia is probably the most important determinant of increased fetal risk in pregnant women with diabetes. This conclusion is supported by repeated observations that normalizing blood glucose concentrations before and early in pregnancy can reduce the risk of spontaneous abortions and congenital malformations to nearly that of nondiabetic women [9].

PREGNANCY RECOMMENDATIONS

Weight gain — The amount and pattern of weight gain during pregnancy depend upon an adequate number of calories each trimester. These factors influence the health, size, and growth of the fetus. Prepregnancy body weight and gestational weight gain have independent, but cumulative, effects on infant birth weight. In addition, it has been observed that the birth weight of boys is about 100 g heavier than the birth weight of girls and this appears to be due to higher energy intake in pregnant women carrying males [10]

The average weight gain in healthy primigravidas is 12.5 kg. The fetus, placenta, uterine hypertrophy, breast enlargement, and retention of water comprise approximately 9 kg; maternal fat storage accounts for the remainder [11]. The Institute of Medicine (IOM) recommendations for weight gain during singleton pregnancy are:

- 12.5 to 18 kg for underweight women — BMI <19.8 kg/m²
- 11.5 to 16 kg for normal weight women — BMI 19.9 to 26.0 kg/m²
- 7 to 11.5 kg for overweight women — BMI 26.0 to 29.0 kg/m²
- ≥6.8 kg for obese women — BMI >29.0 kg/m²

A graphic display of the gravida's weight is the simplest method for tracking weight gain. A smooth, progressive change is normal; large deviations may represent

pathology, such as fluid retention from preeclampsia. In practical terms, women with a normal prepregnancy BMI should try to gain about 0.4 kg each week in the second and third trimesters. Weight gain of less than one kg or more than 3 kg per month should prompt questions regarding changes in eating habits and other sources for weight fluctuations. Women with excessive or inadequate weight gain may benefit from individualized nutritional counseling.

The incidence of pregnancy complications is higher at the upper and lower extremes of weight gain. Large cohort studies including several thousand pregnancies have shown a statistically significant increase in births of small for gestational age infants among women with a weight gain below the IOM's BMI-based recommendations [12]. These series have also shown that those women who exceeded the weight gain recommendations approximately doubled their risk of having a macrosomic infant and significantly increased their risk of cesarean delivery, and other adverse maternal and neonatal outcomes. Large gestational weight gain may also increase the risk of childhood obesity.

Excessive weight gain during pregnancy and failure to lose weight postpartum also appear to predict higher BMI long after delivery, further supporting the IOM recommendations. A series with long-term follow-up reported the mean change in maternal weight 8.5 years (range 5 to 10 years) after delivery in women who gained less, achieved, or gained more than IOM recommendations was 4.1, 6.5, and 8.5 kg, respectively [13]. Furthermore, women who attained their prepregnancy weight by six months postpartum had less increase in long-term weight gain than those who did not (2.4 versus 8.3 kg). In addition, women who have large weight gains during the first pregnancy and/or retain weight after delivery are at higher risk of doing so in subsequent pregnancies, thereby increasing their long-term risk for obesity with each pregnancy [14].

Prepregnancy weight is also an important factor. Underweight women with low weight gain during pregnancy appear to be at particularly high risk of preterm birth. Low gestational weight gain, especially in the second and third trimesters, is one of several factors associated with low birth weight, perinatal mortality, and possibly preterm birth. However, there is a wide variation in the amount of weight gained (10 to 21 kg) by women giving birth to optimally grown infants at term. Furthermore, lower infant birth weight in healthy women is related to many maternal characteristics other than gestational weight gain, including: low prepregnancy weight, low BMI, low family income, adolescence, unmarried status, and low educational level.

DIETARY COMPONENTS

Macronutrients — Specific dietary components do not appear to have a significant effect on birth or placental weight in most, but not all trials. Protein supplementation is the macronutrient evaluated most extensively and is usually provided as a balanced high energy-high protein mix. A meta-analysis of 13 trials using this type of nutritional supplement found a minimal effect on birth weight (25 grams, range 4 to 55 grams), but the incidence of small for gestational age infants and neonatal death were reduced (OR 0.64 and 0.61, respectively) [15]. By comparison, very high caloric supplementation appears to have a large positive effect on birth weight only in severely undernourished women. In one study, birth weight increased by

approximately 200 grams among rural Gambian women receiving an energy-dense nutritional supplement in the wet season (ie, when food shortages result in negative energy balance), but not during the dry season (ie, harvest period with positive energy balance) [16]. The proportion of low birth weight babies decreased from 24 to 8 percent.

