

## **Postpartum Obesity: The Root Problem of Childhood Obesity?**

Valencia Browning Keen and Claudia Sealey Potts

Valencia Browning Keen, DPD Director of Dietetics and Dietetic Internship Director, and Professor, Department of Family and Consumer Sciences Sam Houston State University

Claudia Sealey Potts, Department of Nutrition, University of North Florida

### **Abstract**

Remedying childhood obesity cannot take place without first identifying relevant issues commonly influencing gatekeepers of food for children as well as the role modeling for encouraging or discouraging daily activities. Children cannot drive to the store, form grocery lists or complete menu management tasks without adult assistance. Excessive weight gain during pregnancy leads to weight retention postpartum and often increases with each pregnancy. Maternal and postpartum obesity is associated with increased risk of developing gestational diabetes, metabolic syndrome, prenatal morbidity and increased risk of obesity in the offspring through adolescence which without intervention, leads to adulthood obesity. According to the Center for Disease Control (CDC) data, weight gain in excess of the Institute of Medicine (IOM) guidelines is common. CDC data has shown, between 1990-2005, gaining > 40# in all Body Mass Index (BMI) categories has increased between 15-20%. Considering insurance coverage for weight loss management is not promoted by all health care practitioners for all postpartum women and only a percentage of postpartum women choose to breastfeed which can enhance weight loss, strategies for recommending dietitian services to clinics, hospitals and communities for helping moms or gatekeepers lose weight will be shared.

### **Introduction**

The Medline ERIC, Cochrane Database and the Evidence Based Library of the American Dietetic Association were used in the identification of the articles and data cited in this paper. Keywords: perinatal, pre-conception, postpartum obesity, postpartum retention weight, childhood obesity and the overweight and obese pregravid weights affecting medical complications of pregnancy were used. Articles cited in this review are as a result of limited studies on the root problem of childhood obesity and its connection to postpartum obesity. The following is an exploration of various facts, consequences, explanations and recommendations for future direction of intervention to be considered in managing the childhood obesity epidemic.

### **The Problem of Excess Weight Gain During Pregnancy and its Future Postpartum Implications**

Pregnancy is a time during which dramatic psychosocial, physiologic and behavioral changes occur and have long lasting and direct affects on the developing fetus as well as the health of the mother during the current pregnancy as well as future pregnancies. In the United States,

unhealthy gestational weight gain is prevalent and excessive weight gain is more obvious than inadequate weight gain. More than 40% of women begin their pregnancies overweight or obese (Laraia, 2010). Excessive weight gain as well as pregravid overweight can contribute to the development of pre-eclampsia (Bodnar, 2005), gestational diabetes (Solomon, 1997), pregnancy-induced hypertension (Thadhani, 1999) and postpartum anemia (Bodnar, 2004). The literature continues to reveal a need for recommendations of various racial and ethnic groups within the United States and other countries regarding healthy amounts of gestational weight goals along with recommendations for the pregnant adolescent (Olson, 2008). In an effort to recommend appropriate maternal weight gain to reduce low birthweight infants, the Institute of Medicine (IOM) in 1990 developed what was considered appropriate maternal weight gain recommendations and were revised in 2009 (IOM, 2009). These guidelines have been adopted by the American College of Obstetricians and Gynecologists and the guidelines recommend a pattern of weight gain that should be recommended at each trimester during the prenatal visits. Two to four pounds are the recommendations by the end of the first trimester and a pound per week is recommended each week thereafter until the term of the pregnancy. The Institute of Medicine (IOM) believes that any weight above or outside these recommendations contributes to excess adipose tissue deposition versus sustaining the caloric and nutrient needs of pregnancy (Butte, 2004 & Smith, 2008). Stotland (2006) reported that 43% of singleton pregnancies had maternal weight gain above the recommended IOM BMI categories in a cohort of nondiabetic term pregnancies. The strongest influence on weight retention postpartum, seems to be the amount of weight gained during the pregnancy (Gunderson & Abrams, 2000). Olsen and colleagues (2003) investigated the weight gain of 540 healthy pregnant women. Thirty-eight percent gained within the Institute of Medicine guidelines. Even though the mean sustained weight gain at the one year evaluation was  $1.51 \pm 5.95$  kg., 25% of the women sustained a weight gain of 4.55 kg or more one year postpartum.

### **Metabolic Consequences of Maternal Obesity and Influences on Fetal Development and Potential Influences on Childhood Obesity**

Good nutritional status for an optimal pregnancy outcome begins before conception. Adequate nutrient stores for fetal development is critical but excess is unnecessary for the mother as well as the developing infant and child. The prevention of obesity in children does begin in utero and in early infancy as well as childhood (Johnson, 2006). Obesity during pregnancy is associated with adverse outcomes which may include: fetal macrosomia, low birthweight, preterm birth, and increased risk of cesarean delivery (Smith, 2008).

