CHAPTER 10

Nutrition during Pregnancy and Lactation

KEY CONCEPTS

- The mother's food habits and nutritional status before conception—as well as during pregnancy—influence the outcome of her pregnancy.
- Pregnancy is a prime example of physiologic synergism in which the mother, the fetus, and the placenta collaborate to sustain and nurture new life.
- Through the food that a pregnant woman eats, she gives her unborn child the nourishment that is required to begin and support fetal growth and development.
- Through her diet, a breast-feeding mother continues to provide all of her nursing baby's nutrition needs.

Healthy body tissues depend directly on the essential nutrients in food. This is especially true during pregnancy, because a whole new body is being formed. The tremendous growth of a baby from the moment of conception to the time of birth depends entirely on nourishment from the mother. The complex process of rapid human growth and lactation demands a significant increase in nutrients from the mother's diet.

This chapter explores the nutrition needs of pregnancy and the lactation period that follows and recognizes the vital role that each plays to produce a healthy infant.

NUTRITIONAL DEMANDS OF PREGNANCY

Years ago, traditional practices and diet during pregnancy were highly restrictive in nature. They were built on assumptions and folklore of the past, and they had little or no basis in scientific fact. Early obstetricians even supported the notion that semistarvation of the mother during pregnancy was a blessing in disguise, because it produced a small, lightweight baby who was easy to deliver. To this end, physicians recommended a diet that was restricted in kilocalories, protein, water, and salt for pregnant women.

Developments in both nutrition and medical science have refuted these ideas and laid a sound base for positive nutrition in current maternal care. It is now known that the mother's and child's health depend on the pregnant woman eating a well-balanced diet with

increased amounts of essential nutrients. In fact, women who have always eaten a well-balanced diet are in a good state of nutrition at conception, even before they know that they are pregnant. Such women have a better chance of having a healthy baby and remaining in good health compared with women who have been undernourished.

The nine months between conception and the birth of a fully formed baby is a spectacular period of rapid growth and intricate functional development. Such activities require increased energy and nutrient support to produce a positive, healthy outcome. General guidelines for these increases are provided in the comprehensive Dietary Reference Intakes (DRIs) issued by the National Academy of Sciences.[1-6]

The DRIs are based on the general needs of healthy populations. Some women (e.g., those who are poorly nourished when becoming pregnant or those with additional risks) require more nutrition support. The *Dietary Guidelines for Americans* also outline specific recommendations for pregnant and lactating women (Box 10-1).[7] This chapter reviews the basic nutrition needs for the positive support of a normal pregnancy, with emphasis placed on critical energy and protein requirements as well as on key vitamin and mineral needs.

BOX 10-1 *DIETARY GUIDELINES FOR AMERICANS, 2010*, FOR SPECIFIC POPULATIONS REGARDING PREGNANCY AND LACTATION

General Recommendations

- Maintain an appropriate calorie balance during each stage of life, including childhood, adolescence, adulthood, pregnancy and breast-feeding, and older age.

For Women Who Are Capable of Becoming Pregnant

- Choose foods that supply heme iron, which is more readily absorbed by the body; additional iron sources; and enhancers of iron absorption, such as vitamin C-rich foods.
- Consume 400 micrograms per day of synthetic folic acid from fortified foods or supplements in addition to food forms of folate from a varied diet.

For Women Who Are Pregnant or Breast-Feeding

- Consume 8 to 12 ounces of seafood per week from a variety of seafood types.
- Because of their high methyl mercury content, limit white (albacore) tuna to 6 ounces per week and do not eat the following four types of fish: tilefish, shark, swordfish, and king mackerel.
- If pregnant, take an iron supplement as recommended by an obstetrician or another health care provider.

From the U.S. Department of Agriculture, U.S. Department of Health and Human Services. *Dietary guidelines for Americans, 2010.* Washington, DC: U.S. Government Printing Office; 2009.

Energy Needs

Reasons for Increased Need

During pregnancy, the mother needs more energy in the form of kilocalories for two important reasons: (1) to supply the increased fuel demanded by the metabolic workload for both the mother and the fetus; and (2) to spare protein for the added tissue-building requirements. For these reasons, the mother must include more nutrient-dense food in her diet.

Amount of Energy Increase

The national standard recommends an increase of 340 kcal/day during the second trimester of pregnancy and of approximately 450 kcal/day during the third trimester.[5] This brings the total kilocalorie recommendation to about 2200 to 2800 kcal/day for most women starting with the second trimester of pregnancy, which is an increase of about 15% to 20% over the energy needs of nonpregnant women. Active, large, or nutritionally deficient women may require even more energy. The emphasis always should be on adequate kilocalories to secure the nutrient and energy needs of a rapidly growing fetus. Sufficient weight gain is vital to a successful pregnancy; however, excess weight gain can pose risks and should be avoided. Increased complex carbohydrates, monounsaturated, and polyunsaturated fats, and protein in the diet are the preferred sources of energy, especially during late pregnancy and lactation.

Protein Needs

Reasons for Increased Need

Protein serves as the building blocks for the tremendous growth of body tissues during pregnancy, as follows:

- *Development of the placenta.* The placenta is the fetus's lifeline to the mother. The mature placenta requires sufficient protein for its complete development as a vital and unique organ to sustain, support, and nourish the fetus during growth.
- *Rapid growth of the fetus.* The mere increase in size of the fetus from one cell to millions of cells in a 3.2-kg (7-lb) infant in only 9 months indicates the relatively large amount of protein that is required for such rapid growth.
- *Growth of maternal tissues.* To support pregnancy and lactation, the increased development of uterine and breast tissue is required.

- *Increased maternal blood volume.* The mother's plasma volume increases by 40% to 50% during pregnancy. More circulating blood is necessary to nourish the fetus and to support the increased metabolic workload. However, with extra blood volume comes a need for the increased synthesis of blood components, especially **hemoglobin** and plasma protein, which are proteins that are vital to pregnancy. An increase in hemoglobin helps to supply oxygen to the growing number of cells. Meanwhile, **plasma protein** (albumin) production increases to regulate blood volume through osmotic pressure. Adequate albumin prevents an abnormal accumulation of water in tissues beyond the normal edema of pregnancy.
- *Amniotic fluid.* Amniotic fluid, which contains various proteins, surrounds the fetus during growth and guards it against shock or injury.
- *Storage reserves.* Increased storage reserves of tissue are needed in the mother's body to prepare for the large amount of energy that is required during labor, delivery, the immediate postpartum period, and lactation.

Amount of Protein Increase

Protein intake during pregnancy should increase by 25 g/day above nonpregnancy needs.[5] This increase is approximately 50% more than the average woman's protein requirement. However, high-risk or active pregnant women may require even more protein.

Food Sources

The only complete protein foods of high biologic value are eggs, milk, cheese, soy products, and meat (e.g., beef, poultry, fish, pork). Certain other incomplete proteins from plant sources such as legumes and grains contribute additional secondary amounts. Protein-rich foods also contribute other nutrients, such as calcium, iron, and B-complex vitamins. The amount of food from each food group that supplies the needed nutrients is indicated in the sample food plan given in Table 10-1 (see Chapter 4 for a discussion of dietary sources of protein and protein quality).

Key Mineral and Vitamin Needs

Increases in several minerals and vitamins are needed during pregnancy to meet the greater structural and metabolic requirements. These increases are indicated in the DRI tables that are inside this text's front cover. Because a growing fetus cannot be protected from the poor diet of the mother, special attention to the nutrients that pose a specific risk for deficiency is warranted.

Minerals

Calcium. A good supply of calcium—along with phosphorus, magnesium, and vitamin D—is essential for the fetal development of bones and teeth as well as for the mother's own body needs. Calcium is also necessary for blood clotting. A diet that includes at least 3 cups of milk or milk substitute daily plus dairy or dairy substitute products (e.g., calcium-fortified soy products) and generous amounts of green vegetables and enriched or whole grains usually supplies enough calcium. During pregnancy, physiologic changes occur in the mother's absorption capacity to help meet the needs of some nutrients; for example, calcium and zinc are both more bioavailable during pregnancy. The body's enhanced capability to absorb and retain these nutrients from the diet during pregnancy helps the mother to meet her nutrient needs as well as those of the growing fetus. Calcium supplements may be indicated for cases of poor maternal intake or pregnancies that involve more than one fetus. Because food sources of the two major minerals (i.e., calcium and phosphorus) are almost the same, a diet that is sufficient in calcium also provides enough phosphorus.

Iron. Particular attention is given to iron intake during pregnancy. Iron is essential for the increased hemoglobin synthesis that is required for the greater maternal blood volume as well as for the baby's necessary prenatal storage of iron. Iron deficiency anemia affects about 30% of low-income pregnant women and increases the risk of preterm delivery and low birth weight infants.[8] Because iron occurs in small amounts in food sources and because much of this intake is not in a readily absorbable form, the maternal diet alone rarely meets requirements, despite increased absorptive capacity during pregnancy. The current standards recommend a daily iron intake of 27 mg/day, which is significantly more than a woman's nonpregnant need of 18 mg/day.[4] Consuming foods that

hemoglobin a conjugated protein in red blood cells that is composed of a compact, rounded mass of polypeptide chains that forms globin (the protein portion) and that is attached to an iron-containing red pigment called *heme;* hemoglobin carries oxygen in the blood to cells.

plasma protein any of a number of protein substances that are carried in the circulating blood; a major one is *albumin,* which maintains the fluid volume of the blood through colloidal osmotic pressure.

