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The Association between Breast Feeding and Being Overweight in Children

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Master of Public Health Research Project

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"The Association between Breast Feeding and Obesity in Children"

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Purpose: Obesity/Overweight in children is an epidemic and the most common disorder of childhood in the developed world. Prevalence is increasing, leading to short- and long-term complications. Breastfeeding may protect against childhood obesity, but the debate is ongoing. The main purpose of this project was to assess the relationship between breastfeeding and being overweight in early childhood.

Methods: Data were collected from the State and Local Area Integrated Telephone survey; National Survey of Children's Health, 2003. Overall, 16,358 children, ages 3 to 5, were included in the sample. SPSS Complex Sample software was utilized to generate for all analyses. Complex samples crosstabs was utilized to see if there is association between the outcome and risk factors. Complex samples logistic regression was done to assess whether breastfeeding is associated with being overweight in childhood after adjustment for potential confounders.

Results: Being overweight was more prevalent among children who are Black, living at <133% of poverty level, have mothers with less than 12 years of education, and have a mother or father in poor health. Children who were not breastfed were more likely to be overweight (BMI > 95^{th} percentile). After adjusting for confounders, the effect remained statistically significant (OR: 1.6; 95% confidence interval: 1.2-2.1).

Conclusions: Breastfeeding has a protective effect against being overweight in children 3 to 5 years of age. While more research is needed to investigate the risk factors for overweight, public health efforts should continue to promote breastfeeding as a safe and effective method for nutrition, which has the potential to improve the overall health of children.

INTRODUCTION

Researchers have labeled the phenomenon of being overweight in childhood an epidemic (Dietz, 2001; Flegal, 1999; Lavalle & Mosca, 2002; Sorof & Daniels, 2002). The prevalence of being overweight in childhood has increased dramatically in the last thirty years in the United States. Specifically the rate of being overweight for school-aged children and adolescents increased from 5% in 1970, to more than 15% in 2000. Further, it is the most common disorder of childhood in the developed world and its prevalence is still increasing Reilly (2005). The prevalence of overweight pre-schoolers, two to five years of age, has doubled with significant increases for the youngest group, ages six to 23 months. (Dewey, 2003). The most recent National Health and Nutrition Examination Survey, (NHANES II) estimated that 20.6% of children two to five years of age, and 30.3% of young adults 12-19 years are overweight. Over 9 million (16%) children and teens ages six to 19 were considered overweight according to the 1999-2002 data, which is triple the proportion in 1980. Worldwide, it is estimated that 22 million for children under five years of age are overweight or obese. (Miller et al, 2004).

Overweight Defined

Obesity in adults is defined as an excessively high amount of body fat tissue in relation to lean body mass, and it is defined by body mass index (BMI), a common measure expressing the relation of weight in kilograms to height in meters squared. The Centers for Disease Control and Prevention (CDC) uses the term “overweight” rather than “obesity” for children and adolescent populations. BMI is used to assess “underweight”, “overweight”, and “being at risk for overweight” for children and is gender and age specific (Hammer et al.1991; Pietrobelli, 1998.) The CDC classifies overweight according to two levels: (1) “being at risk for overweight”, which

corresponds to a BMI from the 85th percentile through the 95th percentile for age and sex, and (2) "overweight", which corresponds to a BMI greater than the 95th percentile for age and sex. The degree of body fat is different for boys and girls, and this difference is more obvious as children grow. For calculating BMI, the CDC uses the childhood growth charts, which are used as standards for diagnosing inadequate growth or overweight, or to certify children for participation in nutrition programs funded federally. In comparison with their 1977 version, Ogden et. al (2002) describe a revised version of reference growth charts, which are based on a wider national representation of children, as well as a reference for weight relative to height for adolescents.

Application of Childhood BMI in Research

In 1997, an international conference convened by the International Obesity Task Force concluded that BMI is a reasonable measure for assessing overweight in children and adolescent worldwide (Dietz & Bellizzi, 1999). Using national reference data, with the commonly recommended BMI percentile cut-offs, obesity is diagnosed reasonably well**.** BMI identifies children within population with high specificity but with moderate sensitivity (Reilly et al., 2002). For clinical purposes the high specificity minimizes risk of stigmatization of non-obese children by labeling them obese, but for epidemiological reasons low sensitivity may lead to underestimation of high levels of body fat content. There are some limitations to BMI in children: 1) children may have large bone and muscle mass without increased body fat (Dietz & Robinson, 1998) and 2) two developmental growth spurts at four to six years of age and during adolescence are associated with higher potential for overweight (Dietz, 2001). However, BMI-based cut-points are the most reliable measures for overweight and obesity estimations, because we still do not have validated cut-off points for defining obesity based on alternative measures,

such as skin fold thickness, waist circumferences, and body composition techniques for measuring fat and fat free mass, and weight gain relative to linear growth.

Risk Factors

Most researchers agree that childhood obesity is a multifactorial disease (Balaban G. et al. 2004). While genetic factors are responsible for overweight among some children, the current epidemic indicates that environmental factors are to blame, specifically with the rapid change of the community from an active to sedentary lifestyle, and the consumption of large amount of food rich in high calories. (Story et al. 2003). Other risk factors include: sex, race/ethnicity, socioeconomic status, and having parents who are obese (Poulsen & Vaag, 2003; Miller et al., 2004; Reilly, et al., 2005). Reilly et al. (2005), identified more than 31 potential risk factors including parity, season of birth, gestational age, number of fetuses, timing of introduction of complementary feeding, number of siblings, maternal age, and time spent in the car as well as birth weight, sleep duration, and television viewing behavior.

Consequences of Childhood Overweight

Being overweight in childhood increases risk of morbidity and/or premature mortality. Thus high BMI points to the increased risk of adverse health outcomes (Reilly, 2005). The increase in the prevalence of childhood obesity is also alarming due to the increased risk of these children becoming obese adults (Whitaker, et al., 1997; Guo & Chumlea., 1999). World health officials are urging an aggressive approach to head off a global explosion of fat-related diseases Collins, A. (2005).

The effects of childhood obesity may be observed in the short and long term. Short term complications include elevated level of blood pressure, cholesterol, triglyceride, and insulin (Freedman, et al., 1999; Becque, et al., 1988). Orthopedic disorders, respiratory problems, and

psychosocial disorders are also a consequence of childhood overweight. In the long term, quality of life could be affected by symptoms like tiredness, breathlessness, back pain, stress incontinence, and depression, etc. Further, coronary heart diseases have been associated with individuals who were obese in childhood or adolescence (Balaban G., et al., 2004).

A new definition of 'obesity disease in childhood' is given to the Japanese children, and is associated with health or medical problems with an indication for medical intervention (Asayama K et al., 2003). The immediate intervention is considered for treatment of hypertension, sleep apnea, impaired glucose tolerance, and increased waist circumference or accumulation of visceral adipose tissue.

In the United States, the dollars spent on the obesity related issues is 5% to 7% of all health spending (James P.T, 2004). Pediatric obesity-related hospital costs that have tripled in the last 20 years to approximately $127 million (Goran, et al., 2003; Wang & Dietz, 2002). In addition, costs continue to rise due to indirect costs spent on weight loss programs and greater use of social services (Thompson D. & Wolf A, 2001). Childhood obesity is expected to facilitate the return of cardiovascular disease as the leading killer of Americans, surpassing the efforts reached by controlling hypertension, hyperlipidemia and smoking (Miller et al., 2004).

