

Position of the American Dietetic Association: Nutrition and lifestyle for a healthy pregnancy outcome

ABSTRACT

It is the position of the American Dietetic Association that women of childbearing potential should maintain good nutritional status through a lifestyle that optimizes maternal health and reduces the risk of birth defects, suboptimal fetal growth and development, and chronic health problems in their children. The key components of a health-promoting lifestyle during pregnancy include appropriate weight gain; consumption of a variety of foods in accordance with the Food Guide Pyramid; appropriate and timely vitamin and mineral supplementation; avoidance of alcohol, tobacco, and other harmful substances; and safe food-handling. Prenatal weight gain within the Institute of Medicine (IOM) recommended ranges is associated with better pregnancy outcomes. The total energy needs during pregnancy range between 2,500 to 2,700 kcal a day for most women, but prepregnancy body mass index, rate of weight gain, maternal age, and physiological appetite must be considered in tailoring this recommendation to the individual. The consumption of more food to meet energy needs and the increased absorption and efficiency of nutrient utilization that occurs in pregnancy are generally adequate to meet the needs for most nutrients. However, vitamin and mineral supplementation is appropriate for some nutrients and situations. This statement also includes recommendations pertaining to use of alcohol, tobacco, caffeine, street drugs, and other substances during pregnancy; food safety; and management of common complaints during pregnancy and specific health problems. In particular for medical nutrition therapy, pregnant women with inappropriate weight gain, hyperemesis, poor dietary patterns, phenylketonuria (PKU), certain chronic health problems, or a history of substance abuse should be referred to a qualified dietetics professional.

POSITION STATEMENT

It is the position of the American Dietetic Association that women of childbearing potential should maintain good nutritional status through a lifestyle that optimizes maternal health and reduces the risk of birth defects,

suboptimal fetal development, and chronic health problems in their children. The key components of a health-promoting lifestyle during pregnancy include appropriate weight gain; consumption of a variety of foods in accordance with the Food Guide Pyramid; appropriate and timely vitamin and mineral supplementation; avoidance of alcohol, tobacco, and other harmful substances; and safe food-handling. In particular for medical nutrition therapy, pregnant women with inappropriate weight gain, hyperemesis, poor dietary patterns, phenylketonuria (PKU), certain chronic health problems, or a history of substance abuse should be referred to a qualified dietetics professional.

ENVIRONMENT DICTATING NEED FOR POSITION

Pregnancy is a critical period during which good maternal nutrition is a key factor influencing the health of both child and mother. Maternal weight gain during pregnancy influences infant birth weight and health, and outcomes vary depending on the mother's prepregnancy nutritional status. Birth weight and gestational age have long been recognized as important determinants of infant morbidity and mortality (1). Impaired intrauterine growth and development may also "program" the fetus for cardiovascular, metabolic, or endocrine disease in adult life (2). In long-term follow-up studies, risk of coronary heart disease, type 2 diabetes, hypertension, and hyperlipidemia is increased among men and women who were small or disproportionate at birth (3,4). At highest risk for these health problems are low birth weight infants born to undernourished mothers. In the United States, maternal obesity is also a concern and increases the risk of gestational diabetes, cesarean deliveries, complications during delivery, macrosomia, congenital defects, and childhood obesity (5). In fact, the adequacy of birth weight as a measure of maternal and infant risk may be obscured in some populations with high rates of maternal obesity and type 2 diabetes (6). Excessive prenatal weight gain in overweight and obese women increases the risk of maternal postpartum weight retention and macrosomia in the infant (5). Nutritional guidelines during pregnancy must consider the need to prevent low birth weight and, except in underweight women,

avoid postpartum weight retention.

Inadequate intake of micronutrients is also associated with increased risk of poor pregnancy outcomes. Folate, required for deoxyribonucleic acid synthesis and cell division, plays a critical role in fetal development. Periconceptional use of vitamin-mineral supplements containing folic acid reduces occurrence and reoccurrence of neural tube and other defects (7,8,9). Low folate status also increases risk of preterm delivery, low birth weight, and fetal growth restriction (10). Maternal iron deficiency anemia is associated with risk of preterm delivery and subsequent low birth weight and may contribute to low iron status in the infant (11,12).

Many women of childbearing age in the United States do not maintain good nutritional status before, during, and after pregnancy. National studies indicate that intakes of vitamin B6, vitamin E, iron, magnesium, zinc, and especially calcium are less than recommended levels for women between 20 to 49 years of age (13). Between 19% and 38% of pregnancies occur in women who are overweight at conception. Only 30% to 40% of women actually gain weight within the recommended ranges during pregnancy (14). Use of alcohol, tobacco, and other substances during pregnancy poses risks to the mother and child (1,15). Recent trends also indicate increased use of alternative medicine and botanicals, many of which may be unsafe for pregnant women and their fetuses (16,17).

RATIONALE AND OBJECTIVES

To optimize the health outcomes of both mother and child, women of childbearing years should begin their pregnancies in good nutritional status. Thus, advice needs to reach women before they become pregnant, as well as during their prenatal and postpartum care. Some popular books question the safety of eating certain foods or ingredients and may worry pregnant women. However, evidence is often lacking to recommend avoiding these items entirely during pregnancy. Based on the scientific evidence and current population trends, this position paper has the following objectives:

- to educate health care professionals; public health professionals; teachers of junior and senior high school students; and lay groups on the need for a healthful diet and lifestyle in women of childbearing age;
- to emphasize the key components of a health-promoting lifestyle during pregnancy: appropriate weight gain; consumption of a variety of foods according to the Food Guide Pyramid (18); appropriate vitamin and mineral supplementation; avoidance of alcohol, tobacco, and other harmful substances; and safe food-handling; and
- to provide dietetics professionals with clarification on various nutrition issues related to maternal care during pregnancy.