Several factors affect the progressive development of the fetus. These include: genetics and the maternal environment. While genetics will always influence the growth rates of the fetus, the environment induces changes in fetal growth in regard to nutrient availability or transfer of nutrients, maternal hormones and oxygen levels. Environmental factors in utero may influence body size, adiposity and risk of chronic disease throughout life (Oken & Gillman, 2003; Ozanne,

2004). A large birth weight appears to be associated with high Body Mass Index (BMI) as an adult (Oken & Gillman, 2003 & Johnson, 2006).

When identifying the substrate exchange between mother and child, the quantity of glucose, fatty acids and amino acids as well as insulin, leptin and adiponectin can reach abnormal levels and contribute to metabolic complications which then lead to preeclampsia, pregnancy induced hypertension and gestational diabetes (King, 2006). The ongoing effects of increasing hyperglycemia in pregnancy is associated with an increased risk of childhood obesity (Hillier, 2007). Pettitt (1998) found an overall linear association between maternal glucose concentration ( 2 hour glucose on the 75-g oral glucose tolerance test (OGTT) and obesity in Pima Indian offspring. The strongest single risk factor for obesity in Pima Indian children is exposure in utero to maternal diabetes, independent of maternal obesity and birth weight (Hillier, 2007).

Large for gestational age infants occurs more often among obese women versus normal weight women (Castro, 2002). Larger placental-to-birth weight ratios are more common in women with higher BMI's (Fox, 2004). The embryonic and placental development is not only complex but extremely sensitive and delicate processes which develop due to nourishment exchanges between the mother and fetus. Infants born to obese women have shown a higher prevalence of congenital anomalies as compared to normal weight women. Since adipose tissue is an active endocrine organ, the maternal hormones can alter the cytokines, metabolites and growth factors which can affect embryonic development. Obese women are more likely to present with larger placentas as well as larger infants (Evans, 1997). Predictors of adult onset chronic diseases such as coronary heart disease, diabetes and hypertension have been noted in children who were born to women with larger placentas (King, 2006).

Maternal obesity could produce a hypoxic state if glycosylated hemoglobin levels are increased and the affinity for oxygen is reduced. Because of the adipose tissue being an active endocrine organ, metabolic deviations are already in place and will contribute to congenital malformations. Maternal obesity produces a subclinical inflammatory state since increases in body fatness are associated with elevated cytokine levels and subclinical inflammation (Godfrey & Barker, 2001). Due to these pathophysiological changes, the developing infant adjustments involve metabolic and circulatory changes to provide nourishment, oxygen and removal of waste products. The fetus and the progressing infant uses the environment to make decisions such as immediate survival choices or long term adjustments such as secreting excess insulin if the fetus experiences high blood glucose levels. Environment signals from obese mothers to the fetus influences the fetal development(King, 2006). Epidemiological studies suggest a strong relationship between birth weight and childhood and adult body mass index (BMI). High birth weight appears to be associated with high BMI in an adult whereas low birth weight has been associated with high central adiposity (Johnson, 2006).

## **The Infant and Early Childhood Introduction of Solid Foods and Childhood Obesity**

Flavors of the maternal diet during pregnancy and the flavors of breastmilk experienced by some infants are certainly influenced by the diet of mom ( Mennella, 1995; Hauser, 1985; Schaal, 2000; (Mennella, 2001; Sullivan & Birch, 1994; Pearcey & DeCastro, 1997). As children have various solid foods introduced to them, the culture, preference and choices of their parents and or additional care givers reflect the foods available and accessible considering they do not drive or shop. To promote healthy intake patterns as well as realistic activity patterns, research has identified various areas to consider when attempting to identify the contributions to childhood obesity. These include: exposure and positive affirmations, repeated experiences with food, observation of others consumption of food, parenting styles and role modeling of good food habits, access to media, who is present during family meals, what is served and strategies used to feed children continue to be emerging themes in the literature ( Fisher & Birch, 1999; Fitzpatrick, 2007; Tibbs, 2001).

The pattern of growth and the rapid and early weight gain in infancy appears to increase the risk of overweight in childhood and into adulthood (Johnson, 2006). During the preschool years, there is a decrease in BMI yet begins to increase between the ages of 4-7. Adiposity rebound needs to be assessed between these years. Children who experience early BMI rebounds are often heavier throughout childhood . The parent's perception of their child's weight is of relevance as to whether they believe their child's weight is inappropriate. By sharing the plotting of their child's anthropometrics on the growth grid as a tool to reveal to parents that crossing percentiles on the growth chart in a short period of time can be a cause of concern, parents can become more actively involved in their child's growth interruption if it is too rapid.