Micronutrients — Micronutrients generally have not been shown to have a significant effect on birth weight or gestational duration in well-nourished women. In developing countries, however, consumption of multivitamins may improve birth weight. This was illustrated in a trial in Tanzania that randomly assigned 8468 HIV-negative women at 12 to 27 weeks of gestation to receive daily multivitamins or placebo [17]. The amounts of vitamin E, C, and B complex in these vitamins were two- to 10-fold higher than the recommended daily intake. The risk of delivering a small for gestational age infant was significantly reduced in the multivitamin group (RR 0.77, 95% CI 0.68-0.87), but there was no significant reduction in risk of preterm birth (delivery at less than 37 weeks was approximately 17 percent in both groups). The mean birth weight in multivitamin and placebo groups was 3148 and 3083 grams, respectively.

Data from two studies in Nepal also showed that micronutrient supplementation was associated with a significant reduction in birth of small for gestational age infants [18]; smaller studies have confirmed this trend, but results did not reach statistical significance [19]. Further investigation is needed to determine whether factors other than micronutrient supplementation contributed to these results, which micronutrients may have the potential for improving birth weight, and the populations most likely to benefit from this intervention.

Calories — The National Research Counsel recommends a 300 kcal per day increase in calories above nonpregnant levels throughout pregnancy. Calories are the single most important nutritional factor in determining birthweight.

Protein — The fetal/placental unit consumes approximately 1 kg of protein during pregnancy, with the majority of this requirement in the last six months. Thus, the gravida needs to ingest an additional 5 to 6 grams protein/day above the non-pregnant state.

The important difference between proteins of plant and animal origin is in the concentration of indispensable or essential amino acids. Animal foods are considered complete or high-quality proteins because they contain all nine essential amino acids that the body needs for growth and repair of body tissues. Plant-based foods are usually incomplete, meaning that they are deficient in one or more of the essential amino acids. Several approaches help to correct this deficiency, such as using soy products, complementary foods, and dairy products.

Iron — Iron is necessary for both fetal-placental development and to expand the maternal red cell mass. Iron losses associated with pregnancy and lactation are about 1000 mg. The current recommendation is to increase iron consumption by 15 mg/day (to an RDA of 30 mg/day), an amount readily met by most prenatal vitamin formulations. This is adequate supplementation for non-anemic women. Most studies report supplementation decreases the prevalence of maternal anemia at delivery. In

contrast, it is unclear whether iron supplementation in non-anemic, well nourished pregnant women improves birth outcome [20].

Women with iron deficiency anemia (first or third trimester hemoglobin (Hb) <11 g/dL or second trimester Hb \leq 10.4 g/dL and low serum ferritin) should receive an additional iron supplement of 30 to 120 mg per day until the anemia is corrected.

Severe anemia with maternal hemoglobin below 6 g/dL has been associated with reduced amniotic fluid volume, fetal cerebral vaso dilation, and nonreassuring fetal heart rate patterns.. Increased risks of prematurity, spontaneous abortion, low birth weight, and fetal death have also been reported [21]. It is probably prudent to treat severe anemia aggressively, as with red cell transfusion, if there are signs suggestive of fetal hypoxemia.

Calcium — Fetal skeletal development requires about thirty grams of calcium during pregnancy, primarily in the last trimester. This total is a relatively small percentage of total maternal body calcium and is easily mobilized from maternal stores, if necessary. Calcium absorption increases during pregnancy and allows progressive retention throughout gestation [22]. The RDA for elemental calcium is 1000 mg per day in pregnant or lactating women 19 to 50 years of age (1300 mg for girls 14 to 18 years old).

Folic acid — Folate requirements are higher in pregnancy. The preconceptional period is the optimal time for ensuring adequate folic acid consumption. The RDA recommendation is for all fertile women to take at least 400 micrograms of folic acid per day; higher doses (4 milligrams per day) are recommended for women known to be at increased risk for offspring with neural tube defects. A folic-acid fortified multivitamin may also reduce the risk of other congenital anomalies.

Multivitamin and mineral supplements — The Institute of Medicine recommends multivitamin supplements for pregnant women who do not consume an adequate diet. Women at higher risk for dietary deficiencies include those who are carrying twins (or any other multiple gestation), heavy smokers, adolescents, complete vegetarians, substance abusers, and women with lactose deficiency.

Multivitamin content varies depending on the product used. The Institute of Medicine suggests that the daily multivitamin-mineral supplement contain: Iron (30 mg), Zinc (15 mg), Copper (2 mg), Calcium (250 mg), Vitamin B6 (2 mg), Folate (0.6 mg), Vitamin C (50 mg), Vitamin D (5 micrograms or 200 IU).

Individual adjustments should be made based upon the woman's specific needs. Well-nourished women may not need multivitamins to satisfy these daily requirements, but in the absence of a careful evaluation by a nutritionist, it is prudent to recommend them.

The use of self-prescribed supplements is commonplace and has led to numerous case reports of vitamin or mineral toxicities due to overuse of over-the-counter medicines. Specific substances identified as potentially toxic when taken in large quantities include, but are not limited to: iron; selenium; and vitamins A (>10,000 IU per day may be teratogenic) and D (which can cause hypercalcemia). However, the toxic dose

of vitamin D is poorly defined and vitamin D deficiency appears to be far more common than excess intake. Low vitamin D intake may be associated with a slight reduction in birth weight. Excessive quantities of iodine can cause fetal goiter. Intake of large amounts of vitamins E and K may also be toxic.