KEY POINTS

Optimizing Outcomes through Good Nutrition before Conception

Women need to attain good nutritional status before, during, and after, pregnancy to optimize maternal health and reduce the risk of birth defects and chronic disease in their children in later adulthood. Folic acid supplements taken before and during pregnancy can reduce the risk of neural tube and other birth defects, especially in children of women at high risk (7,8,9,19). Women of childbearing age should consume 400 µg per day of folic acid from fortified foods, supplements, or both,

in addition to folate contained in a varied diet, to reduce the risk of neural tube defects (20). Vegans and other strict vegetarians should also take a supplement of vitamin B12, because low folate and vitamin B12 are independent risk factors for neural tube defects (20). Prior to cereal fortification, mean total folate intake in US women was about 250 µg per day. Efforts to prevent birth defects must go beyond cereal fortification, which is expected to increase folate intake in most women by an average of 80 µg per day. If a woman has iron-deficiency anemia when she becomes pregnant, repleting her iron stores during pregnancy may be very difficult. Iron supplementation of adolescent girls prior to pregnancy may improve maternal iron stores during pregnancy. However, further studies on the effectiveness of prepregnancy iron supplementation on preventing prenatal iron depletion are needed (21). Although vitamin and mineral supplementation may be beneficial for many women, guidance is needed to avoid excessive levels of intake, particularly of vitamin A (22, 23). Intakes of vitamin A above 10,000 IU (3,000 RAE)/day¹ during early pregnancy can cause birth defects (25). Women most likely to benefit from vitamin-mineral supplements include those who have inappropriate dietary patterns or food avoidances; are underweight or constantly trying to lose weight; or abuse alcohol or other substances (1).

Bringing maternal weight into a healthy range before pregnancy makes conception easier, improves pregnancy outcomes, and may enhance lactational performance (26). Obese women are at a greater risk of hypertension, gestational diabetes, induced labor, and caesarean sections. Children of obese women are at risk of macrosomia, low Apgar scores, shoulder dystocia, and childhood obesity (5,27). Maternal obesity increases the risk of neural tube defects in the child, independently of folate intakes (28). After delivery, overweight and obese women have more difficulty initiating breastfeeding than do women of normal weight (29).

Women of childbearing years should be physically active to optimize nutritional status. The current recommendation is to accumulate at least 30 minutes a day of moderate physical activity on most days of the week, preferably daily (30). Regular physical activity confers many health benefits, including weight management; increased physical fitness and psychological well-being; and reduced risk of chronic disease. Even more benefits will accrue by spending more than 30 minutes a day in physical activity or by taking part in more vigorous activities.

Between 3,000 to 4,000 US-born women of childbearing age are estimated to have phenylketonuria (PKU) without severe mental retardation, because as newborns their diet was strictly controlled (31). If women with PKU do not adhere to a low-protein, amino acid-modified diet during pregnancy, their infants are at very high risk for mental retardation and microcephaly. To prevent these adverse outcomes, women with PKU should maintain dietary control of blood phenylalanine levels starting before, and continuing throughout, pregnancy.

¹ 1 IU vitamin A activity equivalent to 0.3 µg of all-trans-retinol, 3.6 µg all-trans-β-carotene, or 7.2 µg other provitamin A carotenoids; 1 retinol activity equivalent (RAE) equivalent to 1 µg of all-trans-retinol, 12 µg all-trans-β-carotene, or 24 µg other provitamin A carotenoids; RDA for < 18 yrs. is 750 µg RAE and for 19 to 50 yrs, 770 µg. Upper tolerable limit is 2800 µg for < 18 yrs. and 3000 µg for 19 to 50 yrs (24)

Table 1
Cut-off values for clinical parameters during pregnancy

Parameter	First trimester	Second trimester	Third trimester	Significance of abnormal values
Hemoglobin g/L	110	105	110	Low values may indicate iron deficiency. High values (>150 g/L) may indicate poor blood volume expansion in the 2nd trimester or later.
Hematocrit (%)	33.0	32.0	33.3	Low values may indicate iron deficiency. High values (>45.0%) may indicate poor blood volume expansion in the 2nd trimester or later.
Fasting plasma glucose, FPG (mmol/L)*	6.1	6.1	6.1	Normal values below the cutoffs. A FPG >6.9 or a 2-h PG >11.1 mmol/L is an indicator of diabetes
2-hr postload glucose, 2-h PG	7.8	7.8	7.8	FPG ≥6.1 and <6.9 or 2-h PG ≥7.8 and <11.1 are indicators impaired fasting glucose or impaired glucose tolerance.

References (60, 114)

*To convert SI Units to conventional units (mg/dl), multiply by conversion factor 18.0

Definition and Assessment of a Healthy Pregnancy

A healthy pregnancy is without physical or psychological pathology in the mother or fetus and results in the delivery of a healthy baby. During pregnancy, maternal metabolism adjusts dramatically, mediated by changes in key reproductive hormones—human chorionic gonadotropin, human placental lactogen, progesterone, estradiol, estrone, estriol, prolactin, and cortisol (32). The hormonal milieu during pregnancy is important for maintaining the flow of nutrients to the fetus, stimulating uterine growth, and promoting mammary development, among many other functions. By reducing maternal energy intake, the early nausea and vomiting associated with these hormonal changes may play a role in partitioning nutrients to the placenta and fetus (33). Progesterone also relaxes the smooth muscle in the gastrointestinal tract, contributing to decreased gut motility (32). Absorption of iron and calcium are increased during pregnancy. Blood volume expands in the course of a normal, healthy pregnancy, mainly due to a 35% to 40% increase in plasma volume. Red cell mass also increases but to a lesser extent (15% to 20%), so that hemoglobin concentration and hematocrit decline until the end of the second trimester. Concentrations of total plasma proteins and many nutrients also decline during pregnancy, but most plasma lipids increase. In most cases, these declines in plasma vitamin and mineral concentrations are due to normal, physiological changes secondary to the expansion of blood volume. During pregnancy, dramatic changes in renal function occur and are associated with marked excretion of glucose, amino acids, and water-soluble vitamins. Maternal weight gain must support the products of conception (fetus, placenta, and amniotic fluid) and maternal accretion of tissues (expansion of blood volume and extracellular fluid, uterine and mammary glands, and maternal fat stores). The target range for weight gain, to be discussed in a later section, is that associated with a full-term, healthy baby, weighing an average of 3 to 4 kg (6.6 to 8.8 lb).