Breastfeeding and Childhood Overweight

Researchers have been searching for solutions to the obesity epidemic. Since Kramer (1981) showed that breastfeeding has a potential protective effect against childhood obesity, the relationship of breastfeeding and obesity has received increased attention and the debate on this issue continues.

The benefits of breast milk are well known. The changing composition from colostrum to mature milk satisfies the growing needs of newborns to older age infants. Breast milk protects

the infant from infectious diseases and strengthens immunity. The mother also benefits from breastfeeding directly by decreasing postpartum bleeding, shrinking of the uterus as well as decreasing the risk of breast, ovarian and endometrial cancer (Guise et al., 2003).

The lack of agreed definitions for breastfeeding spurred international efforts in 1991 to define breastfeeding for purposes of data collection. In 2001 these definitions were adopted in Australia. “Exclusive breastfeeding” is when an infant has received only breast milk and no other liquids or solids. “Ever breastfed” refers to an infant who has been put to the breast at least once or received expressed milk. A “fully breastfed” child is one who has received breast milk as their main source of nourishment.

Previous studies evaluating growth after the first two years showed that the differences in fatness among breastfed children became less apparent with age, (Butte, NF, 2001). However, recent studies consistently show that overweight is shifting toward younger ages.

An overview article by Butte, covering the literature from 1945 to 1999, tried to define the role of breastfeeding in obesity (Butte, 2001). This article observed the anthropometric studies on tracking of body size and other determinants of childhood obesity and the association of breastfeeding and later obesity. In studies where feeding groups were clearly defined and the sample size was sufficient, weight gain was lower in breastfed infants. In other studies comparing body composition, most of them did not find any differences (Butte et al ; Evans, 1978; Ferris et al 1979; Harrison et al 1987; Kohler et al., 1984; Roberts, 1980; Michaelsen 1994) while others found increased skin fold in formula fed groups (Yeung, 1983; Shepherd et al 1988; De Bruin et al 1998; Dewey et al 1993), and only three studies found contrary results with greater increase in skin fold in breastfed groups (Oakley, 1977; D’Souza et al., 1979; Salmenpera, et al., 1985). A third group of studies used direct in vivo measurements of body

composition. Bellu et al (1997) showed lower weight and body fat mass among breastfed infants at one year of age, while de Bruin et al (1998) used a longitudinal study with sample size of 23 for each group of feeding model and concluded that formula-fed girls at age 1 through 4 months showed higher weight gain, higher fat free mass, but no increase in percentage of fat mass at 4 and 8 months.

Dewey published a review article examining studies examining the association of breastfeeding and obesity in the United States that were published between 1999 and 2002 (Dewey, 2003). Dewey considered the limitations of earlier studies and included in her review studies with special criteria such as sample size of more than 100 per each group and follow-up time of at least three years as well as the inclusion of the percentage of overweight as an outcome. A common feature for these studies was the control for many confounding factors, particularly birth weight, sex, parental overweight, socioeconomic status (education and income), race/ethnicity, and age and timing of introductions of solid foods. Five of the eleven studies reviewed focused on children younger than six years of age. Three of these studies showed some association, while the others two did not (Butte, 2001). For example, Hediger et al. (2000) used NHANES-III cross-sectional health survey data for their study and chose the age group four to 71 months old (n=5594). Outcomes were weight, length and arm anthropometry and four feeding groups were defined on the basis of infant feeding patterns. After adjustment for potential confounding factors such birth weight, race, and maternal weight, the authors observed no significant evidence that formula fed infants were heavier in the first year of life or through age five than were breastfed infants. Demographic and maternal factors associated with breastfeeding were: being non-Hispanic white, older age, nonsmokers, and higher level of education and have a residence in the Western United States Census region.

Von Kries et al. (1999), found similar results to Hediger using a cross-sectional study design with 9,357 German children between five and six years old. The results supported the persistence of a protective effect of breastfeeding even after adjustment for possible confounding factors (i.e. parents' age, parents' education, early feeding, number of elder sibling, and child's health at birth). The prevalence of obese children among breastfed infants was 2.8% compared to 4.5% for infants who had never been breastfed. Obesity was defined as a BMI above the 97th percentile and overweight as a BMI above the 90th percentile in this study.

A retrospective study of 3,731 children in the United Kingdom by Wadsworth et al. (1999) found no significant association between breastfeeding and the prevalence of overweight and obesity among six year olds. It is important to note that the German cohort was born 45 years later than the United Kingdom cohort, which may explain the different results, by attributing that to residual confounders related to changing social and economical and educational factors.

Gillman et al. (2001) to conducted a large cross-sectional study of the Growing Up Today Study cohort with children ages nine to 14 years (n=15,341). The authors found a protective effect of breastfeeding, and a dose-dependent effect after breastfeeding for seven months even after controlling for many confounders including sexual maturation, time spent watching television, physical activity and other social and economical lifestyle factors.

To answer the same question about a protective effect of breastfeeding against childhood obesity, Arenz et al. (2004) did a systematic review and meta-analysis (cohort, case-control, or cross sectional studies) of all published epidemiologic studies from 1966 to 2003. Nine of the 953 relevant studies met inclusion criteria which included: 1) adjustment for at least three of the most recognized confounders, (i.e. birth weight, parental overweight, household smoking, diet,

physical activity, socioeconomic status) and 2) a relative risk or risk estimates had to be reported. An adjusted odds ratio was calculated, heterogeneity was tested, and assessment of symmetry to rule out publication bias was done. A sensitivity analysis was done for different: 1) study designs, 2) definitions for breastfeeding and obesity, 3) age groups, and 4) confounders. The pooled adjusted odds ratio for breastfeeding in these nine studies was 0.78 (95% CI: 0.71, 0.85). This review was important because it utilized a systematic identification of relevant studies and a prospective study protocol with a focus on adjustment for confounders' risk factors. This result indicates a small but statistically significant protective effect of breastfeeding against childhood obesity.

In another comprehensive meta-analysis of the existing studies on duration of breastfeeding and risk of overweight, Harder, et al. (2005) showed that each month of breastfeeding was associated with a 4% decrease in risk of odds of being overweight. (OR=0.96/month of breastfeeding; 95% CI: 0.94-0.98). From one month onward, the risk of overweight continuously decreased for a total reduction of more than 30%, reaching a plateau at nine months of breastfeeding.

SPECIFIC AIMS

The main purpose of this project was to assess the relationship between breastfeeding and being overweight in childhood, Specifically, this study aims are to determine 1) prevalence of overweight, 2) prevalence of breastfeeding, 3) risk factors for overweight, 4) risk factors for not breastfeeding, and 5) to determine the effect of breastfeeding on overweight defined by the body mass index (BMI) for children 3 to 5 years of age.

METHODS

Data Collection

Data were derived from the National Survey of Children's Health, (NSCH), a module of SLAITS, the State and Local Area Integrated telephone survey, conducted by CDC, which is a surveillance system at the state and local level. The NSCH uses random-digit-dialing survey methodology and surveys are conducted by trained interviewers using computer-assisted telephone interviewing software. The NSCH includes information from households with children less than 18 years of age from each of the 50 States and the District of Columbia. Given the desire to have a representative national sample, particular areas of the country are oversampled. NSCH data were obtained through a complex sample design involving clustering of children within households and stratification of households within state. A total of 102,353 adults provided information on a child in their household. Specifically, during the telephone interview, one child was randomly selected from all children in each identified household to be the subject of the survey. The respondent was the parent or guardian who knew the most about the child's health and health care. This cross-sectional study utilizes the data for all three to five year olds in the national sample (n=16,358 children).