## **Postpartum Weight Gain**

Childbearing in most cultures is not associated with an increased risk of obesity. For a subset of women however, the postpartum period appears to be a growing critical risk period of weight retention. Weight retention beyond 2 years postpartum has been examined in very few studies( Gunderson, 2004; & Smith, 1994) and only one study has examined weight retention up to 15 years postpartum (Linne, 2004) and one at 21 years postpartum (Mamum, 2010). Most of the weight gain during postpartum has been due to environmental pressures such as access to food throughout the day considering they are still on maternity leave in their home environments that they are usually away from during the day. Our culture often greets the new arrival in the home with foods from the church, neighborhood and workplace the family may have not traditionally purchased or ate before so that the new mother does not have to cook. Lower levels of exercise, increased time watching television, less social support, increased food intake, greater access to food during the day all contribute to retaining the weight gain and possibly increasing even more weight (Harris, 1999).

Carter, Baker and Brownell (2000) recognized a relationship between postpartum depression and BMI as well as eating attitudes which could contribute to inadequate dietary intakes and potential eating disorders. A number of studies have reported inadequate intakes of omega-3, folate, B Vitamins, iron and calcium in pregnant women which can increase a mother's risk for maternal depression as identified in Leung and colleagues literature review of perinatal depression and nutrition links often leading to postpartum depression and misguided food choices (Leung, 2009).

In our present culture, many women have chosen to support partial breastfeeding which has not shown compelling evidence with substantial weight loss in the postpartum woman (Lederman, 2004) consistently. In Arenz, et al's (2004) meta-analysis of nine studies with a total of more than 69,000 participants, breastfeeding showed a small but protective effect against obesity in children. In Grummer-Strawn & Mei, 2004 and Bogen, et al 2004 studies of low-income children of non-Hispanic white children, a protective effect of breastfeeding were identified with an effect against obesity in children. Exclusive breastfeeding for several months seems to offer the most protection against obesity (Poulton, 2001). According to Gunderson and Abrams (2000), postpartum weight retention is most likely due to factors such as inappropriate dietary intake, lack of physical activity, limited lactation, smoking status, pre-gravid body mass index and parity. Gunderson and colleagues, (2008) have also recognized that sleeping  $\leq 5$  hours/day at 6 months postpartum is strongly associated with retaining  $\geq 5$  kg at one year postpartum.

### **Childhood and Puberty**

Most childhood obesity and adolescent experts agree that the obesogenic environment contributes to the lack of exercise and or daily activity patterns . Dietary recommendations for developing healthy and lifetime food habits in order to provide variety, nutrient dense versus energy dense foods, avoiding overconsumption of beverages and food through proper modeling behavior by parents is critical (Nicklas, 2004; Savage& Fisher& Birch, 2007). Berkowitz, et al (2005) looked at the growth of children at risk for obesity from birth to 6 years of life who were born to either overweight or lean mothers. Weight and lean body mass was greater at 4 and 6 years of age and fat mass was greater at 6 years in children born to overweight mothers. As mentioned earlier, children who experience BMI rebounds early tend to be heavier throughout their childhood and can have higher BMI's later in childhood progressing toward high BMI's in adulthood as well (Freedman et al, 2001). Adiposity rebound is considered a critical time frame during childhood. Obesity in this period strongly predicts adult obesity(Hillier et al, 2007).

Early onset of puberty has been shown to be associated with high adiposity when the child reaches adulthood (Laitinen et al, 2001). African American girls who have matured early ( $\leq 11$  years of age), are at twice the risk of being overweight as adults compared with African American girls who mature at an average age (Morrison et al, 1994). While data is limited, a diet high in fiber and low in fat with a daily routine being active may be protective against early

puberty (Johnson, 2006). Low income adolescent girls who report seeing their fathers consume milk have higher calcium intakes than do girls who do not see their fathers drink milk. Parental modeling has been positively associated with greater fruit juice and vegetable intake among children and adolescents (Savage et al, 2007). Decreasing the risk of obesity in children and adolescents takes the homes, schools, and communities embracing and promoting healthy foods and activities (Johnson, 2006 & Savage, 2007).