TABLE 10-1 DAILY FOOD PLAN FOR PREGNANT WOMEN

This particular food plan is based on the average needs of a pregnant woman who is 30 years old, who is 5 feet and 5 inches tall, who weighs 125 pounds before pregnancy, and who is physically active between 30 and 60 minutes each day. Plans provided by the MyPlate.gov site are specific to each individual woman; however, this is an example for a woman of the described stature and activity level.

	First Trimester	Second Trimester	Third Trimester
	2200 kcal	2400 kcal	2600 kcal
Grains[1]	7 ounces	8 ounces	9 ounces
Vegetables[2]	3 cups	3 cups	3½ cups
Fruits	2 cups	2 cups	2 cups
Milk	3 cups	3 cups	3 cups
Meat & Beans	6 ounces	6½ ounces	6½ ounces
Make half of your grains whole.			
Aim for at least this amount of whole grains per day.	3½ ounces	4 ounces	4½ ounces
Vary your veggies.			
		Aim for this much weekly	
Dark green vegetables	3 cups	3 cups	3 cups
Orange vegetables	2 cups	2 cups	2½ cups
Dry beans and peas	3 cups	3 cups	3½ cups
Starchy vegetables	6 cups	6 cups	7 cups
Other vegetables	7 cups	7 cups	8½ cups
Oils and Discretionary Calories			
Aim for this amount of oils per day.	6 teaspoons	7 teaspoons	8 teaspoons
Limit extras (extra fats and sugars) to this amount per day.	290 calories	360 calories	410 calories

These plans are based on 2200-, 2400-, and 2600-calorie food-intake patterns. The recommended nutrient intake increases throughout the pregnancy to meet changing nutritional needs.
From the U.S. Department of Agriculture, Center for Nutrition Policy and Promotion. *USDA's MyPlate home page* (website): www.choosemyplate.gov. Accessed August 23, 2011.

are high in vitamin C along with dietary sources of iron enhances the body's ability to absorb and use iron with a low bioavailability. In addition, avoiding foods that inhibit iron absorption (e.g., whole-grain cereals, unleavened whole-grain breads, legumes, tea, coffee) within meals that provide significant iron is recommended.

Because the increased pregnancy requirement is difficult to meet with the iron content of a typical American diet, daily iron supplements are often recommended. As with most supplemental forms of nutrients, bioavailability is suboptimal compared with food sources; thus, the encouragement of a balanced diet with ample iron is preferable (see Table 8-6 for a list of foods that are high in iron). Although there is limited research available regarding dietary supplement use in pregnant women, one report noted that adherence to iron supplementation is correlated with ethnicity and socioeconomic status.[9] Thus, additional encouragement and education for African-American, Mexican-American, and low-income women to continue taking appropriate iron supplements during pregnancy may benefit both the mother and the fetus.

Many women believe that iron supplements will result in unpleasant gastrointestinal side effects. Historically, iron supplements given to pregnant women were in excessively high doses (e.g., 100 to 200 mg/day), in which cases some negative side effects were experienced. However, studies show that iron supplements that are taken between meals or at bedtime in doses of 20 to 80 mg/day are adequate to prevent iron-deficiency anemia with no clinical gastrointestinal side effects.[10]

Vitamins

Increased attention to most all vitamins is needed to support a healthy pregnancy. Vitamins A and C are needed in higher amounts during pregnancy, because they are both important elements in tissue growth. The need for B vitamins is increased because of the vital role of these vitamins as coenzyme factors for energy production and protein metabolism.

Folate

Folate builds mature red blood cells throughout pregnancy, and it is also particularly needed during the early periconceptional period (i.e., from approximately 2 months before conception to week 6 of gestation) to ensure healthy embryonic tissue development and to prevent the malformation of the neural tube. The neural tube forms during the critical period from 17 to 30 days' gestation, and it grows into the mature infant's spinal column and its network of nerves. Although the exact mechanism by which folate helps thwart neural tube defects (NTDs) is unknown, it is estimated that 46% to 70% of NTD cases could be prevented with adequate folate supplementation during and immediately before pregnancy.[11,12] **Spina bifida** and **anencephaly** are the two most common forms of NTDs, which are defined as any malformation of the embryonic brain or spinal cord. The Centers for Disease Control and Prevention estimates that, before the national fortification of grains with folic acid, there was an annual average of 4130 NTD-affected pregnancies in the United States. Following the 1998 federally mandated food fortification, the national average of NTD-affected pregnancies has declined by 27%.[13]

Spina bifida occurs when the lower end of the neural tube fails to close (see Figure 7-6). As a result, the spinal cord and backbone do not develop properly. The severity of spina bifida varies in accordance with the size and location of the opening in the spine. Disability ranges from mild to severe, with limited movement and function. Anencephaly occurs when the upper end of the neural tube fails to close. In this case, the brain fails to develop or is entirely absent. Pregnancies that are affected by anencephaly end in miscarriages or death soon after delivery.

The current DRIs recommend a daily folate intake of 600 mcg/day during pregnancy and of 400 mcg/day for nonpregnant women during their childbearing years.[2] Women who are unable to achieve such dietary recommendations by eating foods that are fortified with folate may do so with a dietary supplement. All enriched flour and grain products as well as fortified cereals contain a well-absorbed form of dietary folic acid. Other natural sources of folate include liver; dark green leafy vegetables; legumes (e.g., pinto beans, black beans, kidney beans); soybeans; wheat germ; orange juice; asparagus; and broccoli.

Vitamin D

As was mentioned in Chapter 7, vitamin D deficiency is a common worldwide problem, including among pregnant women. Vitamin D deficiency during pregnancy is linked with many adverse outcomes for both the mother and the fetus, including preeclampsia, gestational diabetes, and impaired growth of the fetus.[14-16] Increased vitamin D needs to ensure the absorption and use of calcium and phosphorus for fetal bone growth can be met by the mother's intake of at least 3 cups of fortified milk (or milk substitute) in her daily food plan. Fortified milk contains 10 mcg (400 IU) of cholecalciferol (i.e., vitamin D) per quart, which is twice the Adequate Intake amount. The mother's exposure to sunlight increases her endogenous synthesis of vitamin D as well. Lactose-intolerant women or vegetarians can obtain adequate vitamin D from fortified soymilk or rice milk products.

Registered dietitians are an excellent resource for pregnant women who need help planning a well-accepted balanced diet. DRI tables that are inside this text's front cover list all nutrient recommendations for pregnant and lactating women. Many important nutrients are needed in higher quantities during pregnancy; only the ones that pose a significant risk for deficiency have been discussed here.

Weight Gain during Pregnancy

Amount and Quality

The mother's optimal weight gain during pregnancy, which should be sufficient to support and nurture both herself and her fetus, is essential. Appropriate weight gain is a positive reflection of good nutritional status, and it contributes to a successful course and outcome of pregnancy. The average weight gained is approximately 29 lb (Table 10-2). The Institute of Medicine recommends setting weight gain goals together with the pregnant woman in accordance with her prepregnancy nutritional status and her body mass index (BMI), as follows[17]:

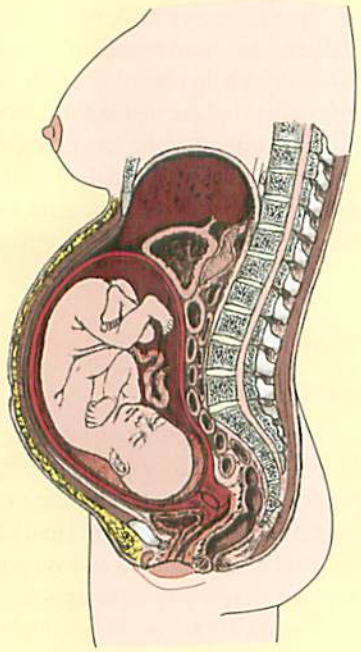
- Underweight women (BMI of ≤ 18.5 kg/m^2): 28 to 40 lb
- Normal-weight women (BMI of 18.5 to 24.9 kg/m^2): 25 to 35 lb
- Overweight women (BMI of 25 to 29.9 kg/m^2): 15 to 25 lb

spina bifida a congenital defect in the embryonic fetal closing of the neural tube to form a portion of the lower spine, which leaves the spine unclosed and the spinal cord open to various degrees of exposure and damage.

anencephaly the congenital absence of the brain that results from the incomplete closure of the upper end of the neural tube.

TABLE 10-2 APPROXIMATE WEIGHT GAIN DURING A NORMAL PREGNANCY

Product	Weight (lb)
Fetus	7.5
Placenta	1.5
Amniotic fluid	2
Uterus (weight increase)	2
Breast tissue (weight increase)	2
Blood volume (weight increase)	3
Maternal stores: fat, protein, water, and other nutrients	11
Total	29



9 Months

Full-term pregnant woman.

(Reprinted from Lowdermilk DL, Perry SE. *Maternity & women's health care.* 9th ed. St. Louis: Mosby; 2007.)

