Lifecourse Approach to Racial/Ethnic Disparities in Childhood Obesity[1–3]

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ABSTRACT

Eliminating racial/ethnic disparities in health and health care is a national priority, and obesity is a prime target. During the last 30 y in the United States, the prevalence of obesity among children has dramatically increased, sparing no age group. Obesity in childhood is associated with adverse cardio-metabolic outcomes such as hypertension, hyperlipidemia, and type II diabetes and with other long-term adverse outcomes, including both physical and psychosocial consequences. By the preschool years, racial/ethnic disparities in obesity prevalence are already present, suggesting that disparities in childhood obesity prevalence have their origins in the earliest stages of life. Several risk factors during pregnancy are associated with increased risk of offspring obesity, including excessive maternal gestational weight gain, gestational diabetes, smoking during pregnancy, antenatal depression, and biological stress. During infancy and early childhood, rapid infant weight gain, infant feeding practices, sleep duration, child's diet, physical activity, and sedentary practices are associated with the development of obesity. Studies have found substantial racial/ethnic differences in many of these early life risk factors for childhood obesity. It is possible that racial/ethnic differences in early life risk factors for obesity might contribute to the high prevalence of obesity among minority preschool-age children and beyond. Understanding these differences may help inform the design of clinical and public health interventions and policies to reduce the prevalence of childhood obesity and eliminate disparities among racial/ethnic minority children. *Adv. Nutr. 3: 73–82, 2012.*

Introduction

In the past 3 decades, rates of overweight and obesity among adults and children have substantially increased worldwide with all but the poorest countries now struggling with a growing obesity problem (1). In the United States alone, the prevalence of overweight and obesity in school-aged children and adolescents approaches one-third (2–4). The epidemic has not spared even our youngest children (5,6). Even though U.S. childhood obesity rates in some population subgroups, such as whites and those of higher socioeconomic status (SES), may have peaked, overall rates remain stubbornly high and racial/ethnic disparities appear to be widening (7–9).

The lifecourse approach to chronic disease prevention posits that factors may act in the prenatal period into infancy, childhood, and beyond to determine risk of chronic disease (10). These factors can range from the social/built environment (macro) through behavior, physiology, and genetics (micro). Factors interact with each other over the lifecourse, with different determinants being more or less important at different life stages. When risk factors have much more influence at a particular life stage than either before or after, it is called a sensitive period (10).

Today, we recognize that the prenatal, infancy, and early childhood periods are likely to be key to the development and thus prevention of obesity and its consequences in children. In addition, given the high prevalence of obesity among racial/ethnic minority children < 6 y of age, the lifecourse approach could provide a framework both for understanding the etiology of early differences in risk factors and disparities in prevalence and for intervening during these periods to eliminate racial/ethnic disparities.

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In the subsequent sections we review the prevalence of childhood obesity and its comorbidities, summarize evidence on racial/ethnic differences in early life risk factors for obesity, and discuss potential approaches for reducing early childhood obesity and eliminating racial/ethnic disparities in obesity.

Methods

We conducted a systematic review of the published literature on childhood obesity prevalence; obesity risk factors in pregnancy, infancy, and childhood; and racial/ethnic disparities in these areas. We also conducted a review of current childhood obesity prevention efforts and efforts to eliminate racial/ethnic disparities in the United States. Databases searched included MEDLINE/Pub Med, Academic Search Premier, RePort, ERIC, the Cochrane Database of Systematic Reviews, and the Cochrane Register of Controlled Trials. We also reviewed reference lists of included papers and other relevant reviews and meta-analyses.

Current status of knowledge

Childhood obesity is prevalent, of consequence, and has its origins in the earliest stages of life

In the US, ~32% of children ages 2–19 y are overweight (age- and sex-specific BMI 85th to 94th percentile) or obese (BMI ≥ 95th percentile) (2). Even among preschool-age children 2–5 y of age, studies also suggest a high prevalence of obesity. The NHANES 2007–2008 reported an obesity prevalence of 10.4% in the 2- to 5-y-old group. Furthermore, a 2008 report by the CDC Pediatric Nutrition Surveillance System showed an obesity prevalence rate of 14.6% among low-income, preschool-aged children (ages 2–4 y) (11). Obesity in children is associated with both short- and long-term adverse outcomes, including both physical and psycho-social consequences (12–16) and even perhaps shortened lifespan (17). Children who are overweight tend to become overweight adults and, once present, obesity is notoriously hard to treat (18–20). The obesity epidemic has spared no age group, including young children. Recent data show that even infants have experienced a dramatic rise in excess weight in the past 20 y, implying that the roots of the epidemic can be found as early as infancy, and before (21). Taken together, these facts indicate that finding new etiologic clues, starting at the very earliest stages of human development, is potentially crucial to stemming the rising tide of obesity.

Substantial racial/ethnic disparities exist in childhood obesity and its related comorbidities

Racial/ethnic minority children bear a disproportionate share of the burden of obesity and its related comorbidities (22). According to the most recent NHANES 2007–2008, the prevalence of children ages 2–19 y having a BMI ≥ 95th percentile was 15.3% among non-Hispanic white children, 20.0% among non-Hispanic black children, and 20.8% among Mexican American children (2). By the preschool years, racial/ethnic disparities in obesity prevalence are already present and are particularly evident among non-Hispanic black girls and Mexican American boys (3). According to a 2008 survey of low-income, preschool-aged children by the CDC Pediatric Nutrition Surveillance System, obesity prevalence was highest among American Indian/Alaska Native (21.2%) and Hispanic (18.5%) children and lowest among non-Hispanic white (12.6%), non-Hispanic black (11.8%), and Asian/Pacific Islander (12.3%) children (11).