### **Food Insecurity in the Life Cycle and its Impact on Childhood Obesity**

For the health of our next generation, combating and intervening against the impact food insecurity has on childhood obesity is critical. Malnutrition has been identified as a condition of undernutrition as well as overnutrition (Tanumihardjo et al, 2007). Poverty related factors include food insecurity and can contribute to barriers to recommendations of weight gain and poor pregnancy outcome (Borders et al, 2007). Of the eight Millennium Development Goals set by the United Nations Millennium Declaration in the Year 2000, eradicating extreme poverty and hunger was identified as goal number one and was agreed to have continuous evaluation as to the progress toward eradication until 2015 (Tanumihardjo et al, 2007). The fourth Millennium Development Goal is to reduce child mortality which is associated with the obesity pandemic in children. A new paradox has emerged worldwide that links poverty, food insecurity and malnutrition to obesity. The paradox is an interrelationship which identifies poverty as causing food insecurity yet one of the outcomes of food insecurity which is identified is obesity. How can this be? Excessive caloric energy may be available but the nutrient density or quality and variety of foods in the community or culture of people is limited in micronutrients. It should be noted that households as food insecure in America also have the highest body mass index (BMI) and ongoing prevalence of obesity or BMI being  $\geq 30$  (Jackson et al, 2003). In a population-based, cross-sectional survey of Jamaicans, income was positively related to obesity in men however in women, rates of obesity was high among the poor as well and a relationship that is often seen in non-hispanic black women in the United States (Mendez et al, 2004 & Flegal et al, 2002).

Women are unfortunately overrepresented in the numbers of poor throughout the world and typically linked to inequalities in the workforce and take-home salaries. Yet, the woman is usually the educator, role model and health care “Mom” who teaches their children about proper exercise, nutrition education and activity. Children in single-parent homes are more likely to present with low height-for-age (Tanumihard et al, 2007). Height cannot be retrieved at certain times during a child’s development therefore, the child who does not reach his height potential may end up considered overweight or obese according to the WHO and CDC growth grids if their height is never achieved (Medeiros & Wildman, 2012).

Early prenatal and postnatal metabolic conditions of mothers such as obesity and diabetes can have a direct result of imprinting on the neuroendocrine pathways that are linked to energy utilization and balance in the developing fetus. The body weight of mom appears to be linked to

the potential body weight of the infant. Nutrition education knowledge can assist the new mother on how to make better choices to combat modeling poor food choices in the postpartum mom so that weight loss can be achieved and to limit the child from making poor food choices as well ( Nuss et al, 2007& Kloe-Lehman et al, 2006). Unfortunately, while many programs exist to assist with access to food for the food insecurity issues, a positive relationship has been observed between the SNAP program participation and increasing body weight in adult women which is not the goal (Gibson, 2003).

Apparently as income increases along with education, the prevalence of obesity decreases. Data shows that household cost constraints contribute to foods high in fat and carbohydrate choices because they are cheaper (Drewnowski, et al, 2004 & Kloe-Lehman, et al, 2006).

### **Interception in the Life Cycle**

Poor modeling of good nutritional habits and providing proper access and availability of food to the developing child can possibly prevent the progression toward obesity in childhood if proper intervention is adhered to (Tanumihardjo et al, 2007). Because postpartum women sometimes develop psychosocial factors such as: depression or depressive symptoms and negative body images, proper adherence to dietary guidelines may be hindered particularly if they face low economic pressures (George et al, 2005). Postpartum women should be encouraged to maintain positive changes in their lifestyle even after the baby is here. Recommendations include: increased consumption of vegetables and fruits, continued use of MyPyramid Mom by the USDA computer application and meal management ideas (Wansink, 2008), whole grains and a regular aerobic and strength training exercise routine. The relationship of the amount, composition and pattern of weight gain for overweight, obese and severely obese women to maternal and child health outcomes in the long term is needed. A documented measured height and weight in the medical record at each visit would be beneficial for comparisons during postpartum gestational weight gain comparison.

Early on in the pregnancy, breastfeeding should be encouraged by the entire health care team for the weight management benefits for both the mother and the child. First Lady, Michelle Obama's quest for focusing on the *Rate Your Plate nutrition education tool* ( a nutrition education model which focuses on the balanced proportionality of the percentage of carbohydrates, protein, fats and fibrous foods that should be on a person's plate using real food) is an ideal platform for a cost effective integrative tool for teaching about meal planning for the peri, pre and postpartum woman. According to Yuasa and colleagues (2008), eating family meals every day is linked to the absence of obesity as well as good lifestyle habits, including meal quality such as eating more vegetables. Children who eat family meals at home are shown to consume a diet of higher quality (Gillman et al, 2000).