- Obese women (BMI of ≥ 30 kg/m^2): 11 to 20 lb
- Teenage girls: 35 to 40 lb (this is the upper end of the recommended range)
- Women who are carrying twins or triplets: 25 to 54 lb

Important considerations in each case are the quantity and quality of weight gain as well as the foods consumed to bring it about, which should involve a nourishing, well-balanced diet. Inappropriate weight gain (i.e., too much or too little) on the basis of the prepregnancy BMI is strongly associated with adverse pregnancy outcomes for both the mother and the infant (e.g., gestational hypertension; delivery complications, low or high birth weight).[18]

Severe caloric restriction during pregnancy is potentially harmful to the developing fetus and the mother. Such a restricted diet cannot supply all of the energy and nutrients that are essential to the growth process. Thus, weight reduction never should be undertaken during pregnancy. Special care for pregnant women who are suffering from eating disorders (e.g., anorexia nervosa, bulimia nervosa) is essential for the health of both the mother and the fetus.

Rate of Weight Gain

Approximately 1 to 2 kg (2 to 4 lb) is the average amount of weight gain that occurs during the first trimester (i.e., the first 3 months) of pregnancy. Thereafter, approximately 0.5 kg (1 lb) per week during the remainder of the pregnancy is typical, although there are exceptions. Only unusual patterns of gain (e.g., a sudden sharp increase in weight after the twentieth week of pregnancy, which may indicate abnormal water retention) must be watched. Alternatively, an insufficient or low maternal weight gain during the second or third trimester increases the risk for **intrauterine growth restriction (IUGR)**. One study found that maternal weight changes from the first to second trimester were strongly associated with fetal femur and tibia lengths and infant length at birth, thus indicating a sensitive period during gestation for linear growth.[19] Increased energy demand is normal during late pregnancy and helps to prepare for full infant growth needs and the mother's approaching delivery and lactation. As always, carbohydrates selected from enriched or whole-grain breads and cereals, fruits, vegetables, and legumes are the preferred energy sources.

Daily Food Plan

General Plan

Ideally, some form of a food plan will be established for the pregnant woman on an individual basis to meet her increased nutrition needs. Such a core plan (see Table 10-1) can serve as a guideline, with additional amounts of foods used as needed to meet her caloric needs. This core food plan is built on basic foods that are available in American markets and designed to supply necessary nutrient increases. Energy needs increase as the pregnancy progresses, and the recommended addition of 340 to 450 kcal/day applies to the second and third trimesters.[5] However, adolescent, underweight, or

intrauterine growth restriction (IUGR) a condition that occurs when a newborn baby weighs less than 10% of predicted fetal weight for gestational age.

malnourished women require special attention to be paid to increased energy needs from the onset of the pregnancy.

Alternative Food Patterns

The core food plan provided here may be only a starting point for women with alternate food patterns. Such food patterns may occur among women with different ethnic backgrounds, belief systems, and lifestyles, thereby making individual diet counseling important. Specific nutrients (not specific foods) are required for successful pregnancies, and these may be found in a variety of foods. Wise health care providers encourage pregnant women to use foods that serve both their personal and nutrition needs. Many resources have been developed to serve as guides for a variety of alternative food patterns (e.g., ethnic, vegetarian). If the mother's vegetarian pattern includes dairy products and eggs (i.e., if she is a lacto-ovo vegetarian), achieving a sound diet to meet pregnancy needs is not a problem. Strict vegans can meet their dietary protein needs through the use of soy foods (e.g., tofu, soy milk, soy yogurt, soybeans) and complementary proteins (see Chapter 4 for additional information and resources that address planning a vegetarian diet).

Specific counseling about avoiding alcohol, caffeine, tobacco, and recreational drug use during pregnancy is also important. Information about the direct effects of poor nutrition on the fetus—especially related to brain development and developmental delays—helps to motivate many pregnant women to choose a well-selected diet of optimal nutritional value.

Basic Principles

Whatever the food pattern, two important principles govern the prenatal diet: (1) pregnant women should eat a sufficient quantity of high-quality food; and (2) pregnant women should eat regular meals and snacks and avoid fasting and skipping meals, especially breakfast.

GENERAL CONCERNS

Functional Gastrointestinal Problems

Nausea and Vomiting

"Morning sickness" (which actually has nothing to with the morning and can happen at any time throughout the day) affects about 75% of women during early pregnancy; it can be distressing and disruptive. It is most likely caused by hormonal adaptations to human chorionic gonadotropin during the first trimester, and it generally peaks at about 9 weeks' gestation.[20] Although pregnant women often resort to alternative treatments (e.g., acupuncture) for the relief of symptoms, to date these methods do not appear to be effective for treating nausea and vomiting in this population.[21] Some studies show improvements in symptoms with the dietary supplementation of vitamin B_6 and ginger, although findings are not consistent.[21-23] The following actions may help with the relief of symptoms: (1) eating small frequent meals and snacks that are fairly dry and bland and that consist of high-protein foods; (2) consuming liquids between (rather than with) meals; and (3) avoiding odors, foods, or supplements that trigger nausea.[20]

If nausea and vomiting persist past the first trimester and become severe and prolonged, then the woman may have a condition called **hyperemesis gravidarum**, and medical treatment is required. Approximately 1% of pregnant women develop hyperemesis gravidarum, and women who have experienced this condition with their first pregnancy are at a much greater risk for recurrence during any additional pregnancies (15.2%).[24] Patients with hyperemesis gravidarum should be closely followed for hydration, electrolyte balance, and appropriate weight gain. Prescription antiemetic medication may benefit some women in this situation (see the Drug-Nutrient Interaction box, "Antiemetic Medications").

Constipation

Although it is usually a minor complaint, constipation may occur during the latter part of pregnancy as a result of the increasing pressure of the enlarging uterus and the muscle-relaxing effect of progesterone on the gastrointestinal tract, thereby reducing normal peristalsis. Helpful remedies include adequate exercise, increased fluid intake, and high-fiber foods such as whole grains, vegetables, dried fruits (especially prunes and figs), and other fruits and juices. Pregnant women should avoid artificial and herbal laxatives.

Hemorrhoids

Hemorrhoids are enlarged veins in the anus that often protrude through the anal sphincter, and they are not uncommon during the latter part of pregnancy. This vein enlargement is usually caused by the increased weight of the baby and the downward pressure that this weight produces. Hemorrhoids may cause considerable

hyperemesis gravidarum a condition that involves prolonged and severe vomiting in pregnant women, with a loss of more than 5% of body weight and the presence of ketonuria, electrolyte disturbances, and dehydration.

discomfort, burning, and itching; they may even rupture and bleed under the pressure of a bowel movement, thereby causing the mother more anxiety. Hemorrhoids are usually controlled by the dietary suggestions given for constipation. Sufficient rest during the latter part of the day may also help to relieve some of the downward pressure of the uterus on the lower intestine. Hemorrhoids resolve spontaneously after delivery in many women, in which case long-term treatment is not necessary.

Heartburn

Pregnant women sometimes have heartburn or a "full" feeling. These discomforts occur especially after meals, and they are caused by the pressure of the enlarging uterus crowding the stomach. The gastric reflux of food may occur in the lower esophagus, thereby causing irritation and a burning sensation. This common symptom has nothing to do with the heart, but it is called "heartburn" because of the close proximity of the lower esophagus to the heart. The full feeling comes from general gastric pressure, the lack of normal space in the area, a large meal, or the formation of gas. Dividing the day's food intake into a series of small meals and avoiding large meals at any time usually help to relieve these issues. Comfort is sometimes improved by the wearing of loose-fitting clothing.

High-Risk Mothers and Infants

Identifying Risk Factors

Pregnancy-related deaths claim the lives of 500 to 600 women in the United States annually.[25] Identifying risk factors and addressing them early are critical to the promotion of a healthy pregnancy. Nutrition-related risk

DRUG-NUTRIENT INTERACTION

ANTIEMETIC MEDICATIONS

Antiemetics are prescribed to control nausea in a number of situations, including migraine headaches, chemotherapy, and postoperative nausea. Occasionally excessive nausea and vomiting during early pregnancy (i.e., hyperemesis gravidarum) can compromise the nutritional status of both the mother and the fetus as a result of food aversions or inadequate nutrient intake. In severe cases, a physician may opt to prescribe an antiemetic medication.[1]

One of these medications, Reglan (metoclopramide), may also be prescribed during lactation to stimulate the secretion of prolactin and thus increase the milk supply. Some nutritional implications of taking antiemetics include dry mouth, diarrhea, abdominal pain, and constipation. Phenergan (promethazine), which is another antiemetic option, may increase the patient's need for riboflavin.[2]

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1. Flake ZA, Scalley RD, Bailey AG. Practical selection of antiemetics. *Am Fam Physician.* 2004;69(5):1169-1174.
2. Pronsky Z. *Food-medication interactions.* 15th ed. Birchrunville, Penn: Food-Medication Interactions; 2008.

CLINICAL APPLICATIONS

NUTRITIONAL RISK FACTORS DURING PREGNANCY

Risk Factors at the Onset of Pregnancy

- Age: 18 years old or younger or 35 years old or older
- Frequent pregnancies: three or more during a 2-year period
- Poor obstetric history or poor fetal performance
- Poverty, food insecurity, or both
- Bizarre or trendy food habits or eating disorder
- Abuse of tobacco, alcohol, or drugs
- Therapeutic diet that is required for a chronic disorder
- Poorly controlled preexisting condition (e.g., diabetes, hypertension)
- Weight: either less than 85% or more than 120% of ideal weight

Risk Factors during Pregnancy

- Anemia: low hemoglobin level (i.e., less than 12 g) or hematocrit level (i.e., less than 34%)
- Inadequate weight gain: any weight loss or weight gain of less than 1 kg (2 lb) per month after the first trimester
- Excessive weight gain: more than 1 kg (2 lb) per week after the first trimester
- Substance abuse (i.e., alcohol, tobacco, drugs)
- Gestational diabetes, pregnancy-induced hypertension, hyperemesis gravidarum, pica, or another pregnancy-related condition
- Poor nutritional status, especially involving folic acid, iron, or calcium
- Multifetal gestation

factors are listed in the Clinical Applications box, "Nutritional Risk Factors During Pregnancy."