The degree of obesity also differs among racial/ethnic minority children. Compared to non-Hispanic white children, non-Hispanic black girls and Hispanic boys had almost 2-fold greater odds of being severely obese (BMI ≥ 97th percentile) in 2007–2008 (2). In another study examining severe obesity from 1976 to 2006, Wang et al. (7) found that the prevalence of severe obesity in the 2- to 19-y age range was much higher in non-Hispanic black girls (9.1%) compared to non-Hispanic white girls (3.5%) and Hispanic girls (5.1%). Similarly, the age-adjusted prevalence of severe obesity was higher in non-Hispanic black boys (7.1%) and Hispanic boys (6.9%) compared to non-Hispanic white boys (4.0%).

The adverse sequelae of obesity are also more common among racial/ethnic minority children. Obesity in childhood is a significant risk factor for obesity in adulthood. According to results from the Bogalusa Heart Study, obese black children are much more likely than their white counterparts to remain obese as adults (23,24). The epidemiologic shift of obesity to younger ages is also expected to have a profound impact on rates of type 2 diabetes in young adults (25). Evidence from the SEARCH for Diabetes in Youth Study, a multicenter population-based study, has shown higher incidence rates of type 2 diabetes compared with type 1 diabetes mellitus among African American, Hispanic, Asian American, and American Indian adolescents (26). The proportion of all diabetes that was diagnosed as type 2 among 10–19 y olds were: 6% for non-Hispanic whites, 22% for Hispanics, 33% for African Americans, 40% for Asian/Pacific Islanders, and 76% for American Indians. Among children aged 8–17 y in the NHANES 1999–2000, blood pressure levels were higher among African Americans and Mexican Americans compared with non-Hispanic whites. These differences were reduced or eliminated after adjustment for BMI, suggesting that higher adiposity accounted for much of the elevated blood pressure (27). Racial/ethnic differences also exist for fatty liver related to obesity. In a study of obese children ages 2–19 y, fatty liver disease was present in 50% of Hispanics, 35% of whites, and 10% of blacks (28).

In sum, existing evidence overwhelmingly suggests that racial/ethnic disparities exist in childhood obesity and its related sequelae. The consistency of these disparities across the spectrum of obesity-related sequelae underscores the importance of identifying the underlying causes of the disparities.

Established early life risk factors for childhood obesity

Prepregnancy and pregnancy risk factors. Maternal obesity is one of the strongest and most reliable predictors of later obesity in children (18). Maternal overweight or obesity entering pregnancy is also a risk factor for childhood

obesity. Infants born to overweight mothers are more likely to be born large for gestational age, are less likely to be breastfed, and are at higher risk for obesity and type 2 diabetes in later life (29–36).

Gestational weight gain (GWG) is an important and independent predictor of child weight and health. Higher GWG is associated with greater birth weight for gestational age, which predicts offspring weight and risk of overweight in later life (37). Independent of its relationship with fetal growth, we and others have found that even among overweight mothers, higher GWG is a strong risk factor for child obesity and its sequelae (38–41).

Children born to mothers with impaired glucose tolerance during pregnancy are more likely to be macrosomic and have higher body fat at birth and subsequently may be at elevated risk for becoming overweight and developing related complications such as higher blood pressure and risk for type 2 diabetes (42–49). The link between a mother's glucose tolerance during pregnancy and her child's weight and glucose tolerance appears not only to result from shared genes and behaviors but also from a direct influence of the adverse intrauterine environment on the fetus (43,50,51).

A recent meta-analysis of 14 studies showed that smoking during pregnancy is associated with a 50% increased odds of obesity during childhood (52). We previously reported that maternal smoking during early pregnancy is associated with elevated risk for having a BMI that exceeds the 85th percentile for age and sex, higher BMI Z-score, and higher systolic blood pressure at age 3 y (53).

Finally, previous studies found that maternal stressors, such as depression, are associated with childhood obesity (54,55). Other characteristics and behaviors during pregnancy, including diet and diet quality, may influence weight gain and obesity among offspring, but these factors remain understudied.

Infancy risk factors. In the first year of life, the primary determinants of later obesity appear to be rapid weight gain and type and duration of infant feeding. Both fetal growth and rapid, early, infancy weight gain are associated with later BMI in childhood or adulthood (56–59). Furthermore, 2 meta-analyses (60,61) found that breastfeeding is associated with a 10–20% reduction in obesity prevalence in childhood or adulthood, with duration showing a dose-response relationship (62). Previous studies also found that introduction of solids at < 4 mo old is a risk factor for increased infant weight gain (63–65).

Children naturally regulate their intake, but parents' feeding behaviors may override children's internal appetite signals. Birch et al. (66) reported that overly restrictive feeding behaviors are associated with overeating and poorer self-regulation of energy intake in preschool-aged children and, among girls, increased adiposity. It is possible that, compared with parents who bottle-feed, mothers who breastfeed may be more responsive to the infant's signals for frequency and volume of feedings (67). In some studies, mothers' pressure on their children to eat in the absence of hunger has also been associated with disinhibited eating (68), increased child energy intake and body weight (69).

An inverse association between sleep duration and obesity has been observed in cross-sectional studies of children and adolescents (70–73). Taveras et al. (74) recently reported that infant sleep of <12 h/d was associated with a 2-fold increased odds of obesity at age 3 y. This association has been observed in infants as young as 6 mo old. Tikotzky et al. (75) found that short nocturnal sleep was associated with increased weight and weight:length ratio in 6-mo-old infants. Finally, early child care attendance has been shown to be a risk factor for greater weight gain in the first year of life (63).