Early prenatal care is important for assessment and follow-up to ensure optimal outcomes. During assessment, the health professional should screen for indicators of physiological (see Table 1) or psychological problems. Some indicators would include low rates of weight gain, failure of plasma volume

expansion, anemia, pregnancy-induced edema and hypertension, gestational diabetes, alcohol consumption, and smoking. Health professionals should also screen for history of elevated blood phenylalanine. Lack of social support, depression, and low levels of mastery and self-esteem are psychological indicators that have been associated with low weight gain patterns in some ethnic groups (14).

The wide variability in metabolic energy expenditure during pregnancy makes it difficult to set standards for energy intake (34). For normal and overweight women in developed countries, the additional energy need may actually be less than the 300 kcal per day usually recommended, especially in sedentary women. Appropriate weight gain and appetite are better indicators of energy sufficiency than the amount of calories consumed. Health professionals need to screen carefully for signs and symptoms of eating disorders, because pregnant women with these problems may be very reluctant to disclose their dieting practices to their providers (35,36). Low weight gain in the second trimester, history of eating disorders, and hyperemesis gravidarum are warning signs that current eating disorders may be negatively influencing the course of pregnancy (36).

Weight Gain during Pregnancy

Recommendations for weight gain during pregnancy should be individualized according to prepregnancy body mass index (BMI) (weight/height squared or kg/m²) to improve pregnancy outcome, avoid excessive maternal postpartum weight retention, and reduce risk of adult chronic disease in the child. Prenatal weight gain within the Institute of Medicine (IOM) recommended ranges is associated with better pregnancy outcomes (see Table 2), but many women do not gain within these ranges (1, 37). Women with a BMI < 19.8 are at high risk of delivering a low birth weight infant if their prenatal weight gain is inadequate. However, even women with a BMI > 29.0 should gain at least 7.0 kg (15 lb); those who lose weight or gain less than 6 kg are more likely to deliver an infant that is small for gestational age infant (38). Women with a BMI > 29.0 should be advised to gain at a rate that does not exceed 11.4 kg (25 lb) throughout total pregnancy to

Table 2
Guidelines for prenatal weight gain

	Recommended wt gain	Wt gain per wk after 12 weeks
Body Mass Index (BMI): BMI <19.8	12.5 to 18 kg (28-40 lb)	0.5 kg (\approx 1 lb.)
BMI of 19.8 to 26.0	11.5 to 16 kg (25-35 lb)	0.4 kg
BMI >26.0 to 29.0	7 to 11.5 kg (15-25 lb)	0.3 kg
BMI >29.0	at least 7.0 kg (15 lb)	
Other: Twin pregnancy	15.9–20.4 kg (34-45 lb)	0.7 kg
Triplet pregnancy	overall gain of 22.7 kg (50 lb)	
References (1, 134)		

reduce risk of postpartum weight retention (39). Excessive weight gain in women with a BMI > 26 also places the child at risk of being large-for-gestational age (5), which, in turn, has been associated with excess body fat during childhood (40). Although African American women are at greater risk of delivering low birth weight babies, recent evidence does not support a recommendation that these women should strive for weight gains in the upper half of the IOM recommended ranges (41). A study of Chinese women concluded that cutoffs for pregravid weight status and recommended weight gain ranges associated with good pregnancy outcomes differ from IOM guidelines, due to differences in maternal anthropometry across ethnic groups (42). However, more research studies are needed before formulating recommendations for specific population subgroups. Because of limited studies, decisions regarding maternal weight gain in such subgroups should rest with the physician, the dietetics professional, and the patient.

The risk of maternal overweight due to excessive pregnancy weight gain needs to be balanced against the risk of poor fetal growth associated with low weight gain. Compared to recommended weight gains, excessive weight gain (above the upper limit of the IOM range) contributes more to postpartum weight retention and less to fetal growth in normal weight (43) and overweight women (44). Reducing the risk of low birth weight while avoiding postpartum weight retention is especially problematic in teenagers. Excessive weight gains in normal weight and overweight teenagers (> 0.4 kg per week) increase the risk of obesity, particularly in girls whose pregravid BMI is high (45). Higher weight gains and greater postpartum weight retention tend to occur in pregnant teenagers who are still growing, compared to teens who have completed their growth (46). However, maternal growth in multiparous teenagers is also associated with lower birth weights (47). Therefore, health care providers should exercise caution in advising pregnant teenagers to limit excessive weight gains. Instead, they should focus efforts on helping teens return to normal weight after delivery and preventing subsequent teenage pregnancies.

The timing of prenatal weight gain is also important. Regardless of the mother's pregravid weight, low weight gain in either

the second or third trimester increases the risk of intrauterine growth retardation (48,49). Low weight gain in the third trimester is also associated with a higher risk of preterm delivery (48,50,51).

Depending on its type, frequency, duration, and intensity, exercise may confer health benefits to both mother and fetus (52). Thus, healthy women with uncomplicated pregnancies may continue moderate exercise on a regular basis, but they should be advised about appropriate activities and contraindications (53,54). A woman who has not been exercising before pregnancy should talk to her doctor first before starting an exercise program. Activities at a low to moderate intensity level are generally safe and may include walking, swimming, running, aerobic dancing, and riding on a stationary bicycle. Activities that may not be safe include ball games that increase risk of abdominal trauma, weight lifting, scuba diving, martial arts, anaerobic exercise (sprinting), exercise above 2,500 meters of altitude, and any exercise with a high risk of falling or requiring balance, especially in late pregnancy. Exercise is contraindicated for women with pregnancy-induced hypertension, toxemia, preeclampsia, preterm rupture of membranes, history of preterm labor, persistent second or third trimester bleeding, incompetent cervix, or any sign of intrauterine growth retardation. Pregnant women who exercise should be especially careful to maintain an adequate intake of calories, nutrients, and fluids and to avoid strenuous exercise. Additional guidelines are summarized in Figure 1.

