The Role of Nutrition in Infant Mortality: A Public Health Perspective

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Nutrition is a modifiable risk factor that must be addressed as part of infant mortality efforts. While nutrition is not the only factor in infant mortality reduction, it is part of a complex whole of interventions necessary to make a sustained difference. A focus on nutrition is not a new approach to reducing infant mortality. However, nutrition is often inadequately addressed and must be integrated into all reduction and prevention activities. This brief summarizes the impact of nutrition on infant mortality and identifies areas where nutrition interventions can make a difference in reducing infant mortality. This paper also describes the critical role that public health nutritionists play in preventing infant mortality.

> Infant mortality is a multi-factorial phenomenon, with rates reflecting a society's commitment to the provision of high quality health care, adequate food and good nutrition, safe and stable housing, a healthy psychological and physical environment, and sufficient income to prevent impoverishment.
>
> — *Recommendations for HHS Action and Framework for a National Strategy; 2013.*[1]

Infant Mortality

According to the Centers for Disease Control and Prevention, about 25,000 infants die each year in the United States. The United States' Infant Mortality Rate (US IMR) is higher than the rates found in many western European and east Asian countries. Infant mortality refers to deaths that occur during the first year of life after a live birth and is measured in deaths per 1,000 live births. Most recent data (2008) from the Organization for Economic Cooperation and Development documents the US IMR as 6.6 deaths per 1,000 live births, ranking the United States at 31st in the world. This number is a decrease from the United States' 1960 ranking of 13th in the world with 12 deaths per 1,000 live births.[2]

The IMR in the United States varies by racial and ethnic group, with infants born to black mothers dying at twice the rate of those born to white mothers. The Congressional Research Service[3] cites a number of maternal demographic characteristics, including race, education, and age, that may directly or indirectly influence the IMR. Also, the IMR may be affected by health and health system characteristics such as the mother's health behaviors or whether she receives prenatal care.

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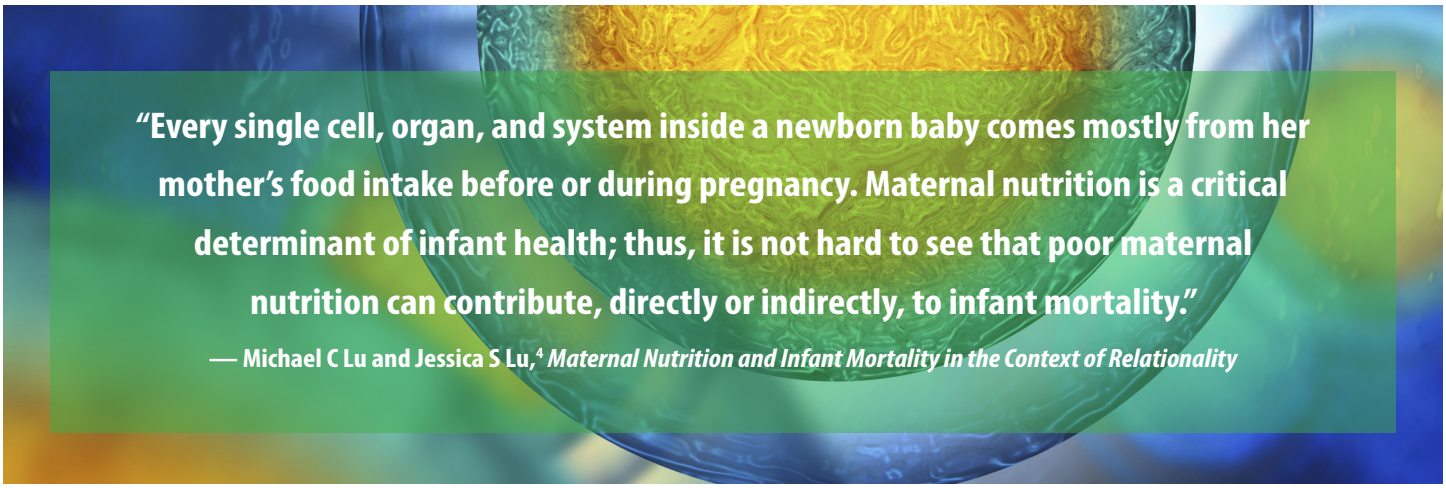
— Nutrition and Infant Mortality —



"Every single cell, organ, and system inside a newborn baby comes mostly from her mother's food intake before or during pregnancy. Maternal nutrition is a critical determinant of infant health; thus, it is not hard to see that poor maternal nutrition can contribute, directly or indirectly, to infant mortality."