To protect the confidentiality of individual children, very short heights, very tall heights, very low weights, and very high weights have been suppressed in NSCH data. Because suppression of height and weight variables may hinder calculations of BMI, a variable (BMICLASS) was added. Children ages two to 17 years were classified as underweight (BMI for age is the 5^{th} percentile or lower), normal weight (BMI for age is between 5^{th} and 85^{th} percentiles), at risk for being overweight (BMI for age is in the 85^{th} percentile or greater), and overweight (BMI for age is in the 95^{th} percentile or greater). Percentiles were determined using the 2000 CDC growth charts. Because age was reported in years for this survey, children were

assumed to be at the midpoint of the age-year for purposes of calculating BMI. All measures, including height and weight were reported by parents and not directly measured.

Variables

The main outcome variable, BMI, was dichotomized into "overweight" (BMI in the 95th percentile or higher) and "not overweight" (BMI less than the 95% percentile).

Questions included in the SLAITS assessed whether the child's mother ever breastfed the child as well as the duration of breastfeeding. Breastfeeding duration was grouped into 7 categories, 0-6 days, 7-42 days, 43-90 days, 91-180 days, 181-365 days, 366-730 days, and 731 days or more. All variables were treated as categorical.

We were interested in the main effect of breastfeeding on being overweight in childhood. Potential confounders, including, but not limited to gender, race, household education, household poverty level, household smoking, as well as mother's and father's health were assessed.

Data Analysis

NSCH data were obtained through a complex sample design involving clustering of children within households and stratification of households within state. Therefore, the interview records have unequal weights. Thus, statistical software programs that assume simple random sampling generally compute standard errors that are too low, which could lead to misleading conclusions. (J.M. Brick et al 2000). SPSS Complex Samples software was utilized for all analyses given the data collection sampling scheme and need for weighted analysis.

The SPSS Complex Samples analyses used in the current study allows us to select a sample according to a complex design and incorporate the design specification into the data analysis, using stratum identifiers, primary sampling unit, and the sample weight which are necessary for the calculation of the variances, thus ensuring that our results are valid.

Specifically, the distribution of children by age, gender, race, age groups, breastfeeding status, level of education, poverty level, household smoking status, parents physical and emotional status, health coverage, being born in US, spoken language, rank in the household, and number of children, as well the frequency of different body mass index subgroups was determined. Complex Samples crosstabs was utilized to see if there is an association between the outcome and risk factors mentioned earlier. Complex Samples logistic regression was done to assess whether breast feeding is associated with being overweight in childhood after adjustment for potential confounders. In addition to stratifying by at-risk groups, we looked at the effect of the intensity of breastfeeding on overweight status; this was stratified according to the seven subgroups of breastfeeding duration.

Results

Sample characteristics are presented in Table 1. The sample was 74.5% white and 15.8% Black. Overall the proportion of overweight children was 40% of all children, and an additional 12.1% were ‘at risk for overweight’. Most (65.9%) of the sample had ‘more than high school education’, and 26.3% of children were from smoking households.

Table 2 presents the weighted percentage and crude odds ratios associated with risk factors for not breastfeeding. Over 50.0% of Black mothers did not breastfed. Failure to breastfed was also more common among women with a high school diploma or less, lower poverty level, smoking household, and non-English speaking. Black women were 2.8 times less likely to breastfeed than white women (OR=2.8; 95% CI: 2.3-3.2).

Table 3 presents weighted percentages and crude odds ratios associated with various risk factors for being overweight. Overweight prevalence was highest for children who: were Black

(57%), lived in households at < 133% poverty level (50%), had mothers with < 12 years of education (51%), and had a mother (54%) or father (63%) in poor health.

Table 4 presents the prevalence and risk of overweight by breastfeeding status. Not being breastfed was associated with a higher prevalence of being overweight. Even after adjusting for a list of variables associated with both overweight and non-breastfeeding (i.e. race, age, education level, household poverty level, smoking household, health of mother and father, Hispanic ethnicity, and spoken language), there was still a statistically significant effect (OR =1.6; 95% CI: 1.2-2.1)

Table 5 presents the duration of breastfeeding results. Longer duration of breastfeeding was associated with a protective effect against overweight. But the relationship was not statistically significant.

Discussion

The current study used the most recent data released (March 2005) by the National Health Survey of Children Health (NSCH), conducted on all 50 states and the District of Columbia. Each interviewed child was given a sampling weight, which was used in all analyses; the adjusted weight was then post stratified so that the sum of the weights for each state equaled the number of children in the state, as determined from the July Census Bureau estimates and the 5% Public Use Micro-Data sample files from Census 2000.

Our results show that Black race is associated with increased risk for being formula-fed and being overweight. This is true for other studies as well (Bogen, et al., 2004, Grummer-Strawn et al., 2004). Bogen et al. (2004) questioned if race itself was the cause for being overweight, postulating that other unknown factors such as difference patterns in maternal-child feeding interaction, or other activities may be responsible. Maternal interaction with her child is

influenced by many known and unknown factors. Breastfeeding could be part of a lifestyle running in families, and could be a proxy for lifestyle in some environments (Elliot, et al., 1997). For more than two decades, a fatty child symbolized a healthy child, and it was accepted and encouraged to be bigger (De Onis, 2004), so for long time a 'bigger child' was a good indicator of being healthy and for sure it is a complement for the mother's taking care of her child. This conception was also accepted by pediatricians and caretakers. For some races the weight gain is an obvious indicator of the good health, and good mother's care, while only concentrating on this measure, this could mislead the mother from overseeing other variables, like physical activity and mental development.

This conception is somehow associated with education level and consequently with income level, and vice versa. Being the child of a mother who is educated less than 12 years is a risk factor for being overweight, and this could be an indirect indication of the socioeconomic level of the mother or the household. This is reflected by many others studies. Dewey (2003) in her review article mentioned that breastfeeding is less common in overweight women, partly because of socioeconomic status, and showed lower risk of becoming overweight after adjustment for socioeconomic status.

Our data showed that breastfeeding was protective against being overweight (see Table 4), where not being breastfeeding was associated with higher prevalence for being overweight (48.9%), and the crude odds ratios of 1.7 (95%CI: 1.5-1.9). After adjustment for potential confounding risk factors considered in this analysis the adjusted odds ratio still statistically significant at 1.6 (95% CI: 1.2-2.1). This is confirms the works of others (Kramer, 1981; Strbak et al., 1991; Toschke et al., 2002; Tulldahl et al., 1999).