Risk factors in early childhood through preschool age. After the first year of life, several risk factors emerge that have been found to be associated with later obesity. Among school-aged children, there is strong evidence from both observational (76–78) and experimental (79,80) research that television viewing is positively associated with risk of overweight. In preschool-aged children, Dennison et al. (81) found that the number of hours a child spends watching TV is associated with increased risk of obesity. Additionally, Lumeng et al. (82) found that exposure of ≥2 h/d of TV was positively associated with an increased risk of overweight at ages 36 and 54 mo. Having a TV in the child's bedroom is also associated with greater amounts of time watching TV and with increased risk of overweight (81). Additionally, while watching TV, children are exposed to substantial amounts of advertisements for food products. Two- to seven-y-old children view an average of 2:23 min of food advertising per hour (83). In a study of 2- to 6-y-old children, children who watched a cartoon with commercials were more likely to prefer the products advertised than children who watched the same cartoon but were not exposed to commercials (84). These findings suggest that food advertising can affect children's food preferences and could contribute to greater energy intake and increase obesity risk.

Short sleep duration persists as a potential risk factor for obesity in childhood as well. Accumulating evidence links short sleep with increased risk of obesity in children, with short sleep duration and late bedtime showing a dose-response relationship with increased odds of obesity (71). Evidence suggests that sleep insufficiency in early childhood may be associated with a long-term risk of obesity in later years. Insufficient nighttime sleep in children 0–4 y old has been associated with increased odds of overweight (vs. normal weight) and obesity (vs. overweight) 5 y later (85). In a population-based birth cohort study, Landhuis et al. (86) found that the mean childhood sleep duration from ages 5 to 11 y was inversely associated with risk of adult obesity at 32 y of age.

Sugar-sweetened beverage consumption has increased rapidly among children. Between 1977 and 2001, consumption of sugar-sweetened beverages increased from 3.0 to 6.9% among children ages 2–18 y in the US (87). Children start drinking sugar-sweetened beverages at a remarkably young age and consumption increases through young

adulthood. Among school-aged children, intake of sugar-sweetened beverages has been associated with greater caloric intake (88) and increased BMI (89). Results from both cross-sectional and prospective studies suggest that intake of sweetened beverages may be associated with increased risk of obesity in preschool-aged children (90–92).

Over the last 30 y, consumption of fast food has paralleled the rise in childhood obesity prevalence (93–95). Consumption of fast food by children increased 5-fold from 2% of total energy in the late 1970s to 10% of total energy in the mid-1990s (94). Greater consumption of fast food has been found to be associated with poorer diet quality among children (96) and is usually accompanied by other unhealthy dietary practices like large portion sizes (93) and high energy density, which are known to contribute to body weight (97).

Finally, regular participation in physical activity has multiple health benefits for children (98). Evidence suggests that physical activity has a substantial influence on BMI (99) and that children who are active early in life have a reduced risk for large adiposity gains in elementary school through adolescence (100–102).

Parents play a key role in childhood obesity prevention interventions. Several studies have examined the effects of particular household routines on the prevalence of childhood overweight and obesity. For example, fewer family meals and increased TV viewing have been associated with an increased risk for childhood overweight (103). In a cross-sectional study of 8550 4-y-old children, Anderson et al. (104) found 3 household routines, e.g. eating family dinners, getting sufficient nocturnal sleep, and limiting screen time, as protective of children's risk for obesity.

Racial/ethnic and socioeconomic differences in early life risk factors for childhood obesity

Previous studies have examined racial/ethnic differences in pregnancy-related risk factors for childhood obesity (105–108). In a national study by Chu et al. (105), black and Hispanic women were more likely than white women to begin their pregnancies already overweight or obese and gained less weight during pregnancy. One study (107) found that Hispanic women have a higher risk of gestational diabetes. Few studies have examined racial/ethnic differences in smoking during pregnancy (108) and in maternal antenatal depression (106).

A recent study by Taveras et al. (109) showed that racial/ethnic differences in risk factors for obesity exist prenatally and in early childhood. In this study, children from underrepresented racial/ethnic groups were found to have a higher risk of various obesity risk factors compared to their white counterparts. Specifically, black and Hispanic children had higher odds of antenatal depression, weight gain during infancy, introduction of solid foods before 4 mo of age, maternal restrictive feeding, television in their bedrooms after age 2 y, and intake of sugar-sweetened beverages and fast food. Conversely, black and Hispanic children had lower odds of protective factors, including exclusive breastfeeding and sleep for >12 h/d during infancy. These findings may help to explain racial/ethnic disparities in early childhood obesity rates while justifying the need for early childhood interventions to reduce these disparities in obesity prevalence.

Several studies of older children have found obesity-related risk factors to be more prevalent among racial/ethnic minority youth. Previous studies have found higher levels of TV viewing and more televisions in bedrooms, higher consumption of sugar-sweetened beverages (110), increased fast food consumption (111), and lower levels of physical activity among black and Hispanic youth compared to white youth (112,113).

What is the role of SES in explaining racial/ethnic differences in obesity and obesity-related risk factors?

SES is a multidimensional construct that is known to exert a profound influence on health (114). The relationship between SES, usually measured as parental income or education, and childhood obesity is complex (28). Although several U.S. studies of the relationship between SES and childhood obesity have shown that low SES and minority groups have a higher prevalence of obesity, more recent data have shown some conflicting results (115–119). A recent study by Wang et al. (116) of secular trends in the relationship between SES and obesity did not find consistent associations between SES and overweight among black and Mexican American children. Among white children, a reverse association was observed between SES and obesity prevalence. Furthermore, the study by Wang et al. (116) showed that although the relationship between SES and obesity has weakened over time, the gap between ethnic groups has become wider.