## Connection to Referral System and Postpartum Obesity

There appears to be a lack of coordination and research in numerous communities as to how nutrition education is provided to pregnant women relating to maternal weight gain and dietary information provided in all areas of the health care system. There is an extended need to identify how nutrition education regarding weight gain and dietary recommendations are influencing their behavior to any extent as noted in the *Position paper for the American Dietetic Association, Obesity reproduction and pregnancy outcomes* (2009). Referrals to registered dietitians should be made to the registered dietitian (RD) anytime one of the following conditions is identified in the peri/pre and postpartum woman. These include: Poor Dietary pattern adherence, phenylketonuria, diabetes, hypertension and any substance abuse (*ADA Position Paper for a Healthy Pregnancy Outcome, 2008*). These conditions exist outside the WIC clientele as well. The case may or may not have a dietitian who has been referred. The lack of attention to weight management issues during the postpartum period is not typically reimbursed in the current health care system unless one of the medical conditions noted above is the reason for the referral.

During the 6 week postpartum period which is the last time the woman is usually scheduled to see her obstetrician and or gynecologist would be the ideal time postpartum for a referral to a dietitian if weight loss is not occurring according to the literature since over two-thirds of women have not attained their prepregnancy body weight (Krummel, 2007). A lack of reimbursement for preventive services is typical in many resources designed for postpartum women. Medicaid ends at two months postpartum and WIC (women, infants, and children) ends at 6 months postpartum (Walker, et al, 2005). Referrals to the registered dietitian needs to include a seamless coding system that could be used by the Food Stamp Program, WIC for longer than 6 months, the Expanded Food and Nutrition Education Program, any Commodity supplemental Food Programs and all outpatient services that employs registered dietitians for as long as it takes to assist the postpartum mother to achieve her prepregnancy weight.

## Conclusion

There is a need for studies with sensitive measures to determine the micronutrient status of the overweight or obese peri, pregnant or postpartum woman. The benefits of breastfeeding should be encouraged by the physician with a strong referral system in place for the dietitian's prolonged involvement for weight loss intervention, nutrition education, goals for achieving weight loss and better role modeling to prevent childhood obesity (Krogstrand, et al, 2005). There also appears to be a lack of research in the area of how nutrition information is actually provided to women during the peri, pre and postpartum journey and whether or not these women have chosen to adhere to the information given (Position Paper of ADA, 2009). The postpartum period is characterized by numerous factors that may lead to weight retention and poor food habit modeling to the developing child (George et al, 2005).



Low income mothers face particular stresses on their wages which may limit the adherence to proper meal planning. New stress, depressive symptoms, negative body image may lead to poor dietary choices. Depressive symptoms that contribute to poor food choices need to be assessed more often for proper intervention to occur. Programs that attempt to intervene with changing dietary habits must address the potential psychosocial issues that may contribute to poor food choices. Because registered dietitians hold certification in weight management, they are ideal for a proper referral source and protocol for proper weight loss and weight management intervention of the postpartum woman and her children if they are overweight or obese. Specific referral guidelines need to be established by all policy makers to enact a seamless referral system to the registered dietitian for intercepting the weight retention in postpartum women so that another generation of overweight or obese children will not persist in America's future.