To avoid the compounding results of poor nutrition during pregnancy, mothers who are at risk for complications should be identified as soon as possible. These nutrition-related factors are based on clinical evidence of inadequate nutrition. Do not wait for clinical symptoms of poor nutrition to appear. The best approach is to identify poor food patterns and to prevent nutrition problems from developing. Three types of dietary patterns that do not support optimal maternal and fetal nutrition are as follows: (1) insufficient food intake; (2) poor food selection; and (3) poor food distribution throughout the day.

Teenage Pregnancy

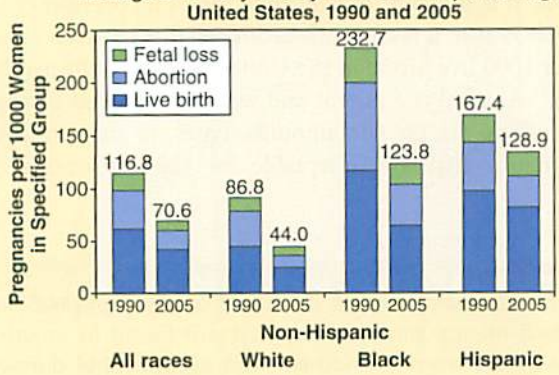
The United States has one of the highest teenage pregnancy rates seen among industrialized nations. The Centers for Disease Control and Prevention reports an annual rate of 70.6 pregnancies for every 1000 girls between the ages of 15 and 19 years.[26] Pregnancy at this early age is physically and emotionally difficult. From a nutrition standpoint, special care must be given to support the adequate growth of both the mother and the fetus. The current DRIs distinguish specific vitamin and mineral needs for pregnant females who are younger than 18 years old. See the For Further Focus box, "Pregnant Teenagers," for more information about health and nutrition for adolescent mothers.

FOR FURTHER FOCUS

PREGNANT TEENAGERS

Few situations are as life-changing for a single teenage girl and her family as an unintended pregnancy. Depending on how she and her family—as well as her partner—deal with the situation, lifelong consequences may occur for them as well as for the broader community. Adolescent pregnancy rates have historically been higher among African-American and Hispanic teens than among Caucasians in the United States, but rates are gradually declining in all ethnic groups[1] (see Figure).

Pregnancy, Birth, Abortion and Fetal Loss Rates for Teenagers 15–19 years by Race and Hispanic Origin: United States, 1990 and 2005



From Ventura SJ, Abma JC, Mosher WD, Henshaw SK. *Estimated pregnancy rates for the United States, 1990-2005: an update* (website): www.cdc.gov/nchs/data/nvsr/nvsr58/nvsr58_04.pdf. Accessed October 9, 2011.

Pregnant teenagers are at high risk for pregnancy complications and poor outcomes, with increased rates of low birth weight and infant mortality. The following problems contribute to these complications: the physiologic demands of the pregnancy, which compromise the teenager's needs for her own unfinished growth and development; the psychosocial influences of a low income; inadequate diet; and experimentation with alcohol, smoking, and other drugs. Little or no access to appropriate prenatal care may also significantly contribute to a lack of nutrition support for the pregnancy. Early nutrition intervention is essential, and it can change the course of events and the pregnancy outcome. Changes from the inconsistent and often poor food pattern of teenagers may be difficult to achieve, and the care of these individuals is challenging. Experienced and sensitive health care workers in teen clinics emphasize the need for supportive individual and group nutrition counseling. The following suggestions may help to secure a positive and healthy environment for the teen.

Know Each Client Personally

All nutrition services must be tailored to the unique needs and characteristics of each pregnant teenager. Many of these girls have lower educational levels and even limited reading skills to which educational material must be adapted. Low-income teens lack the financial resources to maintain an adequate diet, and those who are living at home may have little control over the food that is available to them. Personal stress regarding the pregnancy is paramount, and nutrition concerns are often not a priority. Skipping meals and snacking instead is common, and even dieting is frequent.

Seek Ways to Motivate Clients

Schedule appointments on days that clients are coming in to pick up their food packages from the Women, Infant, and Children (WIC) Food and Nutrition Services program. Invite the teen's mother and her friends to accompany her to group counseling sessions so that they can support the recommendations that are made. Make each recommendation concrete and reasonable. Avoid scare tactics.

FOR FURTHER FOCUS—cont'd

PREGNANT TEENAGERS

Make Appropriate Assessments
Use simple and concrete forms to evaluate dietary intake (e.g., the basic food groups of the MyPlate.gov guidelines). A traditional model can be used, with increased amounts indicated for pregnancy, as both an educational and assessment tool.

Make Practical Interventions
Plan short, enjoyable, and active learning sessions. Use positive reinforcement liberally. Provide specific suggestions for carrying out changes at home. Review progress during follow-up sessions, and always maintain a positive and supportive atmosphere.

Support the Teenager's Responsibility
Help the teenager learn to be responsible. Pregnant teenagers must take on responsibility, often for the first time, for their own nourishment and the nourishment of others. Helping them in a supportive manner to understand and carry out this responsibility—which ultimately only they can do—is a primary objective of nutrition counseling. Nutrition consultants must be skillful so that they can establish the kind of rapport and relationship in which these responsibilities can develop and grow.

1. National Center for Health Statistics. *NCHS data on teen pregnancy.* Atlanta: Centers for Disease Control and Prevention; 2009.

Recognizing Special Counseling Needs

Every pregnant woman needs personalized care and support during pregnancy. However, women with risk factors such as those listed here have special counseling needs. In each case, the clinician must work with the mother in a sensitive and supportive manner to help her to develop a healthy food plan that is both practical and nourishing. Dangerous practices (e.g., fad dieting, extreme macrobiotic diets, attempted weight loss) should be identified early and corrected. In addition to avoiding dangerous practices, several special needs require sensitive counseling, including those related to age and parity, detrimental lifestyle habits, and socioeconomic problems.

Age and Parity. Pregnancies at either age extreme of the reproductive cycle carry special risks. Adolescent pregnancy adds many social and nutritional risks as its social upheaval and physical demands are imposed on an immature teenage girl. Sensitive counseling must involve both information and emotional support with good prenatal care throughout. Alternatively, pregnant women who are older than 35 years old and having their first child also require special attention. Pregnancy rates among women who are more than 35 years old continue to rise in the United States.[26] These women may be more at risk for high blood pressure and gestational diabetes, and they need guidance about the appropriate rate of weight gain and an effective dietary plan. In addition, women with a high parity rate (i.e., those who have had several pregnancies within a limited number of years) may be at increased risk for poor pregnancy outcomes, because they enter each successive pregnancy drained of nutrition resources and usually facing the increasing physical and economic pressures of child care.

Alcohol. Alcohol use during pregnancy can lead to the well-documented **fetal alcohol spectrum disorders (FASD)**, of which **fetal alcohol syndrome (FAS)** is the most severe form (Figure 10-1). Fetal alcohol spectrum disorders comprise the leading causes of preventable mental retardation and other birth defects in the United States. It is difficult to determine the exact prevalence of FAS; however, it is currently estimated that between 2 and 7 per 1000 live births in the United States are affected by FAS.[27] Alcohol is a potent and well-documented **teratogen**. There are no safe amounts, types, or times during pregnancy that are acceptable for the consuming of

fetal alcohol spectrum disorders a group of physical and mental birth defects that are found in infants who are born to mothers who used alcohol during pregnancy; the physical and mental disabilities vary in severity, and there is no cure.

fetal alcohol syndrome (FAS) a combination of physical and mental birth defects that are found in infants who are born to mothers who used alcohol during pregnancy; this is the most severe of the fetal alcohol spectrum disorders, and there is no cure.

teratogen a drug or substance that causes a birth defect.

CLINICAL APPLICATIONS

WHO WILL HAVE A LOW BIRTH WEIGHT BABY?

Infants who weigh less than 2500 g (5 lb 8 oz) at birth often present with medical complications and require special care in the newborn intensive care unit. Poor weight gain during pregnancy is a significant contributor to this problem.