The effect of breastfeeding on obesity is a complex one, and could be explained by many reasons. First, the amount of breast milk is precisely coordinated with the maintenance and growth needs of the breastfed infants (Bergman K.E. et. al., 2003). Second, breastfed infants also regulate the production of breast milk by suckling (Bergman, 2003; Stettler, 2005). So a rapid weight gain observed in the first week of life is probably due to overfeeding in formulated-fed infants, and unlikely to be seen in the exclusively breastfed infants. Third, breastfed infants have lower content of nitrogen and less energy intake than formula-fed infants, especially during the first critical period of their development, 4 to 6 months (Hediger, M. et. al, 2001). The concentration of formula, rich in nitrogen and energy, leads to higher secretion of insulin and insulin-like growth factor 1, leading to increased weight gain without necessarily affecting linear growth. Fourth, the well established point of satiety sensation in breastfed infants is regulated by internal physiologic process rather than external social factors (Bergman K.E. et. al., 2003). Finally, the effect of residual confounding by attributes of the parents and/or the family environment that were not measured here or in other studies. The period of infancy could be seen as an intermediate and necessary period of child growth, between complete dependency, while in his mother‘s womb, for food, air, and protection, and the complete dependency on self regulation, specially for food intake and physical activity. This period is critical for preparing and programming the child’s own inner system for the next stage of his development, so in that way breastfeeding process appears to be a major determinant of this period. Many researchers find the first week of life is critical for later self regulation and adiposity. Stettler et al., (2005) concluded that in formula-fed infants, weight gain during the first week of life may be a critical determinant for the development of obesity several decades later. The protective effect of

breastfeeding in humans could also include metabolic programming on early learned self regulation of food intake (Miller J., 2004).

We did not find strong statistical evidence for the effect of breastfeeding duration, even though the prevalence of overweight children was lowest in the group breastfed for more than 12 months, with a rate of 31.2% compared to 43.2% for the group who were breastfed for only 6 days, and the crude odds ratio for the less than a week breastfeeding was 1.5 (95% CI 0.8-2.7). Hediger et al., (2001), who studied the same age group as ours, showed no clear dose-response relationship between breastfeeding duration and overweight prevalence. It should be noted that the sample size was relatively small. In contrast, Gillman et al. (2001) utilized a much larger sample and reported an adjusted odds ratio for overweight decreasing with breastfeeding duration reaching her lowest at 0.75 at 9 months of breastfeeding. Another explanation could be the effect of residual confounding that could explain the results (Gillman, 2002). Another theory is that there is some difference between women who breastfed for longer duration and the women who did not breastfeed not considered in our analysis (Grummer-Strawn, LM & Mei Z 2004).

The duration of breastfeeding is a limited process, and should end by the time the child is capable to process the food on their own. That could explain some unexpected results (i.e., the effect of breastfeeding could have not a linear correlation, but curvilinear relationship after certain period of time, possibly 6, 9 or 12 months.

The advantage of breastfeeding may be due to: “several factors at play, including differences in food composition (human milk versus formula), food delivery (breast versus bottle), food lifestyle (breastfeeding versus formula feeding) and food behavior (self regulation and demand versus daily schedules and almost fixed amounts” (Agostoni, 2005). Children are

able to self regulate their amount of energy intake, which is controlled by internal satiety cues, and by controlling the production of mother's milk (Stettler et al., 2005). The bottle-feeding method could lead to overweight by encouraging larger amount of milk and disturbing the self-regulation mechanisms (Balaban, 2004).

Limitations

Another fact, that deserves some attention and further investigation, is that some funded nutrition programs, by providing food and formula for free, indirectly encourage the low income group to formula-fed, and consequently later for higher prevalence of overweight in children. This new behavioral pattern with other child-feeding practices and parental control over feeding could explain some of the rapid and consistent rise of prevalence of overweight children.

Maternal smoking affects the risk of childhood obesity in two different periods of life of children. The first period is the prenatal period where it is believed that "maternal smoking affects the appetite regulation system in the developing fetal brain" (Jo, et al. 2002; Grove, et. al., 2001; Von Kries et al., 1999). The second period is the postnatal period, which could be attributed to different environmental factors like diet, or activity behaviors which could be correlated with maternal smoking (Bogen, et. al., 2004). It is important to note that the World Health Organization (WHO), in preparation for the new international reference of childhood growth, included maternal smoking, preterm or multiple births, and significant health problems at birth, as individual exclusion criteria. This confirms the important influence of smoking on the normal weight of children.

Although our study has several strengths, for example, the sample is very large, data was recently collected, from all 50 States and the District of Columbia, and we used Complex Sampling Design weighted to the national population, this study has some limitations. First, the

study is cross-sectional. Second, generalizability is limited. For example, the response rates was relatively low (55.3%), possibly an indication for non-response bias. The questionnaire itself was approximately 30 minutes long, which is a long time for responders to stay on the telephone. Further, the sample was limited to children who reside in households with telephone. Third, the questionnaire itself was not designed specifically to answer research questions about overweight, or to analyze its associations with breastfeeding and other risk factors. Questions like the degree of exclusive breastfeeding, and time of introduction of solid foods were not ascertained, thus we have limited data. Fourth, parental self-report and recall bias could influence the study findings. The need to remember the duration of breastfeeding in days could lead to recall bias. Specifically, mothers could have estimated or rounded the actual length of breastfeeding to months rather than days, which may explain the majority of answers being around six or twelve months. Fifth, data on breastfeeding was not available for children six years of age or older. Therefore, we could only explore the relationship between breastfeeding and being overweight in young children, less than six years of age.

Conclusions

The prevalence of overweight in children is still on the rise and is a major public health issue. Without effectively addressing this epidemic, children will more frequently suffer negative consequences related to being overweight. Further, it is likely that health consequences due to obesity will continue for these children as they reach adulthood. The health impact of obesity will continue to rise in the coming years, which should lead to a call for more investigations to better understand the underlying risk factors and their interaction. It appears that breastfeeding has a protective effect against being overweight in children three to five years of

age. Breastfeeding is a safe, simple, and cost-effective method to combat obesity in children and should be encouraged.

Tables

Table 1. Sample Characteristics.

Variable	Unweighted n	Weighted % (95% CI)
Gender		
Male	8344	51.9 (50.6-53.3)
Female	8005	48.1 (46.7-49.4)
Age		
3- years	5692	33.3 (32.1-34.5)
4- years	5433	34.4 (33.1-35.7)
5- years	5233	32.3 31.1-33.6)
Race		
White only	11872	74.5 (73.2-75.9)
Black only	1603	15.8 (14.7-16.9)
Multiple Race	813	4.2 (3.7-4.8)
Other	773	5.5 (4.6-6.5)
Overweight		
Underweight	1518	11.4 (10.5-12.4)
Normal Weight	5240	36.6 (35.2-38.0)
Risk for Overweight	1684	12.1 (11.1-13.1)
Overweight	5348	40 (38.6-41.4)
Breastfeeding status		
YES	4896	30.4 (29.3-31.6)
NO	11301	69.6 (68.4-70.7
Household Highest Education		
Less than High School	842	8.2 (7.4-9.1)
High School Graduate	3283	25.1 (23.9-26.3)
More than High School	12142	65.9 (64.6-67.3)