Food Guidance for Pregnancy

Women should consume a variety of foods according to the Dietary Guidelines (30), with cultural food practices considered, to meet energy and nutrient needs and gain recommended amounts of weight. The additional energy needs during the second and third trimesters of pregnancy are approximately 300 kcal/day in adults and older adolescents and 500 kcal a day in young adolescents (< 14 years) (55, 56). Thus, the total energy needs during pregnancy range between 2,500 to 2,700 kcal/day for most women. However, the mother's prepregnant body mass index, ma-

- After 20 weeks, avoid doing exercises while lying on the back. This position can impede blood flow.
- Avoid brisk exercise in hot, humid environments.
- Avoid exercise if body temperature is elevated.
- Wear comfortable shoes and clothing, including a supportive bra.
- Drink plenty of water to prevent dehydration and overheating.
- Always begin with a 5 to 10 minute warm-up period and end with a cooling down period.
- Maintain heart rate at 60% to 80% of maximum. (220 minus age = maximum heart rate)
- Stop exercising immediately if any of the following symptoms are noted: outflow of amniotic fluid, breast pain, vaginal bleeding, headaches, edema, back pain, dizziness, nausea, abdominal pain, or uterine contractions.

FIG 1: General guidelines for a safe and healthy exercise program during pregnancy (135)

Group	Serving Size	Servings/day
Breads, cereal, rice, and pasta group	1 slice bread ½ cup of cooked cereal, rice, or pasta 1 cup ready-to-eat cereal	9
Vegetable group	1 cup raw leafy vegetables ½ cup of other vegetables, raw or cooked; ¾ cup vegetable juice	4
Fruit group	1 medium apple, banana ½ cup chopped fruit ¾ cup of fruit juice	3
Milk, yogurt, and cheese group	1 cup of milk or yogurt 1 ½ oz. natural cheese 2 oz. processed cheese	2-3*
Meat, poultry, fish, dry beans, eggs, and nuts group	2-3 oz. of cooked lean meat, poultry, or fish 1 oz. meat = ½ cup cooked dried beans, 1 egg, ½ cup tofu, ⅓ cup nuts, 2 T. peanut butter	2 (6 oz.)

FIG 2: Minimum daily servings from the Food Guide Pyramid during pregnancy (18,30,136)

*Pregnant teenagers may need an additional serving from this group

ternal age, rate of weight gain, and physiological appetite must be considered in tailoring this recommendation to the individual (34). For the latest updates, dietetics professionals should refer to the 2002 Dietary Reference Intakes for energy that soon will be available (57). The minimum number of daily servings from each Food Guide Pyramid (18) group is shown in Figure 2.

Whole grains, leafy green and yellow vegetables, and fruit should be consumed daily to meet nutrient needs and provide enough fiber. Meat, poultry, seafood, legumes, and nuts are important sources of protein, as are zinc, iron, and magnesium. Pregnant adolescents, especially those who make relatively poor food choices, may need an additional serving from the dairy group. Because some women prefer a non-dairy source of calcium, one cup of a soy-based beverage with added calcium may be substituted for a serving from the dairy group. Calcium-fortified juices and foods also supply calcium, but these foods provide a different profile of nutrients from those of the dairy group. For women with lactose intolerance, dairy products with less lactose, such as cheese, yogurt, or milk with added lactase enzyme, can be substituted for regular milk. Pregnant women need 8 to 10 cups of fluids a day for adequate hydration, but some of that requirement is met through milk, juice, and the water contained in fruits, vegetables, and other foods (55). Women who eliminate certain foods or food groups should be encouraged to see a qualified dietetics professional for dietary evaluation.

Dietetics professionals need to develop cultural competency to work effectively with their ethnically diverse clientele. Being respectful, cooperative, and open-minded is key to cultural competency. Many traditional cultures apply a hot-cold classification to foods and believe that some foods or ingredients are to be avoided and others encouraged during pregnancy to prevent imbalances and protect the fetus (58). Health professionals can use their knowledge of cultural beliefs to reinforce positive dietary practices, such as encouraging the consumption of protein-rich soups for the *yin* condition of "weak blood" in Chinese women or cow's milk with almonds and saffron for fetal development in Indian women. However, some cultural beliefs, such as the avoidance of iron supplements to prevent hardening of the fetal bones, may pose special challenges and should be explored with the woman and possibly other family members. Dietetics professionals should become familiar with cultural practices and beliefs that may affect the diet intakes of their clients and provide culturally relevant advice, adapting the Food Guide Pyramid (18) as needed.

Appropriate and Timely Vitamin and Mineral Supplementation

The consumption of more food to meet energy needs and the increased absorption and efficiency of nutrient utilization that occurs in pregnancy are generally adequate to meet the needs for most nutrients. This statement applies if the pregnant woman makes good food choices as shown in Figure 2. However, vitamin and mineral supplementation may be appropriate for some nutrients described below. In general, pregnant women should be careful in choosing a supplement that does not exceed the tolerable upper limits for a particular vitamin or mineral.

Folic acid

The Recommended Dietary Allowance (RDA) for folate during

pregnancy is 600 µg/day of dietary folate equivalents (20). The major natural sources of dietary folate are legumes, green leafy vegetables, liver, citrus fruits and juices, and whole-wheat bread. Compared to naturally occurring folate in foods, the folic acid contained in fortified foods and supplements is almost twice as well absorbed, so that 1 µg from these sources is equivalent to 1.7 µg dietary folate equivalents. To prevent neural tube defects, women of childbearing years and pregnant women should consume 400 µg per day of synthetic folic acid from fortified foods (cereals and other grains), supplements or both, *in addition to* consuming folate from foods in a varied diet. To ensure that blood vitamin levels are adequate at the time of neural tube closure, supplementation should begin at least one month before conception (19). Research indicates that abnormal folate metabolism may also play a role in Down syndrome and other birth defects (9,59).

Women who have previously delivered an infant with a neural tube defect may need to consume more than the recommended amount of dietary folate equivalents (up to 4 to 5 mg/day) (19). Until more information becomes available, pregnant women in the general population, ages 19 years and older, should not exceed the tolerable upper limit of 1,000 µg of folate per day from foods, fortified foods, and supplements (14- to 18-year-olds should not exceed 800 µg per day) (20). Since some prenatal supplements contain 1000 µg of folic acid, pregnant women may need advice from a physician or a qualified dietetics professional to follow these guidelines.