## References

- Arenz, S., Ruckerl, R., Koletzko, B., von Kries, R. (2004) Breastfeeding and childhood obesity-a systematic review. *International Journal Obesity Related Metabolic Disorders*, 28, 1247-1256.
- Berkowitz, R.I., Stallings, V.A., Maislin, G., Stundard, A.J. (2005). Growth of children at high risk of obesity during the first 6 years of life: implications for prevention. *American Journal of Clinical Nutrition*, 81, 140-146.
- Bodnar L.M., Siega-Riz A.M., Arab L., Chantala K., McDonald T. (2004) Predictors of pregnancy and postpartum haemoglobin concentrations in low-income women. *Public Health Nutrition*, 7, 701-711.
- Bodnar, L.M., Ness, R.B., Markovic, N., Roberts, J.M., (2005) The risk of pre-eclampsia rises with increasing prepregnancy body mass index. *Annual Epidemiology*, 15, 475-482.
- Bogen, D.L., Hanusa, B. H., Whitaker, R.C. (2004) The effect of breastfeeding with and without formula use on the risk of obesity at 4 years of age. *Obesity Research*, 12, 1527-1535.
- Borders, A.E., Grobman, W.A., Amsden, L.B., Holl, J.L.(2007) Chronic stress and low birth weight neonates in a low-income population of women. *Obstetrics and Gynecology*, 109,331-338.
- Butte, N., Wong,W.K., Treuth, M., Ellis, K., Smith, E., (2004) Energy requirements during pregnancy based on total energy expenditure and energy deposition. *American Journal of Clinical Nutrition*, 79, 9.
- Carter, A., Baker, C., and Brownell, K. (2000). Body mass index, eating attitudes and symptoms of depression and anxiety in pregnancy and the postpartum period. *Psychosomatic Medicine*, 62, 264-270.
- Castro, L.C., Avira, R.L. (2002) Maternal obesity and pregnancy outcomes. *Current Opinion in Obstetrics and Gynecology*, 14, 601-606.
- Drewnowski, A., and Specter, S.E. (2004)Poverty and obesity: the role of energy density and energy costs. *American Journal of Clinical Nutrition*, 79,6-16.
- Evans, W.L., Newnham, J. (1997) Prospective cohort study of factors influencing the relative weights of the placenta and the newborn infant. *British Medical Journal*, 314,1864-1868.
- Fisher, J.O., Birch, L.L. (1999) Restricting access to a palatable food affects children's behavioral response, food selection and intake. *American Journal of Clinical Nutrition*, 69,1264-1272.
- Fitzpatrick, E., Edmunds, L.S., Dennison, B.A. (2007) Positive effects of family dinner are undone by television viewing. *Journal of the American Dietetic Association*, 107, 666-671.
- Flegal, K.M., Carroll, M.D., Ogden, C.L., Johnson, C.L. (2002) Prevalence and trends in obesity among US Adults, 1999-2000. *Journal of the American Dietetic Association*, 288,1723-1727.
- Freedman, D.S., Kettel, K.L., Serdula, M.K., Srinivasan, S.R., Berenson, G.S. (2001) BMI rebounds, childhood height and obesity among adults: the Bogalusa heart study. *International Journal Obesity Related Metabolic Disorders*, 25, 543-549.
- George, G.C., Milani, T.J., Nuss-Hanss, H., Freeland-Graves, J.H. (2005) Compliance with dietary Guidelines and relationship to psychosocial factors in low-income women in late postpartum. *Journal of the American Dietetic Association*, 105,916-926.
- Gibson, D. (2003) Food stamp program participation is positively related to obesity in low-income women. *Journal of Nutrition*, 133,2225-2231.