The exact role of SES in the relationship between race/ethnicity and obesity is unclear. Singh et al. (120) found that the magnitude of the effects of SES on obesity among 10–17 y olds varied by race/ethnicity. For example, the effects of SES on the odds of obesity were larger for Hispanics than non-Hispanic whites and blacks. Additionally, after adjusting for maternal education, household income, and children's food security status, Whitaker et al. (121) found that the increased odds of obesity risk among Hispanic 3-y-old children did not change substantially, suggesting that the increased prevalence of obesity in Hispanics compared to blacks or whites was not explained by racial/ethnic differences in socioeconomic indicators. Taveras et al. (109) recently found that socioeconomic factors did not explain most racial/ethnic differences in prenatal and early childhood risk factors for obesity. In this study, socioeconomic factors markedly attenuated (>30%) racial/ethnic differences in smoking during pregnancy, maternal depression, breast feeding initiation and duration, and having a TV where the child sleeps. However, adjusting for SES did not completely eliminate observed racial/ethnic differences in obesity risk factors. Thus, existing evidence does not suggest that differences in SES primarily explain racial/ethnic disparities in obesity.

Caprio et al. (28) have discussed the limited nature of using household income and parental education as markers of

SES, because such variables may not fully capture the child's access to resources or the family's socioeconomic position. Braveman et al. (122) found that a given income and education level may not reflect the same amount of wealth across all races/ethnicities. For example, they found that compared to African Americans in the lowest income quintile, whites in the same income quintile had >400 times as many resources. Environmental factors can also contribute to SES. Williams et al. (123) suggested that residential segregation may be responsible for disparities in SES and health. A review by Lovasi et al. (124) suggested that increased access to supermarkets and exercise facilities and better safety perceptions may help foster better diets and physical activity frequency among low-income, black, and Hispanic populations, targeting obesity disparities. However, it was noted that the association between built environment components and obesity prevalence has not been consistent in the literature. Such studies demonstrate that other aspects of socioeconomic position should be examined to better understand the role of SES in racial/ethnic disparities in obesity prevalence.

Contribution of culture and acculturation to racial/ethnic differences in obesity risk factors

Given that SES may not fully explain racial/ethnic differences in obesity prevalence, increased attention has been given to culture and acculturation as underlying factors that may contribute to racial/ethnic disparities in obesity. Accumulating evidence has shown a change in health status with acculturation and more time spent in the US. In particular, studies have shown changes in traditional diet components across generations. Allen et al. (125) found that across generations, Latinos' diets have transitioned from better to worse than whites, with Latinos consuming fewer fruits and vegetables and drinking more soda across generations. McArthur et al. (126) showed that in Hispanic immigrant households, high-fat and -sugar foods, not in the traditional Hispanic diet, were regularly available for children, suggesting that children may have experienced transitions in food preferences. Furthermore, Popkin et al. (127) showed that US-born Asian American and Hispanic adolescents were more than 2 times as likely to be obese compared to foreign-born adolescents. Immigration and nativity status may also interact with other socioeconomic factors. For example, Balistreri et al. (128) found that income was inversely associated with BMI among kindergarten children of US-born Hispanic and white parents. On the other hand, income was positively associated with BMI among foreign-born Hispanic families. Cultural differences among immigrants may explain the different associations and interactions.

Culture may also play a role in shaping parental perceptions of their children's health status. Mothers may have different preferences for what they consider a "healthy" child. In some cultures, mothers may view thinness as a reflection of poor health and malnutrition. For example, some evidence suggests that Hispanic mothers may perceive heavier children as healthier children (129–131). Thus, they may encourage their children to eat more. A qualitative study also showed that Hispanic mothers may perceive a child who is "not hungry" as worrisome (132). At the same time, some parents may not perceive their children as obese. In a study including overweight to very obese 5- to 10-y-old African American children, Young-Hyman et al. (133) found that even though 90% of boys and 80% of girls were obese or very obese, only 30% of their parents classified their child as being very overweight. Such culturally defined perceptions of body image may influence parenting strategies and decisions regarding eating habits, affecting the amount of food children eat and their risk of overweight and obesity.

Opportunities for reducing childhood obesity prevalence in the US

From a lifecourse perspective, the pregnancy and early childhood periods may provide a critical period and unique opportunity for preventing childhood obesity. Pregnancy and early childhood represent periods of maximal environmental dependence and parental care and a developmentally plastic period during which behaviors are modifiable and the physiologic signals among adipocytes, the brain, and other organs are being set (134). Early childhood seems particularly promising and highly sensitive to interventions; there are multiple settings to access parents (e.g. primary care, child care, early education settings, etc.), and parents and caregivers are highly sensitized to children's needs. Habits and tastes develop early in children and thus establishing the tastes for a variety of foods, enjoying active play, developing motor skills, and good sleep habits are all critical for future healthy behavioral patterns.

In recognition of the growing evidence of the importance of assessing the beginnings of obesity and instituting preventive measures in the early years, the Institute of Medicine's Standing Committee on Childhood Obesity Prevention (135) recently published a report examining strategies to prevent overweight and obesity from birth to age 5 y, with a focus on nutrition, physical activity, and sedentary behavior, and made policy recommendations on obesity prevention in the first 5 y. The goals, recommendations, and potential actions for implementation were in the areas of growth monitoring and assessing risk, physical activity, healthy eating, food marketing and screen time, and sleep. The recommendations provide examples of potential intervention targets for prevention policies across a range of settings and types of programs that can influence the environments in which young children develop and grow.

Evidence for effective obesity prevention interventions is increasing rapidly, with the most promising approaches to date being changes in environments and policies aimed at young children (136). Obesity and intervention experts have advocated for the development and testing of multilevel, multi-sector prevention strategies that invoke change at the environment level (137). Recent results from whole-of-community interventions, such as Shape Up Somerville (138) in the US and Romp and Chomp (139) in Australia,

provide further evidence that multi-level interventions can be effective in obesity prevention among children. Few interventions have targeted children < 5 y of age (140,141) and questions remain regarding sources of policy resistance, strategies to overcome such resistance, and the most effective levers of sustainable change in environmental-level interventions (142).