— Michael C Lu and Jessica S Lu,[4] *Maternal Nutrition and Infant Mortality in the Context of Relationality*

The comprehensive report, ***Maternal Nutrition and Infant Mortality in the Context of Relationality****, by Michael C Lu and Jessica S Lu provided background for the following section. It was produced in 2007 for the Joint Center for Political and Economic Studies.*

It is well documented that inadequate nutrition is a key factor in infant mortality. **The four leading causes of infant mortality in the United States are birth defects, low birth weight, Sudden Infant Death Syndrome (SIDS), and maternal complications during pregnancy, including preeclampsia, anemia, infection or inflammation.[5]** Solid evidence exists linking poor maternal nutrition to birth defects, low birth weight and maternal complications. Breastfeeding is associated with SIDS reduction and reduced rates of postneonatal death.[6,7,8,9,10,11]

Nutrition and Birth Defects

- Inadequate intake of folic acid before and during early pregnancy is associated with an increased risk of spina bifida, anencephaly, and other neural tube defects. Folic acid has a protective effect against heart defects.[12] Folic acid supplementation may have an association with a lower risk of autistic disorder.[13]
- Some nutritional excesses such as vitamin A, as well as deficiencies in B vitamins, vitamin K, magnesium, copper, and zinc are linked to birth defects.
- Maternal obesity is associated with increased risk for congenital heart defects, the most common type of birth defect.[14]
- Maternal diabetes can cause fetal death and congenital anomalies, especially if poorly controlled. In women with pregestational diabetes, poor dietary control of blood sugar during critical periods of organogenesis significantly increases the risk of birth defects, particularly cardiac and neural tube defects.
- Congenital malformations are reduced among women with phenylketonuria (PKU) if they comply with dietary restrictions during pregnancy, which includes special metabolic formula consumption.

How Public Health Nutritionists Can Make a Difference

Campaigns and interventions that address healthy weight maintenance or folic acid consumption are examples of how public health nutritionists help with birth defects prevention. Medical nutrition therapy is also important for women entering pregnancy with PKU, diabetes or when gestational diabetes is identified.

Nutrition and Low Birth Weight

About one in every 12 babies in the United States is born with low birth weight (birth weight of 5 pounds, 8 ounces or less). Preterm birth (born at or before 37 weeks gestation) and fetal growth restriction are the main causes of low birth weight. Seven out of ten low birth weight babies are preterm births and one in ten babies experiences intrauterine growth restriction.[15]

- Preterm delivery is comprised of a complex interaction of factors that are still not fully understood. Factors include medical conditions such as chronic hypertension, diabetes, infections, and stress as well as the woman being underweight or obese before pregnancy.[16] Many of the factors associated with preterm birth occur together, particularly in women from diverse groups or who have low incomes.
- The Institute of Medicine[17] includes low maternal prepregnancy weight, total pregnancy weight gain less than 22 pounds or poor nutrition, pregnant woman with hypertension or diabetes as factors associated with low birth weight.
- Low prepregnancy body mass index (BMI) and poor gestational weight gain are associated with greater risk for preterm birth and fetal growth restriction.
- Nutritional deficiencies of iron, folate, and vitamins B6 and B12 can cause anemia. Strong evidence exists for an association between maternal hemoglobin concentration and birthweight and preterm birth.
- Maternal nutrition may impact inflammation which in turn could trigger spontaneous preterm birth.

How Public Health Nutritionists Can Make a Difference

Preconception care and prenatal care with a strong nutrition component helps reduce low birth weight births. WIC and community-based efforts to promote making healthy eating the easy choice are vital interventions. Medical nutrition therapy assists women who are gaining inadequately or experience medical conditions with a nutritional component.

The Promising Practices Network[18] lists the following as the most promising approaches to reducing low birth weight. These approaches will also assist in reducing birth defects and may positively impact maternal complications.

- **Improving women's general health over the life cycle. This includes improving health conditions such as diabetes, asthma, mental illness, and others that are related to poor birth outcomes.**
- **Helping women improve fertility planning to reduce unwanted pregnancies and space births at least 18 months apart.**
- **Encouraging women to engage in healthy preconception behaviors like taking folic acid supplements and identifying pregnancies in a timely fashion.**
- **Improving the health behaviors of pregnant women, including smoking cessation, reducing or quitting drug use, and appropriate weight gain.**
- **Screening pregnant women for certain medical conditions, such as infections or physical abnormalities.**

Strategies that combine nutrition-based interviews, such as improving food intakes and micronutrient status, especially iron status, with approaches that improve women's status and reproductive health are needed to reduce LBW.