Iron

Pregnant women should be encouraged to consume iron-rich foods such as lean red meat, fish, poultry, dried fruits, and iron-fortified cereals. Meat and ascorbic acid-rich fruits enhance the absorption of non-heme iron (ie, from plants and iron-fortified foods). Foods that inhibit iron absorption, such as whole-grain cereals, unleavened whole-grain breads, legumes, tea, and coffee, should be consumed separately from iron-fortified foods and iron supplements.

The Centers for Disease Control and Prevention (CDC) recommend a routine low-dose iron supplement (30 mg/day) for all pregnant women, beginning at the first prenatal visit (60). Although conclusive evidence for the benefits of universal supplementation is lacking, the CDC advocates this position because many women have difficulty maintaining iron stores during pregnancy. Furthermore, iron deficiency during pregnancy is associated with adverse outcomes, while prenatal iron supplementation is not associated with important health risks. Iron supplements also improve the iron status of the mother during pregnancy and the postpartum period and may be especially important where the interval between pregnancies is short (12). When a low hemoglobin or hematocrit (see Table 1) is confirmed by a repeat test, an oral dose of 60-120 mg of iron a day should be prescribed (60). If a healthy woman complies with the treatment, and the anemia does not respond to iron treatment after four weeks, further evaluation with other tests, including mean cell volume and serum ferritin, should be done.

Zinc and copper

Iron can interfere with the absorption of other minerals. Therefore, for women taking supplements with more than 30 mg of iron a day, 15 mg of zinc and 2 mg of copper as supplements are recommended (1). Approximately these amounts of zinc and copper are found in many

vitamin-mineral supplements intended for pregnant women.

Calcium

Due to the increased efficiency of calcium absorption, calcium requirements during pregnancy are similar to those in the nonpregnant state (61,62). An adequate intake of calcium is 1,300 mg for women aged 14 to 18 years and 1,000 for women aged 19 to 50 years (61). Some evidence suggests that pregnant adolescents and women at risk of pregnancy-induced hypertension might benefit from higher intakes of calcium (61,63). For women who do not consume milk products (ie, due to milk allergy or other reason) or calcium fortified foods, a calcium and vitamin D supplement may be needed. The inclusion of vitamin D in the supplement is especially important in northern locations during the winter, as exposure to sunlight may not be sufficient to maintain levels of vitamin D in the body.

Indications for multivitamin and mineral supplements

A multivitamin and mineral supplement is recommended during pregnancy in several circumstances (1,23). Pregnant women who smoke or abuse alcohol or drugs should take a multivitamin and mineral supplement. Multivitamin and mineral supplements are also recommended for women with iron deficiency anemia or poor quality diets and for those who consume animal products rarely or not at all (such as vegans). In the latter case, supplemental B12 is particularly important, especially since folic acid supplementation can mask the symptoms of a B12 deficiency. Finally, women carrying two or more fetuses should also take a multivitamin and mineral supplement.

Guidance on Other Substances

Herbal and botanical supplements and alternative remedies

Many pregnant women who would not consider taking over-the-counter medications often view herbal and botanical products as a safe and natural alternative. However, very few randomized, clinical trials have examined the safety and efficacy of alternative therapies during pregnancy (64). One clinical trial that examined ginger during pregnancy reported reduction in the symptoms of hyperemesis with treatment and no adverse effects (65). However, some question remains about the absolute safety of ginger during pregnancy due to its effects on thromboxane synthetase, which could increase bleeding (66). Many other common remedies for nausea and vomiting, such as red raspberry, wild yam, and homeopathic treatments, have not been formally studied. Unfortunately, the lay literature and even some midwifery journals contain misguided information regarding many herbal products (17). Pregnant women should be advised to consider herbal treatments as suspect until their safety during pregnancy can be ascertained. The American Academy of Pediatrics recommends that pregnant women should limit the consumption of herbal teas (67). They recommend choosing herbal teas in filtered tea bags and limiting consumption to two 8-oz servings per day. Figure 3 contains a list of herbal and botanical supplements that may not be safe for use during pregnancy or lactation. To keep abreast of new information and adverse reactions related to herbal and botanical supplements, health professionals may want to consult a governmental Web site, <http://vm.cfsan.fda.gov/~dms/>

aems.html, or other useful Web sites referenced in the American Dietetic Association position paper on food fortification and dietary supplements (23).

Food additives and ingredients

Use of sweeteners that are classified as Generally Recognized as Safe (GRAS) is acceptable during pregnancy (68). Because saccharin crosses the placenta and may remain in fetal tissues, pregnant women should moderate their intake of this sweetener. Safety of acesulfame-K during pregnancy has been determined from animal studies. Aspartame intake within Food and Drug Administration guidelines also appears safe during pregnancy, although women with PKU should exercise caution with this sweetener because they need to monitor their intake of phenylalanine closely.

Some question remains about the safety of consuming large amounts of foods high in nitrite, nitrates, or nitrosamines, such as cured meats. A case-control study did not find an increased risk of brain tumors in children associated with maternal consumption of nitrites, nitrates, or nitrosamine during pregnancy (69). However, a few epidemiological studies have suggested prenatal and neonatal exposure to nitrosamine may be associated with b-cell destruction and increased incidence of type 1 diabetes in the child, but more studies are needed (70). Until more research is available, pregnant women may continue to consume moderate amounts of cured meats and other foods rich in nitrosamines. Prenatal use of another common additive, monosodium glutamate, is not thought to pose a risk to mother or child (71).

Alcohol

Women who are or may become pregnant should not drink alcoholic beverages at all (30,72). A safe level of alcohol intake has not been established at any stage during pregnancy. Nevertheless, about 15% of pregnant women consume alcohol, and 2% consume alcohol frequently (73). Heavy drinking during pregnancy increases the risk of mental retardation, learning disabilities, and major birth defects, such as those included in fetal alcohol syndrome (74). Moderate alcohol intake, defined as no more than one drink per day for women, has been linked to impaired fetal growth and lower Apgar scores (75) and may reduce fertility in women (76).