Factors That Influence the Trend Toward More Low Birth Weight Babies

- Premature delivery
- Intrauterine growth restriction
- Health complications of the mother, including disease or infection
- Material use of cigarettes, alcohol, and drugs
- Inadequate maternal weight gain
- Poor socioeconomic factors

Reducing the Risk of Low Birth Weight Infants

- Maintain regular eating patterns throughout pregnancy, and be sure to consume an adequate amount of energy and nutrients.
- Take a multivitamin that contains 400 mcg of folic acid before becoming pregnant and one that contains 600 mcg while pregnant.
- Stop using cigarettes, alcohol, and drugs.
- Get early and regular prenatal care.
- Carefully control any preexisting conditions (e.g., diabetes, hypertension).
- Contact your health care providers immediately if preterm labor is suspected.[1]

March of Dimes, *Low Birthweight*. 2008, Access November 2010; Available from: http://www.marchofdimes.com/professionals/medicalresources_lowbirthweight.html.

alcohol. FAS is 100% preventable by abstaining from alcohol during gestation.[28] A study that compared the risk of FAS among different ethnic and socioeconomic groups of women found that the relative risk for FAS varies among populations and that it is influenced by environmental and behavioral conditions in addition to prepregnancy BMI and nutrition status; however, no ethnic or socioeconomic group is without incidence.[29]

Nicotine. Cigarette smoking or exposure to environmental tobacco smoke during pregnancy is associated with placental abnormalities and fetal damage, including prematurity and low birth weight (see the Clinical Applications box, "Who Will Have a Low Birth Weight Baby?").[30-32] An estimated 18% of pregnant women continue to smoke cigarettes during pregnancy, which contributes to complications and poor fetal outcome.[33]

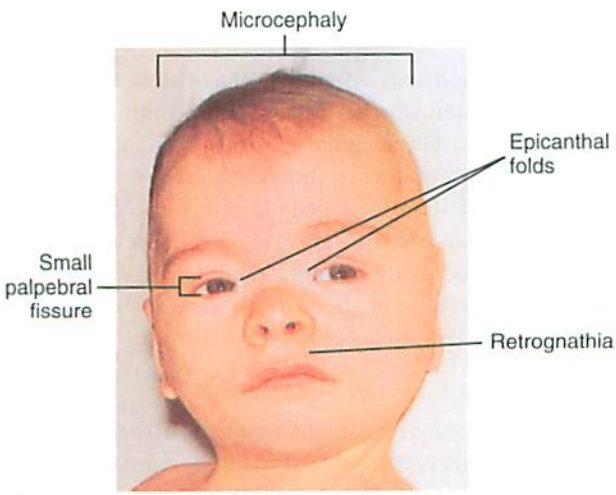


Figure 10-1 Fetal alcohol syndrome. (Reprinted from Thibodeau GA, Patton KG. *Anatomy & physiology*. 6th ed. St.: Mosby; 2007.)

Drugs. Drug use, whether medicinal or recreational, poses many problems for both the mother and the fetus, especially when it involves the use of illegal drugs. Self-medication with over-the-counter drugs also may present adverse effects. Drugs cross the placenta and enter the fetal circulation, thereby creating a potential addiction in the unborn child. Dangers come from the drugs themselves, the use of contaminated needles, and the impurities that are contained in street drugs.

Vitamin abuse from megadosing with basic nutrients such as vitamin A during pregnancy also may cause fetal damage. Drugs made from vitamin A compounds (e.g., retinoids such as tretinoin [Accutane], which are prescribed for severe acne) have caused the spontaneous abortion of malformed fetuses by women who conceived during acne treatment. Thus, the use of these drugs without contraception is contraindicated.

Caffeine. Caffeine use is common during pregnancy. However, caffeine can cross the placenta and enter the fetal circulation. One cup of coffee contains approximately 100 mg of caffeine, and caffeinated soft drinks range between 10 and 50 mg of caffeine per 12-oz serving. Caffeine stays in the bloodstream longer in pregnant women than other adults.[34] Studies have found conflicting results regarding the effects of caffeine on pregnancy

outcome. A recent study of 2643 pregnant women in the United Kingdom found an increase in the prevalence of miscarriage and stillbirth among women who consumed more than 100 mg caffeine per day.[35] However, another large-scale meta-analysis concluded that moderate amounts of caffeine throughout the day do not have negative effects on reproduction or fetal health.[36]

Pica. Pica is the craving for and the purposeful consumption of nonfood items (e.g., chalk, laundry starch, clay). It is a practice that is sometimes seen in pregnant or malnourished individuals. Although the mechanism is not known, pica is significantly associated with iron-deficiency anemia as well as other contributing factors.[37] Although pica may occur in any population group, worldwide it is most common among pregnant women. The practice of eating nonfood substances can introduce pathogens (e.g., bacteria, worms) and inhibit micronutrient absorption, thereby resulting in various deficiencies. Most patients do not readily report the practice of pica; therefore, practitioners should always ask patients directly about their consumption of any nonfood substances.

Socioeconomic Problems. Special counseling is often needed for women and young girls who live in low-income situations. Poverty especially puts pregnant women in grave danger, because they need resources for financial assistance and food supplements. Dietitians and social workers on the health care team can provide special counseling and referrals. Community resources include programs such as the Special Supplemental Nutrition Program for Women, Infants and Children, known as *WIC*, which has helped to improve the health and well-being of many children in the United States (Figure 10-2). WIC also provides nutrition education counseling regarding the nutrition needs of both the mothers and their babies.

Figure 10-2 Measuring a child's growth at a Women, Infant, and Children Food and Nutrition Services appointment. (Copyright Photos.com.)

Complications of Pregnancy

Anemia

Iron-deficiency anemia is the most common nutritional deficiency worldwide. Although a disproportionate amount of these cases occur in underdeveloped countries, approximately 42% of pregnant women worldwide experience iron-deficiency anemia. The prevalence ranges greatly, from 6.1% in North America to 55.8% in Africa.[38] Anemia is more prevalent among poor women, many of whom live on marginal diets that lack iron-rich foods, but it is by no means restricted to lower socioeconomic groups. Dietary intake must be improved and supplements used as necessary to avoid the long-term detrimental effects on the fetus of nutritional deficiencies during gestation. As a result of the severe complications of both iron- and folate-deficiency anemia, the World Health Organization currently recommends a weekly iron and folic acid dietary supplement as a safe, effective, and inexpensive way to prevent nutritional deficiencies during pregnancy.[39]

Neural Tube Defects

As previously discussed, the DRIs of 400 mcg/day of folate for women who are capable of becoming pregnant is increased to 600 mcg/day during pregnancy.[2] This is especially important when individual dietary adequacy is doubtful or if there is a genetic risk for NTDs in the family. Women who do not take folate supplements or who do not frequently consume fruit, juices, whole-grain or fortified cereals, or green leafy vegetables are more likely to have less-than-optimal folate intake.

Intrauterine Growth Restriction

IUGR occurs when an infant weighs less than the 10th percentile of the predicted fetal weight for gestational age. Women with high-risk pregnancies have an elevated risk of IUGR. A fetus with IUGR is at risk for preterm birth, being small for gestational age, and having a low birth weight.[40] Many factors may contribute to IUGR, but low

prepregnancy weight, inadequate weight gain during pregnancy, and the use of cigarettes, alcohol, and other drugs are strong factors. Furthermore, infants who suffer from IUGR are at higher risk for the development of several chronic diseases as adults, including cardiovascular disease, type 2 diabetes, and obesity.

Hypertensive Disorders of Pregnancy

The etiology of **pregnancy-induced hypertension** is unknown, but it is a leading cause of pregnancy-related death. Pregnancy-induced hypertension includes several classifications:

- *Gestational hypertension:* blood pressure of more than 140/90 mmHg
- *Preeclampsia:* gestational hypertension plus proteinuria
- *Eclampsia:* preeclampsia plus seizures
- *HELLP syndrome:* **h**emolysis, **e**levated **l**iver enzymes, and **l**ow **p**latelets

Complications of pregnancy-induced hypertension often require hospitalization and induced labor. Studies have shown that calcium supplementation reduced the risk for hypertension in women who were pregnant for the first time and especially in those with low calcium intake to begin with, although the disorder is not thought to be exclusively associated with diet.[41] Specific treatment varies according to individual symptoms and needs; however, in any case, optimal nutrition is important, and prompt medical attention is required. Early and consistent prenatal care is imperative to identify risks early during the pregnancy. The only cure for severe cases is termination or the delivery of the infant.

Gestational Diabetes

Gestational diabetes is defined as any degree of glucose intolerance with onset during pregnancy, and the definition applies regardless of whether insulin or only diet modification is used for treatment. The prevalence of gestational diabetes in the United States is approximately 7% of all pregnancies (roughly 200,000) annually.[42] Prenatal clinics routinely screen pregnant women between 24 and 28 weeks' gestation with a 50-g oral glucose challenge. Careful follow-up is provided for those who show glucosuria or who meet the following diagnostic criteria: they have a random blood glucose level of more than 200 mg/dL (11.1 mmol/L) or a fasting blood glucose level of more than 126 mg/dL (7.0 mmol/L), or they fail to clear glucose from the bloodstream within the specified time after an oral glucose tolerance test. Particular attention is given to women who are at higher risk for the development of gestational diabetes, including those who are 30 years old and older who are overweight (i.e., those with a BMI of ≥ 26 kg/m^2) and who have a history of any of the following predisposing factors:

- Previous history of gestational diabetes
- Family history of diabetes or ethnicity associated with a high incidence of diabetes
- Glucosuria
- Obesity
- Previous delivery of a large baby weighing 4.5 kg (10 lb) or more

Gestational diabetes occurs more frequently among African Americans, Hispanic and Latino Americans, Asian Americans, Pacific Islanders, and Native Americans. From 20% to 50% of women with gestational diabetes subsequently develop type 2 diabetes later in life, and they are more likely to develop cardiovascular disease and metabolic syndrome at an early age, especially those who also have a family history of type 2 diabetes.[43,44] Therefore, identifying and providing close follow-up testing and treatment with a well-balanced diet, exercise, and insulin (as needed) are important interventions. These women are at higher risk for fetal damage (i.e., birth defects or **stillbirth**), prematurity, **macrosomia**, and neonatal hypoglycemia. Children who are born to women with gestational diabetes are at greater risk for having impaired glucose tolerance, being overweight, and developing metabolic syndrome during adolescence.[45]

Preexisting Disease

Preexisting diseases (e.g., cardiovascular diseases, hypertension, type 1 or 2 diabetes) can cause complications during pregnancy. Inborn errors of metabolism (e.g., phenylketonuria) and food allergies or intolerances (e.g., celiac disease, lactose intolerance) must also be taken into consideration and maintained under good control to mitigate any flare-ups or compromised nutrient intake. All potential preexisting diseases will not be discussed here, because pregnant women may have any combination of preexisting conditions.