- Gillman, M.W., Rifas-Shiman, S.L., Frazier, L., Rockett, H.H., Camargo, C.A., Field, A.E., Berkey, C.S., Colditz, G.A. (2000) Family dinner and diet quality among older children and adolescents. *Archives of Family Medicine*, 9,235-240.
- Godfrey, K.M. & Barker, D.J. (2001) Fetal programming and adult health. *Public Health Nutrition*, 4,611-624.
- Grummer-Strawn, L.M. & Mei, Z. (2004) Does breastfeeding protect against pediatric overweight? Analysis of longitudinal data from the Centers for Disease Control and Prevention Pediatric Nutrition Surveillance System. *Pediatrics*, 113, E81-E86.
- Gunderson, E.P., & Abrams, B. (2000) Epidemiology of gestational weight gain and body changes after pregnancy. *Epidemiology Reviews*, 22, 261-274.
- Gunderson, E.P., Murtaugh, M.A., Lewis, C.E., Quesenberry, C.P., West, D.S., Sidney, S. (2004) Excess gains in weight and waist circumference associated with childbearing: the coronary artery risk development in young adults study (CARDIA). *International Journal of Obesity Related Metabolic Disorders*, 28, 525-535.
- Gunderson, E.P., Rifas-Shiman, S.L., Oken, E., Edwards-Rich, J.W., Kleinman, K.P., Taveras, E.M., Gillman, M.W. (2008) Association of fewer hours of sleep at 6 months postpartum with substantial weight retention at one year postpartum. *American Journal of Epidemiology*, 167, 178-187.
- Harris, H.E., Ellison, G.T., Clement, S. (1999) Do the psychosocial and behavioral changes that accompany motherhood influence the impact of pregnancy on long-term weight gain? *Journal Psychosom Obstetrics and Gynecology*, 20, 65-79.
- Hauser, G.J., Chitayat, D., Berns, L., Braver, D., Muhlbauer, B. (1985) Peculiar odours in newborns and maternal prenatal ingestion of spicy foods. *European Journal of Pediatrics*, 144(4) 403.
- Hillier, T.A., Pedula, K.L., Schmidt, M.M., Mullen, J.A., Charles, M.A., Pettitt, D.J. (2007) Childhood obesity and metabolic imprinting. *Diabetes Care*, 30, 2287- 2292.
- Institute of Medicine, IOM. (2009) Weight Gain during pregnancy: Reexamining the guidelines. Washington, D.C.
- Jackson, M., Walker, S., Forrester, T., Cruickshank, J.K., Wilks, R. (2003) Social and dietary determinants of body mass index of adult Jamaicans of African origin. *European Journal of Clinical Nutrition*, 57,621-627.
- Johnson, D.B., Gerstein, D.E., Evans, A.E., Lopez-Woodward, G. (2006) Preventing obesity: a life cycle perspective. *Journal of the American Dietetic Association*, 106, 97-102.
- Journal of the American Dietetic Association (2008). Position of the American Dietetic Association: Nutrition and Lifestyle for a Healthy Pregnancy Outcome. *Journal of the American Dietetic Association*, 108,553-561.
- Journal of the American Dietetic Association (2009). Position of the American Dietetic Association and American Society for Nutrition: Obesity, Reproduction, and Pregnancy Outcomes. *Journal of the American Dietetic Association*, 109,918-927.
- King, J.C. (2006) Maternal obesity, metabolism, and pregnancy outcomes. *Annual Reviews Nutrition*, 26, 271-291.
- Kloe-Lehman, D.M., Freeland-Graves, J., Anderson, E.R., McDowell, T., Clarke, K.K., Hanss-Nuss, H., Puri, D., Milani, T.J. (2006) Nutrition knowledge is associated with greater weight loss in obese and overweight low-income mothers. *Journal of the American Dietetic Association*, 106,65-75.
- Krogstrand, K.S.,Parr, K. (2005) Physicians ask for more problem-solving information to promote and support breastfeeding. *Journal of the American Dietetic Association*, 105,1943-1947.
- Krummel, D.A. (2007). Postpartum weight control: a vicious cycle. *Journal of the American Dietetic Association*, 107,37-40.
- Laraia, B.A., Riz, A.M.S., & Gundersen, C. (2010) Household food insecurity is associated with self-reported pregravid weight status, gestational weight gain and pregnancy complication. *Journal of the American Dietetic Association*, 110, 692-701.
- Laitinen, J., Power, C., Jarvelin, M.R. (2001) Family social class, maternal body mass index, childhood body mass index and age at menarche as predictors of adult obesity. *American Journal Clinical Nutrition*, 74: 287-294.
- Lederman, S.A. (2004) Influence of lactation on body weight regulation. *Nutrition Reviews*, 62: S112-S 119.
- Leung, B.M., & Kaplan, B.J. (2009) Perinatal depression: prevalence, risks and the nutrition link. A review of the literature. *Journal of the American Dietetic Association*, 109,1566-1575.
- Linne, Y., Dye, L., Barkeling, B., Rossner, S. (2004) Long-term weight development in women: a 15 year follow-up of the effects of pregnancy. *Obesity Research*, 12, 1166-1178.
- Little R., Zadorozhnzaja, T., Hulchiy, O., Mendel, N., Shkyryak-Nyzhnyk, Z. (2003) Placental weight and its ratio to birthweight in a Ukrainian city. *Early Human Development*, 71,117-127.