Caffeine

Caffeine can readily cross the placenta and can affect fetal heart rate and breathing (77). A meta-analysis of 12 studies found an increased risk of spontaneous abortion and low birth weight in pregnant women who consumed more than 150 mg/day of caffeine, but the effects of smoking and alcohol on these outcomes could not be determined (78). In another study, women who consumed only decaffeinated coffee were not at higher risk of delivering preterm or low birth weight infants, compared to women who drank neither decaffeinated nor caffeinated coffee (79). Some evidence suggests that high levels of caffeine intake (above 500 mg/day) may also delay conception (80). Studies are conflicting as to whether caffeine intake during pregnancy increases the risk of sudden infant death syndrome (81,82). No studies in humans have found a link between caffeine consumption during pregnancy and birth defects, but massive doses in mice are teratogenic (83). Since adverse effects on pregnancy outcomes have been linked to high caffeine intakes, prudent advice would be to discourage caffeine intakes above 300 mg/day. To translate that level into

■ Agnus castus	■ Cola	■ Horsetail	■ Pulsatilla
■ Aloes	■ Coltsfoot	■ Horseradish	■ Queen's Delight
■ Angelica	■ Comfrey	■ Hydorcotyle	■ Ragwort
■ Apricot Kernal	■ Cottonroot	■ Jamaica Dogwood	■ Raspberry
■ Asafoetida	■ Cornsilk	■ Juniper	■ Red Clover
■ Aristolochia	■ Crotalaria	■ Liferoot	■ Rhubarb
■ Avens	■ Damiana	■ Licorice	■ Rue
■ Blue Flag	■ Devil's Claw	■ Lobelia	■ Sassafras
■ Bogbean	■ Dong Quai	■ Mandrake	■ Scullcap
■ Boldo	■ Dogbane	■ Mate	■ Senna
■ Boneset	■ Ephedra	■ Male Fern	■ Shepherd's Purse
■ Borage	■ Eucalyptus	■ Meadow-sweet	■ Skunk Cabbage
■ Broom	■ Eupatorium	■ Mellilot	■ Stephania
■ Buchu	■ Euphorbia	■ Mistletoe	■ Squill
■ Buckthorn	■ Fenugreek	■ Motherwort	■ St. John's Wort
■ Burdock	■ Feverfew	■ Myrrh	■ Tansy
■ Calamus	■ Foxglove	■ Nettle	■ Tonka Bean
■ Calendula	■ Frangula	■ Osha	■ Uva-Ursi
■ Cascara	■ Fucus	■ Passion-flower	■ Vervain
■ German Chamomile	■ Gentian	■ Pennyroyal	■ Wild Carrot
■ Roman Chamomile	■ Germander	■ Petasites	■ Willow
■ Chaparral	■ Ginseng	■ Plantain	■ Wormwood
■ Black Cohosh	■ Golden Seal	■ Pleurisy Root	■ Yarrow
■ Blue Cohosh	■ Ground ivy	■ Podophyllum	■ Yellow Dock
	■ Grounseil	■ Pokeroor	■ Yohimbe
	■ Guarana	■ Poplar	
	■ Hawthorne	■ Prickly Ash	
	■ Heliotropium		
	■ Hops		
	■ Horehound		

Figure 3: Herbal and botanical supplements that may not be safe for use during pregnancy (18)

servings, the amount of caffeine is about 85 mg/5 oz cup of percolated coffee, 60 mg/5 oz cup of instant coffee, 40 mg/ 1 oz espresso; 30 mg/5 oz cup of leaf/bag tea, and 36 mg/12 oz cola beverage (84).

Smoking

Carbon monoxide and nicotine from smoking increase fetal carboxyhemoglobin and reduce placental blood flow, both of which limit oxygen supplied to the fetus. Smoking during pregnancy reduces birth weight by an average of 200 g and may increase risk of preterm delivery and perinatal mortality (1,85,86). Moreover, the negative effect of smoking on fetal growth cannot be mitigated by increasing energy intake alone (87). Passive exposure to tobacco smoke may also reduce infant growth (88). Smoking during pregnancy is also associated with other adverse long-term outcomes, including mental retardation, as well as nicotine addiction in the fetus (89). Since smoking can limit fetal growth even among women who quit smoking early during their pregnancies, advice and support related to smoking cessation should target women before conception (90).

Illegal drugs

It is especially important that marijuana, cocaine, and other illegal drugs be avoided during pregnancy. Isolating the effects of specific substances is often difficult, because women who use illegal drugs may use multiple drugs, smoke, and drink alcoholic or caffeinated beverages. Like tobacco smoking, marijuana smoking interferes with the supply of oxygen to the fetus and may impair growth (1). Although findings are inconsistent and more research is needed, marijuana use during pregnancy has been linked to lower birth weight (91)

and neurobehavioral effects (attention deficits/impulsivity) in children (92,93). The vasoconstrictive ability of cocaine may also lead to fetal hypoxia and reduce supply of nutrients to the fetus (1). Cocaine, like amphetamines, acts as an appetite suppressant, so that impaired fetal growth may also be due to inadequate maternal dietary intake. Prenatal use of cocaine has been linked to premature rupture of the membranes, premature labor, intrauterine growth retardation, and spontaneous abortion (1, 94). Infant effects of cocaine exposure may include withdrawal, cerebral infarction, and possibly, congenital effects (1). Prenatal cocaine use is also associated with lower scores on neurological development tests in infants (95, 96) and attention deficits in children (97). Because pregnant woman may be reluctant to admit current use of illegal substances, a history of substance abuse in the woman and possibly her partner could indicate a need for further assessment and follow-up (98).

Common Complaints during Pregnancy and Specific Health Conditions

Nausea and vomiting

Nausea and vomiting or "morning sickness" is one of the most common complaints among pregnant women. In a prospective study of 160 women, 80% of the women with morning sickness experienced this malady all day long, and 50% continued to report symptoms well beyond the first trimester (99). Claims in the popular press that morning sickness protects the fetus by decreasing maternal intake of "harmful," strong-flavored vegetables, have not been substantiated in prospective studies (100).

Management of nausea and vomiting during pregnancy depends on the severity of the symptoms. Milder cases can often be treated by consuming small meals frequently, avoiding offensive odors, drinking enough fluids, and getting fresh air (101). Some pregnant women tolerate foods high in carbohydrate such as crackers better than high-protein or high-fat foods. However, women should learn by experience which foods ease their nausea and consume those foods to avoid an empty stomach. Hyperemesis gravidarum, or severe nausea and vomiting persisting beyond 14 weeks of gestation, is a high-risk condition usually requiring hospitalization, antiemetic medications, rehydration, correction of electrolyte or metabolic disturbances, and nutritional support (102).