Table 1. *Sample Characteristics (continued).*

Variable	Unweighted n	Weighted % (95% CI)
Household Poverty Level		
Less than 100%	2008	18.5 (17.3-19.8)
100% to <133%	1058	8.2 (7.4-9.1)
133% to <150%	542	4.3 (3.7-5.0)
150% to <185%	1089	7.9 (7.2-8.8)
185% to <200%	546	3.2 (2.8-3.7)
200% to <300%	2944	17.8 (16.8-18.8)
300% to <400%	2404	14.5 (13.6-15.5)
at or more 400%	4269	25.5 (24.4-26.7)
Breastfeeding Duration		
0 to 6 days	160	1.1 (0.9-1.4)
7 to 42 days	1569	13.3 (12.3-14.5)
43 to 90 days	1720	14.8 (13.7-16.1)
91 to 180 days	2550	24.6 (23.1-26.1)
181 to 365 days	3281	30.3 (28.8-31.8)
366 to 730 days	1645	15.3 (14.2-16.6)
more than 730 days	80	0.5 (0.4-0.7)
Household Smoking		
Yes	2805	26.3 (24.9-27.7)
No	7313	73.7 (72.9-75.1)
Mother's Health		
Excellent	6129	37.9 (36.6-39.2)
Very Good	5032	31.1 (29.8-39.2)
Good	3262	22.8 (21.6-24.0)
Fair	873	6.9 (6.1-7.7)
Poor	151	1.2 (0.9-1.6)
Mother's Mental Health		
Excellent	6385	39.9 (38.6-41.2)
Very Good	5408	33.1 (31.8-34.4)
Good	2912	21.0 (19.9-22.2)
Fair	654	5.3 (4.6-6.0)
Poor	74	0.6 (0.4-0.8)
Father's Health		
Excellent	5486	42.0 (40.6-43.5)
Very Good	4519	34.1 (32.7-35.5)
Good	2197	19.3 (18.1-20.5)
Fair	403	3.9 (3.3-4.6)
Poor	73	0.6 (0.3-1.2)

Table 1. *Sample Characteristics (continued).*

Variable	Unweighted n	Weighted % (95% CI)
Father's Mental Health		
Excellent	6053	47.2 (45.7-48.7)
Very Good	4494	33.3 (31.9-34.7)
Good	1823	16.6 (15.4-17.8)
Fair	263	2.5 (2.0-3.1)
Poor	31	0.2 (0.1-0.3)
Health Care Coverage		
Yes	15130	91.3 (90.4-92.1)
No	1202	8.5 (7.7-9.3)
Hispanic/Latino Origin		
Yes	2584	20.2 (19.1-21.4)
No	13585	79.4 (78.3-80.6)
Spoken Language		
English	14733	84.7 (83.5-85.8)
Non-English	1618	15.3 (14.1-16.4)
Born in the USA		
Yes	15682	96.4 (95.7-97.0)
No	523	3.6 (3.0-4.2)
People<18 in Household		
One	5636	18.0 (17.2-18.7)
Two	6952	41.1 (39.9-42.4)
Three	2679	25.7 (24.4-27.0)
Four	1091	15.3 (14.1-16.6)

Table 2. *Risk Factors for Not Breastfeeding.*

Variable	Unweighted n	Weighted % (95% CI)	Crude OR (95% CI)
Gender			
Male	8344	30.3 (28.7-32.0)	Referent
Female	8003	30.6 (28.9-32.3)	1.0 (0.9-1.1)
Age			
3- years	5692	29.1 (27.1-31.1)	Referent
4- years	5433	30.4 (28.4-32.4)	1.1 (0.9-1.2)
5- years	5233	31.8 (28.7-34.1)	1.1 (1.0-1.3)
Race			
White only	11872	26.8 (25.6-28.1)	Referent
Black only	1603	50.4 (46.5-54.4)	2.8 (2.3-3.3)
Multiple Race	813	29.5 (23.7-30.0)	1.1 (0.8-1.5)
Other	773	30.6 (29.4-31.8)	0.9 (0.7-1.3)
Overweight			
Yes	5348	38.2 (36.0-40.4)	1.7 (1.5-1.9)
No	8442	26.5 (25.0-28.0)	Referent
Household Highest Education			
<High School	842	33.2 (28.4-38.5)	1.5 (1.2-1.9)
High School Graduate	3283	45.9 (43.1-48.7)	2.6 (2.3-3.0)
>High School	12142	24.2 (23.0-25.4)	Referent
Household Poverty Level			
<100%	2008	41.4 (37.8-45.1)	2.7 (2.2-3.3)
100% to<135%	1058	34.8 (30.3-39.7)	2.1 (1.6-2.6)
135% to<150%	542	39.6 (32.4-47.3)	2.5 (1.8-3.5)
150%to<185%	1089	32.3 (27.5-37.4)	1.8 (1.4-2.3)
185% to 200%	546	33.0 (26.8-39.9)	1.9 (1.3-2.6)
200% to 300%	2944	30.9 (28.2-33.6)	1.7 (1.4-2.1)
300% to 400%	2404	26.6 (23.8-29.5)	1.4 (1.1-1.6)
>400%	4269	20.5 (18.7-22.3)	Referent
Household Smoking			
Yes	2805	41.5 (38.5-44.3)	1.9 (1.6-2.2)
No	7313	26.5 (24.8-28.2)	Referent
Mother's Health			
Excellent	6129	24.8 (23.1-26.6)	Referent
Very Good	5032	29.7 (27.6-31.9)	1.2 (1.1-1.4)
Good	3262	34.4 (31.7-37.2)	1.6 (1.3-1.8)
Fair	873	35.5 (30,2-41.2)	1.6 (1.3-2.1)
Poor	151	29.7 (20.1-4`.6)	1.2 (0.7-2.1)
Mother's Mental Health		.	
Excellent	6385	27.5 (25.8-29.4)	Referent
Very Good	5408	27.9 (25.9-29.9)	1.0 (0.8-1.1)
Good	2912	33.0 (30.2-36.0)	1.3 (1.1-1.5)
Fair	654	33.1 (27.3-39.0)	1.3 (0.9-1.7)
Poor	74	37.6 (24.2-53.1)	1.5 (0.8-3.0)

Table 2. *Risk Factors for Not Breastfeeding (continued).*

Variable	Unweighted n	Weighted % (95% CI)	Crude OR (95% CI)
Father's Health			
Excellent	5486	23.7 (22.0-25.6)	Referent
Very Good	4519	26.8 (24.7-29.0)	1.1 (1.0-1.3)
Good	2197	28.9 (26.0-32.0)	1.3 (1.1-1.5)
Fair	403	34.7 (27.2-43.0)	1.7 (1.1-2.4)
Poor	73	31.1 (13.8-56.0)	1.4 (0.5-4.1)
Father's Mental Health			
Excellent	6053	24.8 (23.0-26.6)	Referent
Very Good	4494	26.6 (24.5-28.8)	1.1 (0.9-1.2)
Good	1823	28.3 (25.0-31.7)	1.1 (0.9-1.4)
Fair	263	35.3 (25.7-46.3)	1.6 (1.0-2.6)
Poor	31	32.3 (15.3-55.6)	1.4 (0.5-3.8)
Health Care Coverage			
Yes	15130	30.7 (29.5-31.9)	1.1 (0.9-1.4)
No	1202	27.2 (23.1-31.7)	Referent
Hispanic/Latino Origin			
Yes	2584	26.7 (23.8-29.7)	Referent
No	13585	31.2 (30.0-32.5)	1.2 (1.0-1.4)
Spoken Language			
English	14733	32.2 (31.0-33.5)	1.8 (1.4-2.2)
Non-English	1618	20.6 (17.6-24.0)	Referent
Born in the USA			
Yes	15682	30.6 (29.4-31.8)	1.6 (1.1-2.3)
No	523	21.2 (15.7-28.0)	Referent
People < 18 in Household			
One	5636	35.4 (33.5-37.3)	Referent
Two	6952	29.5 (27.9-31.2)	1.2 (1.0-1.6)
Three	2679	28.9 (26.4-31.6)	0.9 (0.8-1.2)
Four	1091	29.7 (25.7-33.9)	0.9 (0.7-1.2)
Rank of Child in Household			
One	5636	35.4 (33.5-37.3)	1.2 (0.9-1.6)
Two	3337	23.9 (21.8-26.1)	0.7 (0.5-0.9)
Three	5097	31.4 (29.4-33.5)	1.0 (0.8-1.3)
Four	1676	31.1 (27.9-34.6)	1.0 (0.7-1.4)
Five	612	30.2 (25.0-36.0)	Referent

Table 3. Risk Factors for Overweight.