In each case, a woman's pregnancy is managed—usually by a team of specialists—in accordance to the principles of care related to pregnancy and the particular disease involved. See Chapters 18 through 23 for major

pregnancy-induced hypertension the development of hypertension during pregnancy after the twentieth week of gestation.

stillbirth the death of a fetus after the twentieth week of pregnancy.

macrosomia an abnormally large baby.

nutrition-related diseases that require medical nutrition therapy.

LACTATION

The World Health Organization states that breast-feeding is "an unequalled way of providing ideal food for the healthy growth and development of infants."[46] Breast-feeding is recommended as the exclusive source of nutrition for infants who are up to 6 months old. After 6 months, iron-fortified complementary foods should be added to the basic diet of breast milk. The *Healthy People 2020* goals for breast-feeding are as follows[47]:

- 82% or more of mothers initiate breast-feeding during the early postpartum period
- 44.3% or more of mothers exclusively breast-feed through the first 3 months
- 60.5% or more of mothers continue to breast-feed through the first 6 months, and 23.7% or more exclusively breast-feed for the first 6 months
- 34% or more of mothers continue to breast-feed at 1 year

Trends

Approximately 79% of infants worldwide are breast-fed for the first year compared with 21.4% in the United States. Although the rates are still very low in the United States compared with other countries, breast-feeding here has been on the rise since the 1970s[48] (Figure 10-3). Breast-feeding initiation and continuation are higher among well-educated, older, married women of a higher socioeconomic status (see the Cultural Considerations box, "Breast-Feeding Trends in the United States").[49] The American Academy of Pediatrics recommends breast-feeding for at least the first 12 months postpartum.[50] However, only 43% of American mothers continue any form of breast-feeding past 6 months postpartum.[49] Most women report discontinuing breast-feeding because of difficulties such as sore nipples, the infant spitting up, and engorged breasts. With proper instruction and a caring environment, most of these difficulties can be overcome.

The Baby-Friendly Hospital Initiative

The Baby-Friendly Hospital Initiative, which was launched by the World Health Organization and the United Nations Children's Fund, has increased breast-feeding rates worldwide.[51] Box 10-2 outlines the 10 steps for successful breast-feeding that are recommended by the Baby-Friendly Hospital Initiative. Almost all women who choose to breast-feed their infants can do so. Well-nourished mothers who breast-feed exclusively provide adequate nutrition, with solid foods usually added to the baby's diet when the baby is approximately 6 months old.

Physiologic Process of Lactation

Mammary Glands and Hormones

The female breasts are highly specialized secretory organs (Figure 10-4). Throughout pregnancy, the mammary glands are preparing for lactation. The mammary glands are capable of extracting certain nutrients from the maternal blood in addition to synthesizing other compounds.

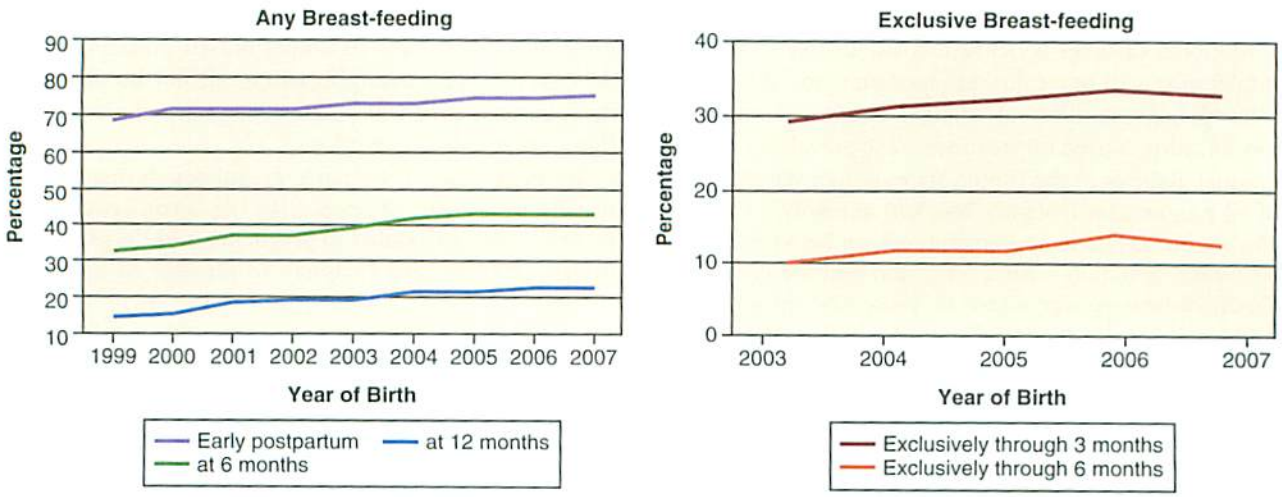


Figure 10-3 Breast-feeding among children in the United States. (Adapted from the Centers for Disease Control and Prevention. *Percent of U.S. children who were breastfed, by birth year, National Immunization Survey, United States, 2010* (website): www.cdc.gov/breastfeeding/data/NIS_data/. Accessed October 9, 2011.)

CULTURAL CONSIDERATIONS

BREAST-FEEDING TRENDS IN THE UNITED STATES

Increasing the prevalence of breast-feeding continues to be a health goal both nationally and internationally, as is seen in the objectives of *Healthy People 2020* and the goals of the World Health Organization. The most recent report from the National Center for Health Statistics shows that the percentage of mothers who initiate breast-feeding has increased from 54.1% in 1986 to 75% in 2007.[1,2] The current national estimates for the percentage of U.S. children who were breast-fed at 6 months is 43%, and it is 22.4% at 12 months; this is just short of the current national goals.[2]

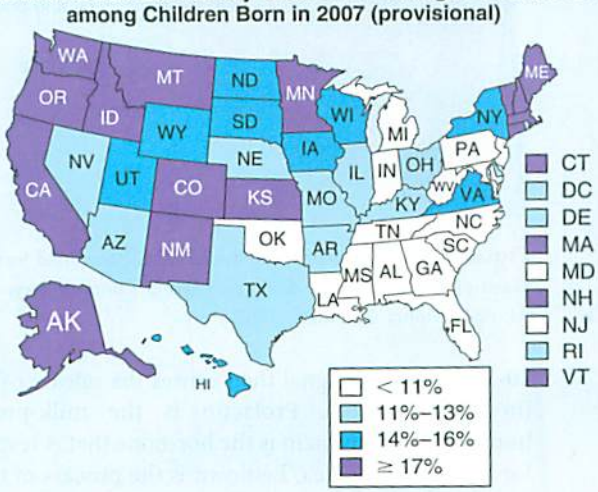
In the United States, breast-feeding is most common among women who are older than 30 years old; are Asian, Hispanic, and Latino; and have higher educations. A higher prevalence of breast-feeding is also noted among married women, and it is more common in the Western states (see map).[2]

PREVALENCE OF BREAST-FEEDING IN THE UNITED STATES

Selected Characteristics of Mother	Percentage Breast-Feeding at 6 Months
Total	43.0
Mother's Age at Baby's Birth	
≤ 20 years	22.2
20 to 29 years	33.4
≥ 30 years	50.5
Race or Ethnicity	
American Indian or Alaska Native	42.4
Asian	58.6
Black or African American	27.9
Hispanic or Latino	46.0
Native Hawaiian or Pacific Islander	45.3
White	45.1
Education	
Not a high school graduate	37.0
High school graduate	31.4
Some college	41.0
Collage graduate	59.9
Poverty Income Ratio*	
< 100%	34.7
100% to 184%	36.9
185% to 349%	45.0
≥ 350%	54.0

As a health care provider, be sure to note the perceived obstacles to the initiation and continuation of breast-feeding so that education and alternatives may be presented at the appropriate time (i.e., before delivery). The American

Percent of Children Exclusively Breast-fed Through 6 Months of Age among Children Born in 2007 (provisional)



From the Centers for Disease Control and Prevention. *Percent of U.S. children who were breastfed, by birth year, National Immunization Survey, United States 2010,* Atlanta: Centers for Disease Control and Prevention; 2010.

CULTURAL CONSIDERATIONS—cont'd

BREAST-FEEDING TRENDS IN THE UNITED STATES

Academy of Pediatrics notes the following potential obstacles[3]:

- Insufficient prenatal education about breast-feeding
- Disruptive hospital policies and practices
- Inappropriate interruption of breast-feeding
- Early hospital discharge in some populations
- Lack of timely routine follow-up care and postpartum home health visits
- Maternal employment (especially in the absence of workplace facilities that support breast-feeding)
- Lack of family and broad societal support
- Media portrayal of bottle-feeding as normative
- Commercial promotion of infant formula through the distribution of hospital discharge packs
- Coupons for free or discounted formula
- Misinformation about what medical conditions may be contraindications for breast-feeding
- Lack of guidance and encouragement from health care professionals

*The poverty income ratio is the self-reported family income compared with the federal poverty threshold value. It depends on the number of people in the household.