A recent national effort to prevent obesity is the *Let's Move!* campaign. In 2010, First Lady Michelle Obama helped launch the *Let's Move!* campaign with the goal of reducing childhood obesity and establishing a healthier generation of youth by involving participants at multiple levels. *Let's Move!* encompasses 5 pillars: early childhood obesity prevention; parent and caregiver empowerment; healthier food in schools; access to healthy, affordable foods; and increased physical activity (143). The early childhood component of *Let's Move!* outlines specific recommendations for pregnant women and those involved in the care of young children. Women are advised to achieve a healthy prenatal weight and adequate GWG in addition to seeking prenatal care. The early childhood component also promotes breastfeeding due to its association with lower rates of obesity in children. The initiative supports research of environmental chemicals that may promote weight gain or obesity in children. *Let's Move!* discourages television and media exposure during early childhood in favor of increased physical activity. Lastly, the campaign calls for interventions in child care settings that are in alignment with the initiative's overarching goals of fitness and nutrition. The guidelines of the *Let's Move!* campaign strive to ignite a national movement in the fight against childhood obesity.

In parallel with the *Let's Move!* campaign and childhood obesity prevention set as a national priority, President Barack Obama created the White House Task Force on Childhood Obesity in February 2010. The task force was charged to develop an action plan (144), including recommendations and concrete goals to eliminate the childhood obesity epidemic within the next generation. The 70 recommendations, which are based on the latest research, focus on the same pillars as the *Lets Move!* public awareness efforts and both efforts strive to jointly engage society to immediately take action against the obesity epidemic.

Approaches to eliminating racial/ethnic disparities in obesity prevalence

Substantial evidence suggests that interventions to modify early life risk factors for obesity and use of the lifecourse approach as a conceptual framework may have substantial impact on reducing disparities in childhood obesity prevalence and its related comorbidities. To date, however, few interventions have been developed to target the prenatal, infancy, and early childhood periods in an attempt to prevent obesity. Although more studies are needed to understand the underlying reasons for the development of these racial/ethnic disparities in obesity prevalence, existing evidence provides strong rationale for testing comprehensive interventions in early life to reduce disparities in obesity prevalence.

Another approach to addressing racial/ethnic disparities in obesity prevalence is to apply biomedical science and technology to evidence-based medicine, public policy, and social programs. Dankwa-Mullan et al. (145) described the need for a paradigm shift in health disparities science to incorporate translational, transformational, and trans-disciplinary approaches to health disparities research. In this way, pioneering research could more efficiently lead from etiology and detection of differences and disparities to intervention studies. With this proposed paradigm shift and research triad, the field of health of disparities science may be able to better accommodate new findings and implement interventions more efficiently. In accordance with the new paradigm shift, the NIH held a summit, titled "The Science of Eliminating Health Disparities," in December 2008. The purpose of the summit was to assess national and global efforts in eliminating health disparities and provide a framework for future endeavors (146). The conclusions of the summit were that health disparities research: *1*) should focus on social determinants of health; *2*) needs to be collaborative and promote community engagement; *3*) should promote effective and sustainable partnership models; *4*) should promote infrastructure and capacity building for health disparities research; and *5*) should consider media outreach and communication as an essential component of dissemination of the research findings. The NIH summit recommendations provide a framework for bridging science, practice, and policy in the health disparities field and could be an important model for guiding obesity prevention among racial/ethnic minority populations.

Conclusions

Effective interventions for addressing childhood obesity and eliminating racial/ethnic disparities will require multi-level, multi-sector strategies, especially those that invoke change at the social environment level and draw lessons from a lifecourse understanding of the etiology of obesity. In addition, to eliminate racial/ethnic disparities there is an important need to identify effective levers of sustainable change and a move toward paradigm-shifting research and interventions that integrate translational, transformational, and trans-disciplinary thinking and approaches.

Acknowledgments

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Literature Cited

1. WHO. Global strategy on diet, physical activity and health [cited 2010 Dec 4]. Available from: http://wwwwhoint/dietphysicalactivity/en/.
2. Ogden CL, Carroll MD, Curtin LR, Lamb MM, Flegal KM. Prevalence of high body mass index in US children and adolescents, 2007–2008. JAMA. 2010;303:242–9.
3. Ogden CL, Carroll MD, Flegal KM. High body mass index for age among US children and adolescents, 2003–2006. JAMA. 2008;299:2401–5.
4. Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM. Prevalence of overweight and obesity in the United States, 1999–2004. JAMA. 2006;295:1549–55.
5. Mei Z, Scanlon KS, Grummer-Strawn LM, Freedman DS, Yip R, Trowbridge FL. Increasing prevalence of overweight among US low-