Variable	Unweighted n	Weighted % (95% CI)	Crude OR (95% CI)
Gender			
Male	8344	43.9 (41.9-45.9)	1.4 (1.2-1.5)
Female	8003	35.1 (33.9-37.7)	Referent
Age			
3- years	5692	43.3 (40.9-45.7)	1.3 (1.1-1.5)
4- years	5433	39.8 (37.5-42.3)	1.1 (0.9-1.3)
5- years	5233	36.7 (34.2-39.2)	Referent
Race			
White only	11872	35.6 (34.2-37.1)	Referent
Black only	1603	57.0 (52.2-61.3)	2.3 (1.9-2.8)
Multiple Race	813	41.9 (35.0-49.1)	1.3 (0.9-1.7)
Other	773	35.1 (26.8-44.5)	0.9 (0.6-1.4)
Breastfeeding Status			
No	4896	48.9 (46.4-51.4)	1.7 (1.5-1.9)
Yes	11301	35.8 (34.2-37.5)	Referent
Household Highest Education			
< High school	842	50.6 (42.5-58.6)	1.7 (1.2-2.4)
High school graduate	3283	47.5 (44.4-50.6)	1.5 (1.3-1.7)
>High school	12142	36.9 (35.4-38.5)	Referent
Household Poverty Level			
<100%	2008	49.7 (45.1-54.2)	2.2 (1.8-2.8)
100% to133%	1058	49.9 (43.9-55.9)	2.2 (1.7-2.9)
133%<150%	542	44.7 (36.2-53.4)	1.8 (1.2-2.6)
150%<185%	1089	51.8 (45.9-57.6)	2.4 (1.9-3.2)
185%<200%	546	44.2 (37.0-51.6)	1.8 (1.3-2.5)
200%<300%	2944	39.7 (36.6-42.8)	1.5 (1.2-1.7)
300%<400%	2404	36.4 (33.1-39.9)	1.3 (1.1-1.5)
>400%	4269	30.3 (28.0-32.7)	Referent
Breastfeeding Duration			
0-6 days	160	43.2 (32.7-54.5)	1.4 (0.7-2.7)
7-42 days	1569	40.5 (36.3-44.8)	1.3 (0.8-2.7)
43-90 days	1720	39.7 (35.1-44.5)	1.2 (0.7-2.1)
91-180 days	2550	37.1 (33.6-40.8)	1.1 (0.7-1.7)
181-365 days	3281	32.9 (30.0-35.9)	0.9 (0.6-1.4)
366-730 days	1645	31.2 27.1-35.6)	0.8 (0.5-1.3)
>731 days	374	34.2 (25.4-44.3)	Referent
Household Smoking			
Yes	2805	47.1 (43.8-50.4)	1.5 (1.2-1.7)
No	7313	37.1 (35.0-39.3)	Referent

Table 3. *Risk Factors for Overweight (continued).*

Variable	Unweighted n	Weighted % (95% CI)	Crude OR (95% CI)
Mother's Health			
Excellent	6129	35.5 (33.4-37.7)	Referent
Very good	5032	38.4 (36.0-40.9)	1.1 (0.9-1.3)
Good	3262	45.7 (42.3-49.2)	1.5 (1.2-1.8)
Fair	873	47.2 (40.7-53.7)	1.6 (1.2-2.1)
Poor	151	54.1 (39.8-67.9)	2.1 (1.1-3.8)
Mother's Mental Health			
Excellent	6385	37.5 (35.3-39.7)	Referent
Very good	5408	36.3 (34.1-38.6)	0.9 (0.8-1.1)
Good	2912	48.3 (44.6-52.0)	1.5 (1.3-1.8)
Fair	654	45.2 (38.1-52.5)	1.3 (1.0-1.8)
Poor	74	42.7 (26.7-60.3)	1.2 (0.6-2.5)
Father's Health			
Excellent	5486	32.8 (30.7-35.0)	Referent
Very good	4519	37.7 (35.1-40.3)	1.2 (1.0-1.4)
Good	2197	44.1 (40.1-48.1)	1.6 (1.3-1.9)
Fair	403	46.7 (37.5-56.1)	1.7 (1.2-2.6)
Poor	73	62.8 (44.4-78.1)	3.4 (1.6-7.3)
Father's Mental Health			
Excellent	6053	34.6 (32.4-36.7)	Referent
Very good	4494	37.4 (34.9-39.9)	1.1 (0.9-1.3)
Good	1823	44.2 (39.9-48.6)	1.4 (1.2-1.8)
Fair	263	45.3 (33.9-57.2)	1.5 (0.9-2.5)
Poor	31	55.6 (29.9-78.6)	2.3 (0.8-6.9)
Health Care Coverage			
Yes	15130	39.5 (38.1-41.0)	Referent
No	1202	45.7 (40.0-51.6)	1.2 (1.0-1.6)
Hispanic/Latino Origin			
Yes	2584	39.5 (38.1-41.0)	Referent
No	13585	45.7 (40.0-51.6)	1.4 (1.2-1.7)
Spoken Language			
English	14733	39.6 (38.2-41.0)	Referent
Non-English	1618	45.3 (38.5-52.3)	1.2 (0.9-1.6)
Born in the USA			
Yes	15682	39.8 (38.4-41.3)	1.1 (0.6-1.8)
No	523	37.2 (26.2-49.2)	Referent
People < 18 in Household			
One	5636	40.0 (37.9-42.2)	Referent
Two	6952	37.9 (36.1-39.8)	0.9 (0.8-1.0)
Three	2679	40.2 (36.9-43.5)	1.0 (0.8-1.1)
Four	1091	45.6 (40.5-50.7)	1.2 (1.0-1.5)

Table 3. Risk Factors for Overweight (continued).

Variable	Unweighted n	Weighted % (95% CI)	Crude OR (95% CI)
Rank of S/C in Household			
One	5636	40.0 (37.9-42.2)	Referent
Two	3337	31.9 (29.4-34.5)	0.7 (0.6-0.8)
Three	5097	40.7 (38.3-43.1)	1.0 (0.9-1.1)
Four	1676	44.2 (40.0-48.5)	1.1 (0.9-1.4)
Five	612	48.2 (41.9-55.2)	1.4 (1.0-1.8)

Table 4. Prevalence And Risk Of Overweight By Breastfeeding Status.

	Un-weighted n	Weighted % (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)
Ever Breastfed?				
Yes	11301	35.8 (34.2-37.5)	Referent	Referent
No	4896	48.9 (46.4-51.4)	1.7 (1.5-1.9)	1.6 (1.2-2.0)

[1]After adjustment for age, sex, race, education level, poverty level, smoking household, mother's and father's health, and spoken language.

Table 5. Prevalence And Risk Of Overweight By Breastfeeding Duration.