References

1. National Center for Health Statistics. *Health, United States, with chartbooks on trends in the health of Americans.* National Center for Health Statistics: Hyattsville, Md; *2005.*
2. Centers for Disease Control and Prevention. *Percent of U.S. children who were breastfed, by birth year, National Immunization Survey, United States.* Centers for Disease Control and Prevention: Atlanta; 2010.
3. Gartner, LM, et al. *Breastfeeding and the use of human milk.* Pediatrics. 2005;115(2):496-506.

BOX 10-2 TEN STEPS TO SUCCESSFUL BREAST-FEEDING

1. Have a written breast-feeding policy that is routinely communicated to all health care staff.
2. Train all health care staff in the skills that are necessary to implement this policy.
3. Inform all pregnant women about the benefits and management of breast-feeding.
4. Help mothers to initiate breast-feeding within 30 minutes after birth.
5. Show mothers how to breast-feed and maintain lactation, even if they may be separated from their infants.
6. Give newborn infants no food or drink other than breast milk unless it is medically indicated to do so.
7. Practice rooming in: allow mothers and infants to remain together 24 hours a day.
8. Encourage breast-feeding on demand.
9. Give no artificial teats or pacifiers to breast-feeding infants.
10. Foster the establishment of breast-feeding support groups, and refer mothers to these groups when they are discharged from the hospital or clinic.

From the World Health Organization; United Nations Children's Fund. *The Baby-Friendly Hospital Initiative* (website): www.unicef.org/programme/breastfeeding/baby.htm. Accessed June 2011.

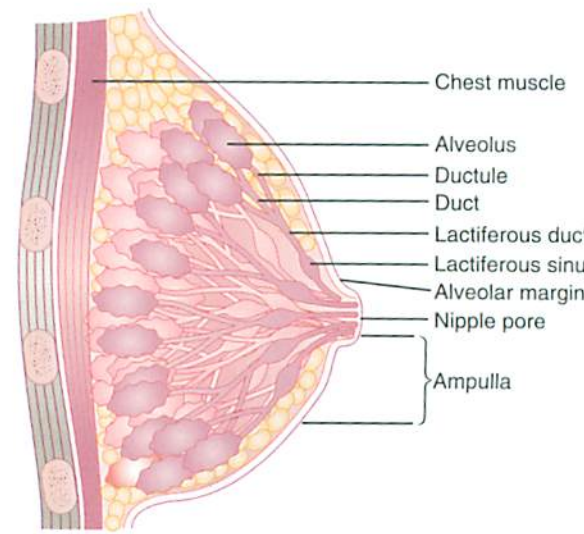


Figure 10-4 Anatomy of the breast. (Reprinted from Mahan LK, Escott-Stump S. *Krause's food & nutrition therapy.* 12th ed. Philadelphia: Saunders; 2008.)

The combined effort results in the nutrient-complete breast milk. After the delivery of the baby, milk production and secretion are stimulated by the two hormones prolactin and oxytocin.

The stimulation of the nipple from infant suckling sends nerve signals to the brain of the mother (Figure 10-5); this nerve signal then causes the release of prolactin and oxytocin. Prolactin is the milk-producing hormone, and oxytocin is the hormone that is responsible for the letdown reflex. Letdown is the process of the milk moving from the upper milk-producing cells down to the nipple for infant suckling.

Supply and Demand

Milk production is a supply-and-demand procedure. The mammary glands are stimulated to produce milk each

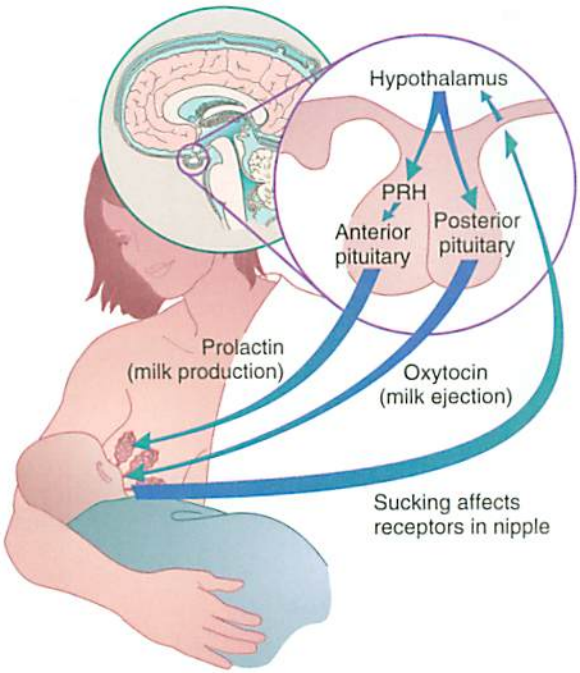


Figure 10-5 Physiology of milk production and the letdown reflex. *PRH,* Prolactin-releasing hormone. (Reprinted from Mahan LK, Escott-Stump S. *Krause's food & nutrition therapy.* 12th ed. Philadelphia: Saunders; 2008.)

time that the infant feeds. Therefore, the more milk that is taken from the breast (i.e., during breast-feeding or pumping), the more milk the mother produces, thereby always meeting the infant's needs. As a result of this supply-and-demand production, mothers of multiple infants (e.g., twins, triplets) are able to produce more milk with the additional stimulation. Some mothers of multiples find it easier to pump and then bottle-feed the infants the breast milk so that other members of the family can help with feedings.

Composition

Breast milk changes in composition to meet the specific needs of infants as they grow. Colostrum is the first milk that is produced after birth. It is a yellowish fluid that is rich in antibodies, and it gives the infant his or her first immune boost. Mature breast milk comes in within a few days after delivery, and the composition changes throughout each feeding as a result of the combination of fore, mid, and hind milk (hind milk is the highest in essential fatty acids). As you can see from Table 10-3, the composition of mature human milk is quite different from that of cow's milk. Cow's milk is an inappropriate food source for infants younger than 1 year old because of its high protein and electrolyte levels.

Nutrition Needs

The basic diet followed during pregnancy *as well as the* prenatal nutrient supplements used should be continued through the lactation period. The MyPlate food guide system provides specific nutrient information for pregnant and lactating moms at www.choosemyplate.gov/mypyramidmoms/index.html. The Daily Food Plan for Moms takes into account the mother's age, height, weight, and physical activity level; the infant's age; and how much breast milk the mom is producing to offer individualized recommendations. The Web site also provides help with menu planning for mothers with an easy-to-use interactive site.

Diet

Energy and Nutrients. Lactation requires energy for both the process and the product. Some of this energy may be met by the extra fat that is stored during pregnancy. The increased calorie recommendations are 330 kcal/day (plus 170 kcal/day from maternal stores) during the first 6 months of lactation and 400 kcal/day during the second 6 months of lactation compared with the woman's nonpregnant, nonlactating energy requirements. The requirement for protein during lactation is 25 g/day more than a woman's average need of 46 g/day (i.e., 0.8 g per kilogram of body weight body weight per day) for a total of 71 g/day (i.e., 1.1 g/kg body weight per day).[5] An example of a core food plan for meeting the nutrient needs of pregnant and lactating women is presented in Table 10-1.

Fluids. Because milk is a fluid, breast-feeding mothers need ample fluids for adequate milk production; their fluid intake should be approximately 3 L/day. Water and other sources of fluid such as juices, milk, and soup contribute to the fluid that is necessary to produce milk. Beverages that contain alcohol and caffeine should be avoided, because these substances pass into the breast milk.

Rest and Relaxation

In addition to the increase in diet and the adequate fluid intake, breast-feeding mothers require rest, moderate exercise, and relaxation. Because the production and letdown reflexes of lactation are hormonally controlled, negative environmental and psychologic factors contribute to the early cessation of breast-feeding.[52,53] Such factors are called *prolactin inhibitors,* and they include stress, fatigue, medical complications, lack of support, poor self-efficacy, and irregular breast-feeding. A lactation specialist can help by counseling mothers about their new family situations and by helping them to develop a plan to meet their personal needs.

TABLE 10-3 NUTRITION COMPOSITION OF HUMAN MILK VERSUS COW'S MILK*

Nutrient	HUMAN MILK			Cow's Milk
	Colostrum	Transitional	Mature	
Kilocalories	67	72	74	70
Protein (g)	2.7	1.6	0.9	3.3
Carbohydrate (g)†	5.3	6.6	7.2	4.8
Fat (g)	2.9	3.6	4.5	3.7
Lactalbumin (g)		0.8	0.3	0.4
Fat-Soluble Vitamins				
A (IU)	296	283	240	303
D (IU)	–	–	5	4
E (mg)	0.8	1.32	0.2	0.06
K (mcg)	–	–	2.3	–
Water-Soluble Vitamins				
Thiamin (mg)	0.015	0.006	0.014	0.042
Riboflavin (mg)	0.029	0.033	0.035	0.16
Niacin (mg)	0.075	0.15	0.2	0.085
Pantothenic acid (mg)	0.183	0.288	0.18	0.3
Vitamin C (mg)	4.4	5.4	4.3	0.9
Folate (mcg)	0.05	0.02	0.52	0.23
Minerals				
Calcium (mg)	31	34	30	125
Phosphorus (mg)	14	17	15	96
Iron (mg)	0.09	0.04	0.03	0.04
Zinc (mg)	0.5	0.4	0.16	0.37
Magnesium (mg)	4.2	3.5	4	13
Iodine (mcg)	6	–	6	11
Electrolytes				
Sodium (mg)	5	19	17	76
Potassium (mg)	74	63	53	152
Chloride (mg)	58	30	37	108

Modified from Mitchell MK. *Nutrition across the life span.* 2nd ed. Philadelphia: Saunders; 2003.
*Per 100 mL.
†Lactose.