- Mamum, A.A., Kinarivala, M., O'Callahan, M.J., Williams, G.M., Najman, J.M., Callaway, L.K. (2010) Associations of excess weight gain during pregnancy with long-term maternal overweight and obesity: evidence from 21 year postpartum follow-up. *American Journal of Clinical Nutrition*, 91, 1336-1341.
- Medeiros, D.M., Wildman, R.E.C. (2012) *Advanced Human Nutrition, 2<sup>nd</sup> Edition*. Sudbury, MA.
- Mendez, M.A., Cooper, R.S., Luke, A., Wilks, R., Bennett, F., Forrester, T. (2004) Higher income is more strongly associated with obesity than with obesity-related metabolic disorders in Jamaican adults. *International Journal of Obesity Related Metabolism Disorders*, 28,543-550.
- Mennella, J.A., Johnson, A., Beauchamp, G.K. (1995) Garlic ingestion by pregnant women alters the odor of amniotic fluid. *Chemical Senses*, 20, 207-209.
- Mennella, J.A., Jagnow, C.P., Beauchamp, G.K., (2001) Prenatal and postnatal flavor learning by human infants. *Pediatrics*, 107, E.88.
- Morsen, J.A., Barton, B., Biro, F.M., Sprecher, D.L., Falkner, F., Obarzanek, E. (1994) Sexual maturation and obesity in 9 and 10 year old black and white girls: The National Heart Lung and Blood Institute Growth and Health Study. *Journal of Pediatrics*, 124, 889-895.
- Nicklas, T., Johnson, R. (2004) Dietary guidance for healthy children. Position of the American Dietetic Association. *Journal of the American Dietetic Association*, 104, 660-677.
- Nuss, H., Freeland-Graves, J., Clarke, K., Klohe-Lehman, D., Milani, T.J. (2007) Greater nutrition knowledge is associated with lower 1-year postpartum weight retention in low-income women. *Journal of the American Dietetic Association*, 107,1801-1806.
- Oken, E. & Gilman, M.W. (2003) Fetal origins of obesity. *Obesity Research*, 11,496-506.
- Olson, C.M., Strawderman, M.S., Hinten, P.S., Pearsen, T.A. (2003) Gestational weight gain and postpartum behaviors associated with weight change from early pregnancy to 1 year postpartum. *International Journal of Obesity and Related Metabolic Disorders*, 27, 117-127.
- Olson, C.M., Strawderman, M.S. (2003) Modifiable behavioral factors in a biopsychosocial model predict inadequate and excessive gestational weight gain. *Journal of the American Dietetic Association*, 103, 48-54.
- Ozanne, S.E., Fernandez-Twinn, D., Hales, C.N. (2004) Fetal growth and adult diseases. *Seminars in Perinatology*, 28, 81-87.
- Pearcey, S.M. & De Castro, J.M. (1997) Food intake and meal patterns of one year old infants. *Appetite*, 201-212.
- Poulton, R., Williams, S. (2001) Breastfeeding and risk of overweight. *Journal of the American Medical Association*, 286, 1449-1450.
- Savage, J.S., Fisher, J.O., Birch, L.L. (2007) Parental influence on eating behavior: conception to adolescence. *Journal of Law, Medicine and Ethics*, Spring Symposium, 177-189.
- Schaal, B., Marlier, L., Soussignan, R. (2000) Human fetuses learn odors from their pregnant mother's diet. *Chemical Senses*, 25,729-737.
- Smith, D.E., Lewis, C.E., Caveny, J.L., Perkins, L.L., Burke, G.L., Bild, D.E. (1994) Longitudinal changes in adiposity associated with pregnancy-the CARDIA study. *Journal of the American Medical Association*, 271,1747-1751.
- Smith, S.A., Hulsey, T., Goodnight, W. (2008) Effects of obesity on pregnancy. *Association of Women's Health, Obstetric and Neonatal Nurses*, 37, 176-184.
- Solomon, C.G., Willett, W.C., Carey, V.J., Rich-Edwards, J., Hunter, D.J., Colditz, G.A., Stampfer, M.J., Speizer, F.E., Spiegelman, D., Manson, J.E. (1997) A prospective study of pregravid determinants of gestational diabetes mellitus. *Journal of the American Medical Association*, 278, 1078-1083.
- Stotland, N.E., Cheng, Y.W., Hopkins, L.M. & Caughey, A.B. (2006) Gestational weight gain and adverse neonatal outcome among term infants. *Obstetrics & Gynecology*, 108, 635-643.
- Sullivan, S.A., & Birch, L.L. (1994) Infant dietary experience and acceptance of solid foods. *Pediatrics*, 271-277.
- Tanumihardjo, S.A., Anderson, C., Kaufer-Horwitz, M., Bode, L., Emenaker, N.J., Haqq, A.M., Satia, J.A., Silver, H.J., Stadler, D.D. (2007) Poverty, obesity and malnutrition: an international perspective recognizing the paradox. *Journal of the American Dietetic Association*, 107,1966-1972.
- Thadhani, R., Stampfer, M.J., Hunter, D.J., Manson, J.E., Solomon, C.G., Curhan, G.C. (1999) High body mass index and hypercholesterolemia: Risk of hypertensive disorders of pregnancy. *Obstetrics and Gynecology*, 94, 543-550.
- Tibbs, T., Haire-Joshu, D., Schechtman, K.B., Brownson, R.C., Nanney, M.S., Houston, C., Auslander, W. (2001) The relationship between parental modeling, eating patterns, and dietary intake among African-American parents. *Journal of the American Dietetic Association*, 101, 535-541.

- Walker, L.O., Sterling, B.S., Timmerman, G.M. (2005) Retention of pregnancy-related weight in the early postpartum period: Implications for women's health services. *Journal of Obstetrics and Gynecology of Neonatal Nursing*, 34,418-427.
- Wansink, B. (2008) Project M.O.M.: mothers & others & MyPyramid. *Journal of the American Dietetic Association*, 108,1302-1304.
- Yuasa, K., Sei, M., Takeda, E., Ewis, A.A., Munakata, H., Onishi, C., Nakahori, Y. (2008) Effects of lifestyle habits and eating meals together with the family on the prevalence of obesity among school children in Tokushima, Japan: a cross-sectional questionnaire-based survey. *Journal of Medical Investigation*, 55, 71-77.

Published by the Forum on Public Policy

Copyright © The Forum on Public Policy. All Rights Reserved. 2011.