Duration of Breastfeeding	Un-weighted n	Weighted % (95% CI)	Crude OR (95% CI)	Adjusted OR[1] (95% CI)
0-6 Days	160	43.2 (32.7-54.5)	1.4 (0.7-2.7)	0.6 (0.3-1.6)
7-42 Days	1569	40.5 (36.3-44.8)	1.3 (O.8-2.0)	0.6 (0.4-1.0)
43-90 Days	1720	39.7 (35.1-44.5)	1.2 (0.7-2.0)	0.6 (0.4-1.0)
91-180 Days	2550	37.1 (33.6-40.8)	1.1 (0.7-1.7)	0.7 (0.4-1.1)
181-365 Days	3281	32.9 (30.3-35.9)	0.9 (0.6-1.4)	0.8 (0.5-1.3)
366-730 Days	1645	31.2 (27.1-35.6)	0.8 (0.5-1.3)	0.7 (0.4-1.2)
More then 731 Days	80	34.2 (25.4-44.3)	Referent	Referent

[1]After adjustment for age, sex, race, education level, poverty level, smoking household, mother's and father's health, and spoken language.

References

REFERENCES

Agostoni, C. (2005). Gherlin, Leptin and the Neurometabolic Axis of Breast-Fed and Formula–Fed Infants. *ACTA Paediatrica*, 94:523-525.

Arenz, S., Ruckerl, R., von Kries R. (2004). Breast-feeding and childhood obesity: a systemic review. *Int J Obes Relt Metab Discor*, 28:1247-1256.

Asayama, K., Ozeki, T., Sugihara, S., Ito, K., Okada, T., Tamai, H., Takaya, R., Hanaki, K., Murata, M. (2003). Criteria for Medical Intervention in Obese Children: A New Definition of 'Obesity Disease' in Japanese Children. *Pediatr Int*, 5(5):642-6.

Balaban, G., Silva, G. (2004). Protective effect of breastfeeding against childhood obesity. *Journal de Pediatrica*, 80:7-16.

Becque, M. D., Katch, V.L., Roccchini, A. P., Marks, C. R., Moorehead, C. (1988). Coronary Risk incidence of obese adolescents: reduction by exercise plus diet intervention. *Pediatrics*, 81:605-612.

Bellu, R., Ortisi, M.T., Agostoni, C et. al. (1997). Total body electrical conductivity derived measurement of the body composition of breast- or formula-fed infants at 12 months. *Nutr Res*, 17:23-29.

Bergmann, K. E. Bergmann, R. L., Kries, R.V., Bohm, O.Richter, R., Dudenhausen , L.W. Wham U. (2003). Early determinants of childhood overweight and adiposity in a birth cohort study: Role of breastfeeding. *International Journal of Obesity*, 27(2): 162-172.

Bogen, D. L., Hanusa, B. H., Whitaker, R. (2004). The effect of breast-feeding with and without formula use on the risk of obesity at 4 years of age. *Obesity Research*, 12:1527-1535.

Brick J. M., Morganstein D, Valliant, R. (2000). Analysis of complex sample data using replication. Retrived February11, 2006, from : http://www.westat.com/wesvar/techpapers/ACS-Replication.pdf.

Butte, N. F. (2001). The role of breastfeeding in obesity. *Pediatr Clin N Amer*, 48:189-198.

Collins, A. (2005). Obesity statistics of obese children. Retrived December14, 2006, from: http://www.annecollins.com/obesity/child-obesity-stats.htm.

De Bruin, N. C., Degenhart, H. J., Gal, S. et. al. (1998). Energy utilization and growth in breast-fed infants measured prospectively during the first year of life. *Am. J. Clin Nutr*, 67:885-896.

De Onis, M. (2004). The use of anthropometry in the prevention of childhood overweight and obesity. *International Journal of Obesity*, 28:81-85.

Dewey, K. G., Heinig, M. J., Nommsen, L.A., et. al. (1993). Breastfed infants are leaner than formula –fed at 1 year of age: the DARLING study, *Am J Clin Nutr* , 57:140-145.

Dewey, K. G. (2003). Is breastfeeding protective against child obesity? *Journal of Human Lactation,* 19(1): 9-18.

Dietz, W. H., Robinson,T. N. (1998). Use of the body mass index (BMI) as a measure of overweight in children and adolescents. *Journal of Pediatrics,* 13:191-193.

Dietz, W. H. (2001). Breastfeeding may help prevent childhood overweight. *JAMA,* 285:2506-2507.

Dietz, W. H., Bellizzi, M. C. (1999). Introduction: the use of BMI to assess obesity in children. *American Journal of Clinical Nutrition,* 70(suppl):123s-5s.

Dietz, W. H. (2001). The obesity epidemic in young children. Reduce television viewing and promote playing. *British Medical Journal,* 322(7282):313-314.

D'Sousa, S.W., Black, P. (1979). A study of infant growth in relation to the type of feeding. *Early Hum Dev,* 3:245-255.

Elliot, K. G., Kjolhede, C. L., Gournis, E., Rasamussen, K. M. (1997). Duration of breastfeeding associated with obesity during adolescence. *Obesity Re,* 5:538-541.

Evans, T. J. (1978). Growth and milk intake of normal infants. *Arch.Dis.Child,* 53(9):749-51.

Ferris, A.G., Beal, V.A., Laus, M. J., et. al. (1979). The effect of feeding on fat deposition in early infancy. *Pediatrics,* 64(4):397-401.

Flegal, K. M. (1999). The obesity epidemic in children and adults: current evidence and research issues. *Medicine and Science in Sports and Exercise,* 31(11):5509-5514.

Freedman, D. S., Dietz, W. H., Srinivasan, S. R., Berenson, G. S. (1999). The relation of overweight to cardiovascular risk factors among children and adolescents: the Bogalusa heart study. *Pediatrics,* 103:1175-1182.

Gillman, M.W., Rifas-Shiman, S. L., Camargo, C. A. Jr., Berkey C. S. Frazier, A. L, Rockett, H. R., Colditz, G. A. (2001). Risk of overweight among adolescents who were breast-fed as infants. *JAMA,* 285 (19): 2461-2467.

Gillman M.W. (2002). Breast-feeding and obesity. *J Pediatr,* 142:149-150.

Goran, M. I., Ball, G. D., Cruz, M. L. (2003). Obesity and risk of type 2 diabetes and cardiovascular disease. *Nutr Rev,* 61:313-316.

Grove, K. L., Sekhon, H. S., Brogan, R. S., Keller, J. A., Smith, M. S., Spindel, E. R. (2001). Chronic maternal smoking exposure alters neuronal systems in the arcuate nucleus that regulate feeding behavior inn the newborn rhesus macaque. *J Clin Endocrinol Metab*, 86:5420-6.

Grummwer-Strawn, L. M., Garza, C., Johnson, C. (2002). Childhood growth charts. *Pediatrics*, 109:141-142.

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(2):81-86.

Guise, J. M., Palda, V., Westhoff, C., Benjamin, K. S., Helfand, M., Lieu, T. A. (2003). The Effectiveness of primary care-based interventions to promote breastfeeding: systematic evidence review and Meta-Analysis for the US preventive services Task Forces. *Annals of Family Medicine,* 1:70-78.

Guo, S. S., Chumlea, W. C. (1999). Tracking of body mass index in children in relation to overweight in adulthood. *Am. J. Clin. Nutr,* 70:145S-8S.