Heartburn

During pregnancy, heartburn may occur as a result of the hormonal changes that slow the movement of food through the digestive tract (101). One or more of the following recommendations may ease heartburn in pregnancy: avoid lying down immediately after eating; sleep with the head slightly elevated to avoid acid reflux; consume small, frequent meals; and avoid known irritants, such as caffeine, chocolate, or highly seasoned foods.

Constipation

Infrequent or hard, dry stools may occur either as a side effect of high doses of supplemental iron or as part of the normal digestive changes during pregnancy (101). To alleviate symptoms, pregnant women may be advised to include high-fiber foods in their diet, increase fluid intake,

and if possible, get regular physical activity.

Food cravings, aversions, and pica

Food cravings and aversions are very common during pregnancy (103,104). Some of the most commonly craved items are chocolate, citrus fruits, pickles, chips, and ice cream. The most common aversions are to coffee, tea, fried or fatty foods, highly spiced foods, meat, and eggs. Food cravings may be related to increased energy intakes, and aversions, to reduced intakes (103).

"Pica" generally refers to the compulsive intake of nonfood substances over a sustained period of time (105,106,107). "Geophagia" specifically refers to compulsive eating of clay or dirt. Other substances that may be consumed include ice or freezer frost (pagophagia), laundry starch, soap, ashes, chalk, paint, or burnt matches. However, abnormal craving for and intake of some food items, such as cornstarch or baking soda, are also considered examples of pica. Pregnant women who practice pica may be, as a result, exposed to lead or other environmental toxicants. Pica has also been associated with reduced serum ferritin and hemoglobin values in the mother and smaller head circumference in the infant (107). Pica is more common in African American women and in those with a family or childhood history of this condition (105,106). In counseling pregnant women, health professionals should be alert to abnormal cravings for and intakes of nonfood and food items and screen for nutritional deficiencies. Health professionals may also need to assess exposure level to toxic substances in these women.

Diabetes

With diabetes on the rise in the general population, more women are expected to enter pregnancy with preexisting diabetes or to develop diabetes during pregnancy. Preexisting diabetes (type 1 or 2) is associated with increased risk of congenital abnormalities, miscarriage, and neonatal death (108). Gestational diabetes (GDM) appears in the latter half (after 24 weeks) of about 7% of all pregnancies. GDM increases the risk of macrosomia and consequently, difficult labor, infant shoulder dystocia (dislocation), and cesarean delivery (109). Infants of mothers with poorly controlled diabetes have severely depleted stores of iron in the liver (6.6% of normal) and other organs (110). A possible mechanism is that elevated levels of insulin and glucose in the fetus may increase cellular oxygen consumption and erythropoiesis, which places demand on storage iron in the fetus. At long-term follow-up, children of women with maternal diabetes show elevated blood pressure and body mass index in childhood (111,112). However, better control and/or milder forms of gestational diabetes are not associated with an increase in the risk of childhood obesity (112,113). Since women with borderline high blood glucose levels are also at risk of delivering infants large for gestational age, more research on appropriate intervention for this population is needed (6).

Guidelines for managing diabetes during pregnancy have been published by the American Diabetes Association (108, 114). For women with preexisting diabetes, achieving good blood glucose control before conception is important. To reduce the risks to mother and infant, achieving levels of hemoglobin A1c less than 1% above normal range is desirable. In addition to their usual prenatal care, pregnant women with diabetes should continue to monitor their diet and blood glucose levels and meet with a qualified dietetics professional to develop an individualized diet plan. In obese women (BMI

> 30), appropriate caloric intake (25 kcal/kg body weight) and restriction of carbohydrate to 35% to 40% of calories is recommended. Gestational diabetes can often be controlled through medical nutrition therapy and moderate exercise, but insulin is recommended in women who do not improve glycemic control through lifestyle changes alone. Oral glucose-lowering agents are generally not recommended during pregnancy.

Pregnancy-induced hypertension

About 8% to 10% of pregnant primiparous women develop pregnancy-induced hypertension (PIH) (115). In more severe forms of PIH (preeclampsia and eclampsia or toxemia), proteinuria, convulsions, and coma may occur. Chronic hypertension or a history of preeclampsia in a previous pregnancy increase the risk of this syndrome in the current pregnancy (116). Other risk factors include nulliparity, younger (< 20 years) or older (> 40 years) maternal age, obesity, change of partners, and genetic factors. Preeclampsia and eclampsia are associated with preterm delivery, intrauterine growth restriction, neonatal death, and maternal morbidity and mortality (115, 116). However, even among women without preeclampsia, a steady increase in blood pressure from early to late gestation has been associated with low birth weight (117). These findings support the premise that pregnancy-induced hypertension affects fetal growth by decreasing uterine blood flow and supply of nutrients. Although still debated, one theory about the development of toxemia proposes that as the placenta becomes more compromised, it releases factors, possibly free radicals that result in damage to the mother's vascular tissues (118).

No specific therapy has been proven effective in preventing or delaying preeclampsia and improving pregnancy outcomes. A meta-analysis of 17 randomized controlled trials concluded that calcium supplements (1-2 g/day) reduce blood pressure and risk of preeclampsia but had no significant effect on reducing maternal and infant morbidity and mortality (119). Calcium supplementation may only be beneficial where calcium intakes are very low. Another study, testing the premise that oxidative stress is involved, found that supplements of vitamin C (1,000 mg/day) and vitamin E (400 IU/day²) reduced risk of preeclampsia without significant improvement in gestational age or birth weight (118). Other dietary modifications, including sodium restriction, magnesium supplements, zinc supplements, and consumption of fatty fish oils have not been proven effective (115,121).

HIV and AIDS

Pregnancy does not appear to have an adverse effect on the natural history of human immunodeficiency virus (HIV), despite a suppression of immune function that is naturally associated with pregnancy (122). In the United States and elsewhere, pregnancy has little effect on viral loads or progression of HIV. In developed countries, the specific effects of HIV on pregnancy outcomes are difficult to separate from those related to substance abuse and inadequate prenatal care.