— U Ramakrishnan[19]

Nutrition and Complications of Pregnancy

- Nutritional deficiencies can cause anemia. Maternal anemia can also contribute to maternal and fetal/infant death and disabilities associated with obstetrical hemorrhage.
- Maternal nutrition may impact inflammation that may lead to spontaneous preterm birth. Vitamin A, zinc, omega-3 polyunsaturated fatty acids and other micronutrient deficiencies likely play a contributing role in maternal infections. Antioxidants may play a major role in modulating inflammation and oxidative stress from maternal infections.
- Obesity among pregnant women is associated with increased risk for multiple pregnancy complications, including gestational diabetes, preeclampsia, chorioamnionitis and postpartum hemorrhage. Women who gain more weight than the recommended Institute of Medicine guidelines (1990) range have increased risks of adverse pregnancy outcomes, including gestational diabetes, prolonged labor, preeclampsia, and cesarean birth.[20] Also, for the woman, weight gain during pregnancy predicts postpartum weight retention, which may have implications for her long-term health and future pregnancies.[21]
- Diabetes complicating pregnancy is the second most frequently reported medical risk factor during pregnancy. Gestational diabetes can increase the risk of fetal macrosomia, birth trauma, newborn hypoglycemia, and hyperbilirubinemia.

How Public Health Nutritionists Can Make a Difference

Again, preconception and prenatal education with a strong nutrition focus are essential and medical nutrition therapy is critical for women with specific health concerns.

"Considering the complexity of the topic, it is unlikely that any specific nutrient on its own, blanket interventions or magic bullets will prevent or treat preeclampsia, hemorrhage, obstructed labor, infections, preterm delivery or death during pregnancy. … . Until then, women and their families should receive support to improve their diets as a general health rule, which is a basic human right."

— J Villar [22]

Nutrition and Sudden Infant Death Syndrome (SIDS)

The *Report of the Secretary's Advisory Committee on Infant Mortality* (SACIM)[23] emphasizes that breastfeeding is a well-known but not sufficiently implemented intervention that can reduce preventable post-neonatal mortality. The report recommends that the United States Department of Health and Human Services promote breastfeeding.

- The risk of sudden infant death syndrome is 56 percent higher among infants who have never breastfed.[24]
- Breastfeeding is associated with a reduction in risk for postneonatal death.[25]
- Exclusive breastfeeding reduces infant mortality from common childhood illnesses such as diarrhea or pneumonia and helps promote a faster recovery from illnesses.[26]
- Breastfeeding is also associated with the development of a preterm infant's immature host defense.[27]

How Public Health Nutritionists Can Make a Difference

Public health nutritionists are important partners in breastfeeding promotion and support through efforts within WIC, MCH programs, and breastfeeding coalitions. Public health nutritionists can collaborate on breastfeeding promotion campaigns, workplace lactation accommodation efforts, implementation of evidence-based maternity care practices such as the Baby Friendly Hospital Initiative, and innovative efforts such as state programs that pay for donor breast milk.

Emphasizing Nutrition to Prevent and Reduce Infant Mortality

Nutrition can play a critical role in decreasing infant mortality rates. At least five nutrition-related areas need to be addressed when considering infant mortality reduction, they are:

- Dietary quality
- Healthy weight entering pregnancy
- Appropriate weight gain during pregnancy
- Medical nutrition therapy for chronic conditions
- Breastfeeding

Preventing infant mortality requires a systems approach that removes critical barriers to pregnant women receiving adequate nutrition. These barriers include access to health care, access to healthy foods, professional training and education, strengthening of referral and care coordination systems, and an overall integration of nutrition into a life course perspective within health and public health systems.

Clinical and public health nutrition efforts are both vital in reducing birth defects and low birth weight, increasing breastfeeding and minimizing maternal complications. Clinical interventions include working as part of the health care team to assist a woman in controlling her diabetes or hypertension. Some efforts such as supporting use of folic acid prior to conception may be accomplished in a clinical or public health setting. Public health nutrition professionals also participate in activities that support community and environmental change strategies, such as campaigns to educate professionals and women about the 2009 Institute of Medicine weight gain guidelines or creating environments where healthy eating is the easy choice.

— Nutrition Focus Areas —

The following nutrition focus areas should be considered when developing infant mortality interventions.