Dietary restrictions — Self-imposed or physician-advised dietary restraints that attempt to avoid excessive weight gain during pregnancy serve no useful purpose. Essential nutrients are often left out of the diet and the goal of an ideal weight gain is not achieved. As an example, one study of 62 women who restrained their intake found that these women were more likely to gain too little or too much weight, rather than the recommended amount.

Certain foods should be limited or avoided during pregnancy because of potentially toxic effects. These include consumption of some types of fish, high caffeine intake, unwashed fruits/vegetables, unpasteurized dairy products, and undercooked meats.

REFERENCES

1. Godfrey, KM, Barker, DJ. Fetal nutrition and adult disease. *Am J Clin Nutr* 2000; 71:1344S.
2. ACOG practice bulletin. Clinical management guidelines for obstetrician-gynecologists. Number 44, July 2003. (Replaces Committee Opinion Number 252, March 2001). *Obstet Gynecol* 2003; 102:203
3. Wald, NJ, Law, MR, Morris, JK, Wald, DS. Quantifying the effect of folic acid. *Lancet* 2001; 358:2069.
4. Use of folic acid to reduce the number of cases of spina bifida and other neural tube defects. 1983-1991. *MMWR Morb Mortal Wkly Rep* 1991; 40:513
5. Thompson, JR, Gerald, PF, Willoughby, ML, Armstrong, BK. Maternal folate supplementation in pregnancy and protection against acute lymphoblastic leukaemia in childhood: a case-control study. *Lancet* 2001; 358:1935
6. Czeizel, AE, Vargha, P. Periconceptional folic acid/multivitamin supplementation and twin pregnancy. *Am J Obstet Gynecol* 2004; 191:790
7. Lenke, RR, Levy, HL. Maternal phenylketonuria--results of dietary therapy. *Am J Obstet Gynecol* 1982; 142:548.
8. Barriers to dietary control among pregnant women with phenylketonuria--United States, 1998-2000. *MMWR Morb Mortal Wkly Rep* 2002; 51:117
9. Greene, MF, Hare, JW, Cloherty, JP, et al. First trimester Hemoglobin A1 and risk for major malformation and spontaneous abortion in diabetic pregnancy. *Teratology* 1989; 39:225.
10. Tamimi, RM, Lagiou, P, Mucci, LA, et al. Average energy intake among pregnant women carrying a boy compared with a girl. *BMJ* 2003; 326:1245.
11. Cunningham, FG, MacDonald, PC, Gant, NF, et al. *Prenatal Care*. In: Williams Obstetrics, 20th ed, Appleton and Lange, Stamford, Connecticut 1997. p.234.
12. Parker, JD, Abrams, B. Prenatal weight gain advice: an examination of the recent prenatal weight gain recommendations of the Institute of Medicine. *Obstet Gynecol* 1992; 79:664.
13. Rooney, BL, Schauburger, CW. Excess pregnancy weight gain and long-term obesity: one decade later. *Obstet Gynecol* 2002; 100:245
14. Linne, Y, Rossner, S. Interrelationships between weight development and weight retention in subsequent pregnancies: the SPAWN study. *Acta Obstet Gynecol Scand* 2003; 82:318.
15. Kramer, MS. Balanced protein/energy supplementation in pregnancy. *Cochrane Database Syst Rev* 2000.

16. Prentice, AM, Cole, TJ, Foord, FA, et al. Increased birthweight after prenatal dietary supplementation of rural African women. *Am J Clin Nutr* 1987; 46:912.
17. Fawzi, WW, Msamanga, GI, Urassa, W, et al. Vitamins and perinatal outcomes among HIV-negative women in Tanzania. *N Engl J Med* 2007; 356:1423.
18. Osrin, D, Vaidya, A, Shrestha, Y, et al. Effects of antenatal multiple micronutrient supplementation on birthweight and gestational duration in Nepal: double-blind, randomised controlled trial. *Lancet* 2005; 365:955
19. Ramakrishnan, U, Gonzalez-Cossio, T, Neufeld, LM, et al. Multiple micronutrient supplementation during pregnancy does not lead to greater infant birth size than does iron-only supplementation: a randomized controlled trial in a semirural community in Mexico. *Am J Clin Nutr* 2003; 77:720.
20. Pena-Rosas, J, Viteri, F. Effects of routine oral iron supplementation with or without folic acid for women during pregnancy. *Cochrane Database Syst Rev* 2006; 3:CD004736.
21. Sifakis, S, Pharmakides, G. Anemia in pregnancy. *Ann N Y Acad Sci* 2000; 900:125.
22. Heaney, RP, Skillman, TG. Calcium metabolism in normal human pregnancy. *J Clin Endocrinol Metab* 1971; 33:661