Long-Term Results of Feeding Methods

Risks of Formula Feeding

Medical professionals agree that breast-feeding is the normal means by which an infant should be fed and that other feeding methods carry risks for the infant. For decades, the literature has presented many benefits of breast-feeding. However, many researchers believe that it is more useful to present the risks of formula feeding as opposed to the benefits of feeding in a normal manner.[54] Another way to look at it is to assume that the many benefits of breast-feeding are only the normal expectations of infant feeding; therefore, infants who are receiving other forms of feeding would suffer the losses of such normal advantages. Because most research to date has focused on the benefits of breast-feeding instead of the risks of formula feeding, it is only appropriate to present the scientific findings in the manner in which they were studied.

Advantages of Breast-Feeding

Many physiologic and practical advantages of breast-feeding are gained by both the mother and the infant; these are listed in Box 10-3. In a policy statement from the American Academy of Pediatrics, the authors cited the health benefits of breast-feeding for the infant, which include decreasing the incidence or severity of infectious diseases; increasing cognitive performance; and decreasing rates of sudden infant death syndrome, type 1 and 2 diabetes, lymphoma, leukemia, Hodgkin's disease, obesity, hypercholesterolemia, and asthma.[50] In addition, the mother receives many health benefits as well. Some noted

BOX 10-3 BENEFITS OF BREAST-FEEDING COMPARED WITH FORMULA FEEDING

BENEFITS FOR INFANTS
- Optimal nutrition for infant
- Strong bonding with mother
- Safe, fresh milk
- Enhanced immune system
- Reduced risk for acute otitis media, nonspecific gastroenteritis, severe lower respiratory tract infections, and asthma
- Protection against allergies and intolerances
- Promotion of the correct development of the jaw and teeth
- Association with higher intelligence quotient and school performance through adolescence
- Reduced risk for chronic diseases such as obesity, type 1 and 2 diabetes, heart disease, hypertension, hypercholesterolemia, and childhood leukemia
- Reduced risk for sudden infant death syndrome
- Reduced risk for infant morbidity and mortality

BENEFITS FOR MOTHERS
- Strong bonding with infant
- Increased energy expenditure, which may lead to faster return to prepregnancy weight
- Faster shrinking of the uterus
- Reduced postpartum bleeding
- Delayed return of the menstrual cycle
- Decreased risk for chronic diseases such as type 2 diabetes and breast and ovarian cancer
- Improved bone density and decreased risk for hip fracture
- Decreased risk for postpartum depression; enhances self-esteem in the maternal role
- Time saved by not having to prepare and mix formula
- Money saved by not buying formula and from not having to pay the increased medical expenses associated with formula feeding

From James DC, Lessen R. Position of the Academy of Nutrition and Dietetics: promoting and supporting breastfeeding. *J Am Diet Assoc. 2009; 109(11):1926-1942.*

advantages of breast-feeding for the mother are decreased bleeding; an earlier return to prepregnancy weight; and decreased risks of breast cancer, ovarian cancer, and osteoporosis.[50]

The antibodies in human milk that are passed to the nursing infant make a significant contribution to the infant's immune system. In addition, a large-scale meta-analysis that was published by the World Health Organization concluded that breast-feeding is "associated with increased cognitive development in childhood, in studies that controlled for confounding by socioeconomic status and stimulation at home."[55] This means that breast-fed infants are cognitively advanced compared with formula-fed infants, despite differences in environmental influences, with a positive relationship seen between the duration of breast-feeding and the intelligence quotient of the child.[56]

Additional Resources

The Academy of Nutrition and Dietetics and the American Academy of Pediatrics encourage and strongly support breast-feeding for all able mothers for the first 12 months of life and continued thereafter for as long as mutually desired.[48,50] The American Academy of Pediatrics keeps updated breast-feeding information available for the public at www.aap.org/healthtopics/breastfeeding.cfm.

The World Health Organization has written and posted an entire chapter entitled "Infant and Young Child Feeding" for medical students and allied health professionals that is freely available online at whqlibdoc.who.int/publications/2009/9789241597494_eng.pdf. A multitude of additional resources about this topic are available from the World Health Organization at www.who.int/topics/breastfeeding/en/index.html.

SUMMARY

- Pregnancy involves the fundamental interaction of the following three distinct yet unified biologic entities: the placenta, the fetus, and the mother. Maternal needs also reflect the increasing nutrition needs of the fetus and the placenta.
- Optimal weight gain during pregnancy varies with the normal nutritional status and weight of the woman, with a goal of 25 to 35 lb for a woman of average weight. Sufficient weight gain is important during pregnancy to support the rapid growth that is taking place. However, the nutritional quality of the diet is as significant as the actual amount of weight gain.
- Common problems during pregnancy include first-trimester nausea and vomiting associated with hormonal adaptations and, later, constipation, hemorrhoids, or heartburn that result from the pressure of the enlarging uterus. These problems are usually relieved without medication by simple and often temporary changes in the diet.

Continued

SUMMARY—cont'd

- Unusual or irregular eating habits, age, parity, pre-pregnancy weight status, and low income are among the many related conditions that put pregnant women at risk for complications.
- The ultimate goal of prenatal care is a healthy infant and a healthy mother who can breast-feed her child if she chooses to do so. Breast milk provides essential nutrients in quantities that are uniquely suited for optimal infant growth and development.

CRITICAL THINKING QUESTIONS

1. Which nutrients are required in larger amounts during pregnancy? Plan a 1-day diet that would meet the nutrient needs of a pregnant women during her third trimester.
2. Identify two common gastrointestinal problems that are associated with pregnancy, and describe the diet management of each.
3. Discuss the major nutritional factors that are needed to support lactation. What additional nonnutrition needs does the breast-feeding mother have, and what suggestions can you give to help her meet them?
4. Why is additional fluid needed for lactation?

CHAPTER CHALLENGE QUESTIONS

True-False

1. *True or False:* The development of the fetus is directly related to the diet of the mother.
2. *True or False:* Strict weight control during pregnancy is necessary to avoid complications.
3. *True or False:* Fat should be removed from the pregnant woman's diet to prevent edema.
4. *True or False:* A higher risk for pregnancy complications occurs among teenagers and older women.
5. *True or False:* A woman's diet before pregnancy has little effect on the outcome of her pregnancy.
6. *True or False:* No woman should ever gain more than 15 to 20 lb during pregnancy.
7. *True or False:* The rapid growth of the fetal skeleton requires increased calcium in the mother's diet.
8. *True or False:* Inadequate vitamin D intake during pregnancy contributes to skeletal development issues in the fetus.
9. *True or False:* Anemia is common during pregnancy.
10. *True or False:* Additional kilocalories and fluids are needed during lactation.

Multiple Choice

1. Maternal blood volume during pregnancy
   a. increases.
   b. decreases.
   c. remains unchanged.
   d. fluctuates widely.
2. Pregnant mothers are often prescribed supplemental iron. Studies show that iron supplements are effective for the prevention of
   a. edema.
   b. gestational diabetes.
   c. anemia.
   d. nausea and vomiting.
3. Women with gestational diabetes have an increased risk of developing what condition later in life?
   a. Osteoporosis
   b. Type 1 diabetes
   c. Type 2 diabetes
   d. Pregnancy-induced hypertension
4. Breast-feeding is the normal method of feeding an infant. Research shows that the benefits that breast-fed infants enjoy over their formula-fed counterparts include
   a. a decreased risk of obesity.
   b. a decreased risk of type 1 and 2 diabetes.
   c. a decreased risk of infectious disease.
   d. All of the above
5. Which of the following hormones is responsible for milk letdown during lactation?
   a. Prolactin
   b. Estrogen
   c. Oxytocin
   d. Human growth hormone
6. The World Health Organization and the American Academy of Pediatrics recommend breast-feeding for at least
   a. 3 months.
   b. 8 months.
   c. 12 months.
   d. 3 years.

Evolve Please refer to the Students' Resource section of this text's Evolve Web site for additional study resources.

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FURTHER READING AND RESOURCES

Each of the following organizations has an earnest interest in the health care of pregnant women and their children. For information about a variety of topics involving pregnancy and lactation, explore their Web sites.

American Academy of Pediatrics. www.aap.org

Birth Defect Research for Children, Inc.. www.birthdefects.org

Canadian Paediatric Society. www.cps.ca

La Leche League International, Inc.. www.llli.org

March of Dimes Birth Defects Foundation. www.modimes.org

U.S. Department of Agriculture WIC Program. www.fns.usda.gov/wic

World Health Organization, Breastfeeding. www.who.int/topics/breastfeeding/en

Kramer MS, Aboud F, Mironova E, et al; Promotion of Breastfeeding Intervention Trial (PROBIT) Study Group. Breastfeeding and child cognitive development: new evidence from a large randomized trial. *Arch Gen Psychiatry.* 2008;65(5):578-584.

Researchers outline and discuss one of the largest randomized trials addressing the benefits of breast-feeding for child cognitive development.

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