1 Nutrition through the Life Course

Women need community environments that support active living and healthy eating. Eating well is important to a healthy life and pregnant women may need guidance to develop this essential skill. Healthy eating behaviors require the ability to access, select and prepare food and beverages. People typically learn these behaviors in families, so it is important that parents know and can transfer these skills. Educators and practitioners in community, school and health care settings assist families in learning about choosing and eating healthy foods. Additionally, some women need access to well-trained health care professionals for counseling to address nutrition-related conditions such as obesity or diabetes.

2 Preconception Care and Pregnancy

It is critical that practitioners include nutrition as part of preconception education since many women do not know they are pregnant well into the first trimester. Nutritional deficiencies before and in early pregnancy are most harmful to the developing fetus and may lead to birth defects in susceptible individuals. Diet in the first trimester may be more important to development and differentiation of various organs. Diet later in pregnancy appears to be important for overall fetal growth as well as brain development.[44]

Preconception nutrition topics include entering pregnancy at a healthy weight, dietary quality and the use of folic acid. During the prenatal period, women need to learn about breastfeeding and appropriate weight gain. Access to the nutrition counseling and the foods offered through the WIC program will benefit pregnant and breastfeeding women with limited incomes. Health care providers and others need to be aware of and make referrals to programs within the community that assist families with limited resources. Post-partum nutrition efforts include returning to a healthy weight and healthy eating and support for breastfeeding.

Healthy Weight and Weight Gain During Pregnancy

More women are entering pregnancy obese and overweight, conditions associated with poor birth outcomes. The most recent National Health and Nutrition Examination Survey (NHANES) found that in the United States, more than one third of women are obese, more than one half of pregnant women are overweight or obese, and eight percent of reproductive-aged women are extremely obese.[32] Also, entering pregnancy underweight and experiencing inadequate weight gain remain factors associated with low birth weight births.

The Institute of Medicine's 2009 report on weight gain during pregnancy[33] reinforces the importance of prepregnancy weight and appropriate weight gain during pregnancy. According to the report, appropriate weight gain, diet and exercise are important factors in both pregnancy outcome and the long-term health of mother and child.[34] The American College of Obstetricians and Gynecologists[35] recommends that all prenatal patients receive counseling about weight gain, diet, and exercise.

Evidence shows that counseling about diet, exercise, and weight gain may currently be inadequate in prenatal and primary care settings, with not all pregnant women receiving sufficient advice regarding weight gain recommendations or dietary quality.[36,37] Approximately one third to one half of patients may not receive advice on pregnancy weight gain[38] from their prenatal care practitioner. Overweight and obese women were more likely to report that they had received advice about the Institute of Medicine's weight gain recommendations (1990), but these women reported weight gain ideals and expectations above these recommendations.[39] These failings may be in part due to health care providers' lack of knowledge in these areas, limited assessment or attention to these topics and patient misunderstanding. Many opportunities exist for public health nutrition in addressing this area.

Dietary Quality

The role of nutrients during pregnancy is well-studied; strong evidence exists that connects maternal nutrition and infant outcomes. However, women eat food, not nutrients, so knowledge about food patterns and behaviors is vital. Strong evidence also exists that pregnant women who are younger, less educated, had more children, and those who had higher prepregnancy body mass index (BMI) also had poorer-quality diets.[29,30]

Dietary patterns and quality among pregnant women is not readily available. However, the Pregnancy, Infection, and Nutrition (PIN) Study in North Carolina indicates that among pregnant women studied, soft drinks, fruit juices, biscuits, muffins, white bread, and other refined carbohydrates were the leading sources of energy from carbohydrates, while mayonnaise, salad dressings, whole milk, french fries, and fried potatoes were the leading sources of energy from fats. A review by Lu[31] indicates that pregnant women in the United States consume more protein, fat and trans-fat, and carbohydrates than recommended. The same review indicated that a substantial proportion of pregnant women do not meet their recommended daily allowances (RDA) for iodine, calcium, magnesium, iron, zinc, vitamins A, B1, B2, B3, B6, B12, and vitamin C from food sources. Dietary intake of folate and vitamin A was inadequate even when multivitamin use was taken into account. Policies that support a healthy eating environment, healthy eating campaigns and individual nutrition counseling all help to improve dietary quality.