income preschool children: the Centers for Disease Control and Prevention pediatric nutrition surveillance, 1983 to 1995. Pediatrics. 1998;101:E12.
6. Sherry B, Mei Z, Scanlon KS, Mokdad AH, Grummer-Strawn LM. Trends in state-specific prevalence of overweight and underweight in 2- through 4-year-old children from low-income families from 1989 through 2000. Arch Pediatr Adolesc Med. 2004;158:1116–24.
7. Wang YC, Gortmaker SL, Taveras EM. Trends and racial/ethnic disparities in severe obesity among US children and adolescents, 1976. Int J Pediatr Obes. Epub 2010 Mar 17.
8. Rifas-Shiman SL, Gillman MW, Oken E, Haines J, Taveras EM. Decrease in overweight prevalence among young children in the 21st century. The 27th Annual Scientific Meeting of The Obesity Society; October 24–28; Washington, DC: The Obesity Society; 2009.
9. Wang Y, Beydoun MA. The obesity epidemic in the United States–gender, age, socioeconomic, racial/ethnic, and geographic characteristics: a systematic review and meta-regression analysis. Epidemiol Rev. 2007;29:6–28.
10. Kuh D, Ben-Shlomo Y. A life course approach to chronic disease epidemiology: tracing the origins of ill-health from early to adult life. 2nd edition. London: Oxford University Press; 2004.
11. CDC. Obesity prevalence among low-income, preschool-aged children: United States, 1998–2008. MMWR Morb Mortal Wkly Rep. 2009;58:769–73.
12. Dietz WH. Health consequences of obesity in youth: childhood predictors of adult disease. Pediatrics. 1998;101:518–25.
13. Dietz WH Jr, Gross WL, Kirkpatrick JA Jr. Blount disease (tibia vara): another skeletal disorder associated with childhood obesity. J Pediatr. 1982;101:735–7.
14. Freedman DS, Khan LK, Dietz WH, Srinivasan SR, Berenson GS. Relationship of childhood obesity to coronary heart disease risk factors in adulthood: the Bogalusa Heart Study. Pediatrics. 2001;108: 712–8.
15. Castro-Rodríguez JA, Holberg CJ, Morgan WJ, Wright AL, Martinez FD. Increased incidence of asthmalike symptoms in girls who become overweight or obese during the school years. Am J Respir Crit Care Med. 2001;163:1344–9.
16. Fagot-Campagna A, Pettitt DJ, Engelgau MM, Burrows NR, Geiss LS, Valdez R, Beckles GL, Saaddine J, Gregg EW, Williamson DF, et al. Type 2 diabetes among North American children and adolescents: an epidemiologic review and a public health perspective. J Pediatr. 2000;136:664–72.
17. Olshansky SJ, Passaro DJ, Hershow RC, Layden J, Carnes BA, Brody J, Hayflick L, Butler RN, Allison DB, Ludwig DS. A potential decline in life expectancy in the United States in the 21st century. N Engl J Med. 2005;352:1138–45.
18. Whitaker RC, Wright JA, Pepe MS, Seidel KD, Dietz WH Jr. Predicting obesity in young adulthood from childhood and parental obesity. N Engl J Med. 1997;337:869–73.
19. Serdula MK, Ivery D, Coates RJ, Freedman DS, Williamson DF, Byers T. Do obese children become obese adults? A review of the literature. Prev Med. 1993;22:167–77.
20. Douketis JD, Feightner JW, Attia J, Feldman WF. Periodic health examination, 1999 update: 1. Detection, prevention and treatment of obesity. CMAJ. 1999;160:513–25.
21. Kim J, Peterson KE, Scanlon KS, Fitzmaurice GM, Must A, Oken E, Rifas-Shiman SL, Rich-Edwards JW, Gillman MW. Trends in overweight from 1980 through 2001 among preschool-aged children enrolled in a health maintenance organization. Obesity (Silver Spring). 2006;14:1107–12.
22. Strauss RS, Pollack HA. Epidemic increase in childhood overweight, 1986–1998. JAMA. 2001;286:2845–8.
23. Freedman DS, Khan LK, Serdula MK, Dietz WH, Srinivasan SR, Berenson GS. Racial differences in the tracking of childhood BMI to adulthood. Obes Res. 2005;13:928–35.
24. Freedman DS, Khan LK, Serdula MK, Ogden CL, Dietz WH. Racial and ethnic differences in secular trends for childhood BMI, weight, and height. Obesity (Silver Spring). 2006;14:301–8.