Hammer, L. D., Kraemer, H. C., Wilson, D. M., Ritter, P. L., Dornbusch, S. M. (1991). Standardized percentile curves of body-mass index for children and adolescents. *American Journal of Disease of Child,* 145:259-263.

Harder, T., Bergmann, R., Kallischnigg, G. Plagemann, G. (2005). Duration of Breastfeeding and risk of overweight: A Meta-Analysis. *American Journal of Epidemiology*, 162(5): 397-403.

Harrison, G. G., Graver, E. J., Vargas, M., et. al. (1987). Growth and adiposity of term infants fed whey-predominant or casein-predominant formulas of human milk. *J. Pediatr.Gastroentero Nutr*, 6:739-747.

Hediger, M. L., Overpeck, M. D., Ruan, W. J., Troendle, J. F. (2000). Early infant feeding and growth status of US-Born infants and children aged 4-71 mos: analysis from the Third National Health and Nutrition Examination Survey, 1988-1994. *Am J Clin Nutr*, 72:159-67.

Hediger M. L, Overpeck M. D, Kuczmarski R. J., Ruan W.J., (2001). Association between infant breastfeeding and overweight in young children. *JAMA*, 285:2453-2460.

James, P.T. (2004). Obesity: the worldwide epidemic. *Clinics in Dermatology,* 22:276-280.

Jo, Y. H., Talmage, D. A., Role, L.W. (2002). Nicotine receptor-mediated effects on appetite and food intake. *J Neurobiol,* 53:618-32.

Kohler, L., Meeuwisse, G., Mortensson, W. (1984). Food intake and growth of infants between six and twenty-six weeks of age on breast milk, cow's milk formula, or soy formula. *Acta Paediatr Scand*, 73:40-48.

Kramer, M. S. (1981). Do breast-feeding and delayed introduction of solid foods protect against subsequent obesity? *J Pediatr*, 98: 883-887.

Lavalle, A., & Mosca, N.W. (2002). Obesity epidemic in school age children: Is school part of the problem or a partner in the remedy? *School Nurse News*, 19(4): 46-47.

Michaelsen, K. F., Larsen, P. S., Thompson, B. L. (1994). The Copenhagen cohort study on infant nutrition and growth: breast-milk intake, human milk macronutrient content, and influencing factors. *Am. J .Clin. Nutr*., 59:600-611.

Miller, J., Rosenbloom, A., Silverstein, J. (2004). Childhood obesity. *The Journal of Clinical Endocrinology & Metabolism*, 9(9):4211-4218.

Oakley, J. R. (1977). Differences in subcutaneous fat in breast- and formula-fed infants. *Arch. Dis. Child*, 52:79-80.

Ogden, C. L., Flegal, K. M., Carroll, M. D., Jhonson, C. L. (2002). Prevalence and trends in overweight among US children and adolescents. *JAMA*, 288:1728-173.

Pietrobelli, A., Faith, M. S., Allison, D. B., Gallagher, D., Chiumello, G., Heymsfield, S. B. (1998). Body mass index as a measure of adiposity among children and Adolescents: A validation study. *Journal of Pediartrics*, 132:204-210.

Poulsen, P., Vaag, A. (2003). The impact of genes and or-and postnatal environment on The metabolic syndrome. Evidence from twin studies. *Panminerva Med* 45:109-115.

Reilly, J. J., Wilson, M.L., Summerbell, C. D., Wilson, A.C. (2002). Obesity: diagnosis, prevention, and treatment; evidence based answers to common questions. *Arch Dis Child*, 86: 392-392.

Reilly, J. J., Armstrong, J., Dorosty, A. R., Emmett, P.M., Ness, A., Rogers, I., Steer, C., Sheriff, A. (2005). Early life risk factors for obesity in childhood: A cohort study. *BMJ*, 330:1357.

Reilly J. J. (2005). Descriptive epidemiology and health consequences of childhood obesity. Best Practice & Research. *Clinical Endocrinology & Metabolism*, 19(3):327-341.

Roberts, D.W. (1980). Growth of breast fed and bottle fed infants. *N.Z. Med J*., 92(664):45-6.

Salmenpera, L., Perheentupa, J., Siimes, M.A. (1985). Exclusively breast-fed healthy infants grow slower than reference infants. *Pediatr Res*, 19:307-312.

Shepherd, R.W., Oxborough, D. B., Holt, T. L., et. al. (1988). Longitudinal study of the body composition of weight gain in exclusively breast-fed and intake-measured whey-based formula-fed infants to age 3 months. *J Pedatr Gastroenterol Nutr*, 7:732-739.

Sorof, J & Daniels, S. (2002). Obesity hypertension in children: A problem of epidemic proportions. *Hypertension*, 40(4):441-447.

Srinivasan M., Laychock G. S., Hill J. D., Patel S. M. (2003) Neonatal Nutrition: Metabolic Programming of Pancreatic Islets and Obesity. *Experimental Biology and Medicine*, 228: 15-23.

Stettler, N., Stallings, V., Troxel, A., Zhao, J., Schinnar, R., Nelson, S., Ziegler, E., Storm, B. (2005). Weight gain in the first week of life and overweight in adulthood. A cohort study of European American subjects fed infant formula. *Circulation*, 111:1897-1903.

Stettler, N., Zemel, B. S., Kumanyika, S., et al. (2002). Infant weight gain and childhood Overweight in a multicenter, cohort study. *Pediatrics*, 109:194-9.

Story, M., Stevens, J., Himes, J., Stone, E., Rock, B., Ethelbah, B., Davis, S. (2003). Obesity in American-Indian children: Prevalence, Consequences, and Prevention. *American Health Foundation*, 37: S3-S12.

Strbak, V., Skultyova, M., Hromadova, M., Randuskova, A., Macho, l. (1991). Late effects of breast-feeding and early weaning: seven years prospective in study in children. *Endocr Regul*, 25:53-57.

Thompson, D., Wolf, A.M. (2001). The medical care cost burden of obesity. *Obes Rev* , 2:189-97.

Toschke, A. M., Vignerova, J., Lhotska, L., Osancova, K., Koletzko, B., Von Kries, R. (2002). Overweight and obesity in 6-14 year old Czech children in 1991: protective effect of breast-feeding. *J Peditr*, 141(6): 764-769.

Tulldahl, J., Petterson, K., Anderson, S.W., Hulthen, L. (1999). Mode of infant feeding and achieved growth in adolescence: early feeding patterns in relation to growth and body composition in adolescence. *Obes Res*, 7:431-437.

Von Kries, R., Koletzko, B., Sauerwald, T., et. al. (1999). Breast feeding and obesity: cross sectional study. *BMJ*, 319:147-150.

Wadsworth, M., Marshall, S., Hardy, R., et. al. (1999). Breast feeding and obesity. *BMJ*, 319: 1576-1576.

Wang, G., Dietz, W. H. (2002). Economic burden of obesity in youths aged 6 to 17 years: 1979-1999. *Pediatrics*, 109:E81-1.

Whitaker, R. C., Wright, J.A., Pepe, M.S., Seidel, K.D., Dietz, W.H. (1997). Predicting obesity in young adulthood from childhood and parental obesity. *New England Journal of Medicine,* 37(13):869-873.

Yeung, D. L. (1983). Infant nutrition. *Canadian Medical Association Journal*, 127 :701-715.