Special Supplemental Food Program for Women, Infants and Children (WIC)

The United States has long placed an emphasis on nutrition when addressing the needs of pregnant women, infants and children. The recognition that nutrition impacts infant mortality led to the development of the Special Supplemental Food Program for Women, Infants and Children (WIC) in the 1970s. Studies show that the WIC program, which focuses on nutrition assessment, counseling and access to food, does reduce conditions associated with infant mortality such as low birth weight. Infants born to mothers enrolled in WIC are also less likely to die from genetic conditions or delivery complications.[40] However, not all women are eligible for WIC, which is income and risk-factor based. Women who are eligible need to be referred and encouraged to enroll in WIC. Women who are not eligible for WIC will rely on health care providers to offer support for appropriate weight gain and dietary quality.

Nutrition and Fetal Origins of Adult Disease Theory

While indirectly related to infant mortality, research about fetal origins of adult disease is intriguing.[41] Evidence links adverse exposures in early life, particularly related to nutrition, to chronic disease susceptibility in adulthood, further emphasizing the importance of maternal nutrition. Nutrition is the major intrauterine environmental factor that alters expression of the fetal genome and may have lifelong consequences.[42] Promoting optimal nutrition will not only ensure optimal fetal development, but will also reduce the risk of chronic diseases in adults.[43]

Affordable Care Act (ACA)

The current health care system does not do enough to ensure that all women have access to the education and support they need to develop positive behaviors. The Affordable Care Act expands health care access, which is an essential step to ensuring health. However, access is only part of the equation. It is also important that a woman receives the right care, in the right intensity, provided by a trained professional. Effective systems of care and care coordination will reduce fragmentation of care. Quality improvement efforts will help identify the best ways to support breastfeeding, achieve a healthy weight, appropriate prenatal weight gain and other topics. To be effective, interventions need to be trust-based, culturally and linguistically competent, and address other elements intrinsic to a satisfactory health care relationship.

The development of a medical home for women is a promising idea that could address needs from conception and infancy through adulthood, focusing on topics such as healthy eating and physical activity during the life course. Strengthened referral systems will ensure that a woman receives the comprehensive services she needs from the best trained professionals. Women can access the services they need by a referral to WIC, through counseling about healthy eating and weight gain during pregnancy, or referral to a registered dietitian for medical nutrition therapy when needed.

Another opportunity in the ACA is the focus on training health professionals. All primary health practitioners will benefit from training to routinely screen for nutrition concerns and to address those issues through counseling or referral. It is important that these primary care practitioners receive education about evidence-based nutrition science and are able to provide basic nutrition assessment and diet counseling and to know when to refer patients to a nutrition specialist.

The Critical Role That Public Health Nutritionists Play in Infant Mortality Reduction

Nutrition is an integral component of infant mortality reduction efforts. Public health nutritionists play many important roles in reducing infant mortality. A primary role is to integrate nutrition into infant mortality prevention efforts. The role of public health nutrition ranges from assessment and research to supporting access to care.

The following four strategies, if achieved, will better integrate nutrition into infant mortality prevention efforts.

1. Public health nutritionists are included in all levels of infant mortality prevention efforts.
2. Environments exist that support breastfeeding and where healthy eating is the easy choice for women, especially those who are or are contemplating becoming pregnant.
3. Life course and preconception care address maintaining or achieving a healthy weight and eating well.
4. Prenatal care addresses appropriate weight gain, healthy eating, medical nutrition therapy as needed and referrals to WIC, if appropriate.

Call to Action

To achieve these strategies, public health nutritionists must work with colleagues to:

- Ensure that nutrition is an integral component of all federal, state and community infant mortality prevention interventions.
- Engage in program development, policy, systems and environmental change activities that support the health of women.
- Support access to healthy foods for girls and women during the life course and education on eating well and maintaining a healthy weight.
- Provide preconception care that specifically addresses healthy weight, eating well, chronic conditions and nutrition related risk factors.
- Address appropriate weight gain during pregnancy, provide any necessary medical nutrition therapy, refer eligible women to WIC, and support breastfeeding initiation.
- Encourage the development of positive feeding behaviors for infants and children throughout the life course.
- Seek solutions to hunger, food insecurity and other factors that reduce women's ability to eat well.

Summary

Nutrition is an essential component of efforts to reduce infant mortality. While a focus on nutrition alone is insufficient to eliminate infant mortality, efforts to reduce infant mortality will only be effective if nutrition is part of a comprehensive effort. Available data and current practice reinforces the importance of nutrition prior to and during pregnancy. However, evidence also indicates that supporting healthy eating and appropriate weight gain during pregnancy is not being done consistently for pregnant women. Nutrition should be integrated into activities directed at reducing infant mortality.

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— Notes —

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