25. Lee JM. Why young adults hold the key to assessing the obesity epidemic in children. Arch Pediatr Adolesc Med. 2008;162:682–7.
26. Liese AD, D'Agostino RB Jr, Hamman RF, Kilgo PD, Lawrence JM, Liu LL, Loots B, Linder B, Marcovina S, Rodriguez B, et al. The burden of diabetes mellitus among US youth: prevalence estimates from the SEARCH for Diabetes in Youth Study. Pediatrics. 2006;118: 1510–8.
27. Muntner P, He J, Cutler JA, Wildman RP, Whelton PK. Trends in blood pressure among children and adolescents. JAMA. 2004;291: 2107–13.
28. Caprio S, Daniels SR, Drewnowski A, Kaufman FR, Palinkas LA, Rosenbloom AL, Schwimmer JB. Influence of race, ethnicity, and culture on childhood obesity: implications for prevention and treatment. Obesity (Silver Spring). 2008;16:2566–77.
29. Li R, Jewell S, Grummer-Strawn L. Maternal obesity and breastfeeding practices. Am J Clin Nutr. 2003;77:931–6.
30. Stuebe AM, Rich-Edwards JW, Willett WC, Manson JE, Michels KB. Duration of lactation and incidence of type 2 diabetes. JAMA. 2005; 294:2601–10.
31. Gunderson EP. Breastfeeding after gestational diabetes pregnancy: subsequent obesity and type 2 diabetes in women and their offspring. Diabetes Care. 2007;30 Suppl 2:S161–8.
32. Gunderson EP, Lewis CE, Wei GS, Whitmer RA, Quesenberry CP, Sidney S. Lactation and changes in maternal metabolic risk factors. Obstet Gynecol. 2007;109:729–38.
33. Mok E, Multon C, Piguel L, Barroso E, Goua V, Christin P, Perez MJ, Hankard R. Decreased full breastfeeding, altered practices, perceptions, and infant weight change of prepregnant obese women: a need for extra support. Pediatrics. 2008;121:e1319–24.
34. Gillman MW, Rifas-Shiman S, Berkey CS, Field AE, Colditz GA. Maternal gestational diabetes, birth weight, and adolescent obesity. Pediatrics. 2003;111:e221–6.
35. Parsons TJ, Power C, Manor O. Fetal and early life growth and body mass index from birth to early adulthood in 1958 British cohort: longitudinal study. BMJ. 2001;323:1331–5.
36. Jeffery AN, Voss LD, Metcalf BS, Wilkin TJ. The impact of pregnancy weight and glucose on the metabolic health of mother and child in the south west of the UK. Midwifery. 2004;20:281–9.
37. Oken E, Gillman MW. Fetal origins of obesity. Obes Res. 2003;11:496–506.
38. Oken E, Taveras EM, Kleinman KP, Rich-Edwards JW, Gillman MW. Gestational weight gain and child adiposity at age 3 years. Am J Obstet Gynecol. 2007;196:322 e1–8.
39. Moreira P, Padez C, Mourao-Carvalhal I, Rosado V. Maternal weight gain during pregnancy and overweight in Portuguese children. Int J Obes (Lond). 2007;31:608–14.
40. Oken E, Rifas-Shiman SL, Field AE, Frazier AL, Gillman MW. Maternal gestational weight gain and offspring weight in adolescence. Obstet Gynecol. 2008;112:999–1006.
41. Olson CM, Strawderman MS, Dennison BA. Maternal weight gain during pregnancy and child weight at age 3 years. Matern Child Health J. 2009;13:839–46.
42. Jang HC, Cho NH, Min YK, Han IK, Jung KB, Metzger BE. Increased macrosomia and perinatal morbidity independent of maternal obesity and advanced age in Korean women with GDM. Diabetes Care. 1997; 20:1582–8.
43. Boloker J, Gertz SJ, Simmons RA. Gestational diabetes leads to the development of diabetes in adulthood in the rat. Diabetes. 2002;51: 1499–506.
44. Silverman BL, Metzger BE, Cho NH, Loeb CA. Impaired glucose tolerance in adolescent offspring of diabetic mothers. Relationship to fetal hyperinsulinism. Diabetes Care. 1995;18:611–7.
45. Pettitt DJ, Knowler WC. Long-term effects of the intrauterine environment, birth weight, and breast-feeding in Pima Indians. Diabetes Care. 1998;21 Suppl 2:B138–41.
46. Silverman BL, Rizzo TA, Cho NH, Metzger BE. Long-term effects of the intrauterine environment. The Northwestern University Diabetes in Pregnancy Center. Diabetes Care. 1998;21 Suppl 2:B142–9.