A major concern during pregnancy is transmission of HIV from mother to child, which ranges from 15% to 40% in the absence of antiretroviral treatment (122). In the United States

and other more developed countries, administration of zidovudine during pregnancy, labor, and the early postpartum period has reduced the rates of transmission to as low as 4% to 6% (123). Most of the transmission is thought to occur in late pregnancy and during labor. In addition to viral and obstetric factors, maternal factors are associated with increased risk of transmission (122). Drug use, smoking, sexual practice, maternal immune status, and poor nutrition may all play a role in viral transmission. Low maternal serum levels of vitamin A have been correlated with transmission in Africa; a possible role for vitamin A in the United States is less clear. Other nutrients that may be involved include zinc and selenium, but more research is needed. In the postpartum period, breastfeeding increases the risk of transmission (123). Dietetics professionals may refer to the American Dietetic Association position paper for more information on nutritional assessment and follow-up of patients with HIV/AIDS (124).

Avoidance of Food-Borne Illness During Pregnancy

Pregnant women are at high-risk for food-borne illness (30, 125). Among the most common causes of diarrhea during pregnancy are several food- or water-borne pathogens (bacteria, protozoa, or viruses), including *Salmonella* species, *Helicobacter pylori*, *Shigella*, *Escherichia coli* (E. coli O157:H7), and *Cryptosporidium* (126). Hepatitis A is also a food- or water-borne pathogen of concern. During pregnancy, listeriosis, caused by *Listeria monocytogenes*, can result in premature delivery, stillbirth or infection in the newborn (127). *Toxoplasma gondii* is a protozoan that can be passed from the mother to the fetus and result in infant death or mental retardation (128).

In accordance with the Dietary Guidelines, pregnant women should not consume unpasteurized juices, raw sprouts, or raw (unpasteurized) milk products (30). Pregnant women should also avoid raw or undercooked meat, poultry, eggs, fish, or shellfish. To reduce the risk of listeriosis, pregnant women should cook leftovers and ready-to-eat foods (eg, hot dogs) until steaming hot and avoid soft Mexican cheeses; homemade cheese or cheese purchased from street vendors; and other soft cheeses, such as Brie, feta, blue, and Camembert (125,127). Although the risk of listeriosis associated with delicatessen foods is low, pregnant women may choose to avoid or thoroughly reheat cold cuts before eating these foods. In addition to handling food safely, pregnant women should take care to wash hands thoroughly after handling cat feces (ie, via cat boxes) to avoid *Toxoplasma* (128).

The Food and Drug Administration has also advised pregnant women to avoid consuming large fish, including shark, swordfish, king mackerel, and tilefish, because these fish may accumulate unsafe levels of methylmercury (129). A moderate amount (12 ounces or less per week) of other fish is probably safe during pregnancy, but women should contact their state or local health departments to find out if there are special advisories regarding methylmercury and other contaminants, such as polychlorinated biphenyls, in fish caught or sold in their local area.

Encouragement to Breastfeed

Dietetics professionals in prenatal practice have the responsibility to educate women about the benefits of breastfeeding before a decision about feeding method is reached (130). Particularly in prenatal settings, educational materials about infant feeding should unequivocally support breastfeeding as

² 0.74 mg *d*- α -tocopheryl acetate or 0.67 mg *d*- α -tocopherol from natural source equivalent to 1 IU or 1 USP. RDA for pregnant women is 15 mg α -tocopherol; Upper limit during pregnancy is 800 mg any form of supplementary α -tocopherol for 14 to 18 years and 1,000 mg for 19 years and older (120).

the optimal choice (131).

Nutritional Advice to the Postpartum Woman

In addition to encouraging breastfeeding, qualified dietetics professionals should provide advice to the postpartum woman to replenish nutritional stores, prevent problems in subsequent pregnancies, and reduce risk of chronic diseases later in life (30,132). During postpartum, women can be encouraged to maintain certain lifestyle changes adopted during their pregnancies, such as smoking cessation and increased consumption of whole grains, fruits and vegetables. Adequate folate intake may reduce risk of coronary heart disease, as well as prevent birth defects in a subsequent pregnancy (132). Postpartum women may need guidance to return to or improve their pre-pregnant weight (133). Although symptoms of gestational diabetes (GDM) disappear after delivery, women who have had GDM, especially those who continue to have impaired glucose tolerance in the postpartum period, are at high risk of developing type 2 diabetes later in life and should be targeted for intensive counseling on risk reduction (114).

Referrals to Professional and Community Services

Referrals should be made to qualified dietetics professionals and community-based programs. Women with poor weight gain, hyperemesis, poor dietary patterns (eg, avoidance of certain food groups), PKU, health problems (eg, diabetes, hypertension, other chronic disease), or a history of substance abuse should be referred to a qualified dietetics professional for medical nutritional therapy. Poverty is a major factor in poor pregnancy outcomes and poses substantial barriers to achieving recommended intakes and weight gains. Low-income pregnant women may benefit from a variety of community programs, including the federal Special Supplemental Nutrition Program for Women, Infants and Children; the Commodity Supplemental Food Program; the Food Stamp Program; the Food Stamp Nutrition Education Program; the Expanded Food and Nutrition Education Program; and the National School Lunch and Breakfast Programs. The latter two programs are especially important for pregnant teenagers. Other appropriate community services may include family service centers, teen pregnancy programs, and minority youth programs.

ROLES AND RESPONSIBILITIES OF DIETETICS PROFESSIONALS

Dietetics professionals should coordinate their efforts with schools, health providers, and other agencies to educate adolescents and women in their childbearing years about the need for good nutritional status before conception. Pregnancy provides a window of opportunity to educate women about the benefits of a good diet and a healthy lifestyle (15). Dietetics professionals should use this opportunity to encourage women to make behavior changes that improve immediate pregnancy outcomes and reduce the risk of future chronic disease in both the mother and her child. Where possible, dietetics professionals should contribute to research efforts that close gaps in our knowledge related to best interventions for optimal pregnancy outcomes.

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