47. Boney CM, Verma A, Tucker R, Vohr BR. Metabolic syndrome in childhood: association with birth weight, maternal obesity, and gestational diabetes mellitus. Pediatrics. 2005;115:e290–6.
48. Hillier TA, Pedula KL, Schmidt MM, Mullen JA, Charles MA, Pettitt DJ. Childhood obesity and metabolic imprinting: the ongoing effects of maternal hyperglycemia. Diabetes Care. 2007;30:2287–92.
49. Wright CS, Rifas-Shiman SL, Rich-Edwards JW, Taveras EM, Gillman MW, Oken E. Intrauterine exposure to gestational diabetes, child adiposity, and blood pressure. Am J Hypertens. 2009;22:215–20.
50. Dabelea D, Hanson RL, Lindsay RS, Pettitt DJ, Imperatore G, Gabir MM, Roumain J, Bennett PH, Knowler WC. Intrauterine exposure to diabetes conveys risks for type 2 diabetes and obesity: a study of discordant sibships. Diabetes. 2000;49:2208–11.
51. Levin BE, Govek E. Gestational obesity accentuates obesity in obesity-prone progeny. Am J Physiol. 1998;275:R1374–9.
52. Oken E, Levitan EB, Gillman MW. Maternal smoking during pregnancy and child overweight: systematic review and meta-analysis. Int J Obes (Lond). 2008;32:201–10.
53. Oken E, Huh SY, Taveras EM, Rich-Edwards JW, Gillman MW. Associations of maternal prenatal smoking with child adiposity and blood pressure. Obes Res. 2005;13:2021–8.
54. Gundersen C, Lohman BJ, Garasky S, Stewart S, Eisenmann J. Food Security, Maternal Stressors, and Overweight Among Low-Income US Children: Results From the National Health and Nutrition Examination Survey (1999–2002). Pediatrics. 2008;122:e529–40.
55. Davis M, Young L, Davis SP, Moll G. Parental depression, family functioning and obesity among African American children. J Cult Divers. 2008;15:61–5.
56. Baird J, Fisher D, Lucas P, Kleijnen J, Roberts H, Law C. Being big or growing fast: systematic review of size and growth in infancy and later obesity. BMJ. 2005;331:929.
57. Stettler N, Kumanyika SK, Katz SH, Zemel BS, Stallings VA. Rapid weight gain during infancy and obesity in young adulthood in a cohort of African Americans. Am J Clin Nutr. 2003;77:1374–8.
58. Ong KK. Size at birth, postnatal growth and risk of obesity. Horm Res. 2006;65 Suppl 3:65–9.
59. Monteiro PO, Victora CG. Rapid growth in infancy and childhood and obesity in later life–a systematic review. Obes Rev. 2005;6:143–54.
60. Arenz S, Ruckerl R, Koletzko B, von Kries R. Breast-feeding and childhood obesity: a systematic review. Int J Obes Relat Metab Disord. 2004;28:1247–56.
61. Owen CG, Martin RM, Whincup PH, Davey-Smith G, Gillman MW, Cook DG. The effect of breastfeeding on mean body mass index throughout life: a quantitative review of published and unpublished observational evidence. Am J Clin Nutr. 2005;82:1298–307.
62. Harder T, Bergmann R, Kallischnigg G, Plagemann A. Duration of breastfeeding and risk of overweight: a meta-analysis. Am J Epidemiol. 2005;162:397–403.
63. Kim J, Peterson KE. Association of infant child care with infant feeding practices and weight gain among US infants. Arch Pediatr Adolesc Med. 2008;162:627–33.
64. Baker JL, Michaelsen KF, Rasmussen KM, Sorensen TI. Maternal prepregnant body mass index, duration of breastfeeding, and timing of complementary food introduction are associated with infant weight gain. Am J Clin Nutr. 2004;80:1579–88.
65. Huh SY, Rifas-Shiman SL, Taveras EM, Oken E, Gillman MW. Timing of solid food introduction and risk of obesity in preschool-aged children. Pediatrics. 2011;127:e544–51.
66. Birch LL, Fisher JO. Development of eating behaviors among children and adolescents. Pediatrics. 1998;101:539–49.
67. Taveras EM, Scanlon KS, Birch L, Rifas-Shiman SL, Rich-Edwards JW, Gillman MW. Association of breastfeeding with maternal control of infant feeding at age 1 year. Pediatrics. 2004;114:e577–83.
68. Carper JL, Orlet Fisher J, Birch LL. Young girls' emerging dietary restraint and disinhibition are related to parental control in child feeding. Appetite. 2000;35:121–9.
69. Klesges RC, Coates TJ, Brown G, Sturgeon-Tillisch J, Moldenhauer-Klesges LM, Holzer B, Woolfrey J, Vollmer J. Parental influences on children's eating behavior and relative weight. J Appl Behav Anal. 1983;16:371–8.
70. von Kries R, Toschke AM, Wurmser H, Sauerwald T, Koletzko B. Reduced risk for overweight and obesity in 5- and 6-y-old children by duration of sleep–a cross-sectional study. Int J Obes Relat Metab Disord. 2002;26:710–6.
71. Sekine M, Yamagami T, Handa K, Saito T, Nanri S, Kawaminami K, Tokui N, Yoshida K, Kagamimori S. A dose-response relationship between short sleeping hours and childhood obesity: results of the Toyama Birth Cohort Study. Child Care Health Dev. 2002;28:163–70.
72. Reilly JJ, Armstrong J, Dorosty AR, Emmett PM, Ness A, Rogers I, Steer C, Sherriff A. Early life risk factors for obesity in childhood: cohort study. BMJ. 2005;330:1357.
73. Locard E, Mamelle N, Billette A, Miginiac M, Munoz F, Rey S. Risk factors of obesity in a five year old population. Parental versus environmental factors. Int J Obes Relat Metab Disord. 1992;16:721–9.
74. Taveras EM, Rifas-Shiman SL, Oken E, Gunderson EP, Gillman MW. Short sleep duration in infancy and risk of childhood overweight. Arch Pediatr Adolesc Med. 2008;162:305–11.
75. Tikotzky L. G DEM, Har-Toov J, Dollberg S, Bar-Haim Y, Sadeh A. Sleep and physical growth in infants during the first 6 months. J Sleep Res. 2010;19:103–10.
76. Berkey CS, Rockett HR, Gillman MW, Colditz GA. One-year changes in activity and in inactivity among 10- to 15-year-old boys and girls: relationship to change in body mass index. Pediatrics. 2003;111:836–43.
77. Dietz WH, Jr., Gortmaker SL. Do we fatten our children at the television set? Obesity and television viewing in children and adolescents. Pediatrics. 1985;75:807–12.
78. Gortmaker SL, Must A, Sobol A, Peterson K, Colditz G, Dietz W. Television viewing as a cause of increasing obesity among children in the United States. Arch Pediatr Adolesc Med. 1996;150:356–62.
79. Robinson TN. Reducing children's television viewing to prevent obesity: a randomized controlled trial. JAMA. 1999;282:1561–7.
80. Gortmaker SL, Peterson K, Wiecha J, Sobol AM, Dixit S, Fox MK, Laird N. Reducing obesity via a school-based interdisciplinary intervention among youth. Arch Pediatr Adolesc Med. 1999;153:409–18.
81. Dennison BA, Erb TA, Jenkins PL. Television viewing and television in bedroom associated with overweight risk among low-income preschool children. Pediatrics. 2002;109:1028–35.
82. Lumeng JC, Rahnama S, Appugliese D, Kaciroti N, Bradley RH. Television exposure and overweight risk in preschoolers. Arch Pediatr Adolesc Med. 2006;160:417–22.
83. Food for thought: television food advertising to children in the United States. The Henry Kaiser Family Foundation; 2007 [cited 2011 Jul 27]. Available from: http://www.kff.org/entmedia/7618.cfm.
84. Borzekowski DL, Robinson TN. The 30-second effect: an experiment revealing the impact of television commercials on food preferences of preschoolers. J Am Diet Assoc. 2001;101:42–6.
85. Bell JF, Zimmerman FJ. Shortened nighttime sleep duration in early life and subsequent childhood obesity. Arch Pediatr Adolesc Med. 2010;164:840–5.
86. Landhuis CE, Poulton R, Welch D, Hancox RJ. Childhood sleep time and long-term risk for obesity: a 32-year prospective birth cohort study. Pediatrics. 2008;122:955–60.
87. Nielsen SJ, Popkin BM. Changes in beverage intake between 1977 and 2001. Am J Prev Med. 2004;27:205–10.
88. Harnack L, Stang J, Story M. Soft drink consumption among U.S. children and adolescents: nutritional consequences. J Am Diet Assoc. 1999;99:436–41.
89. Ludwig DS, Peterson KE, Gortmaker SL. Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis. Lancet. 2001;357:505–8.
90. Dubois L, Farmer A, Girard M, Peterson K. Regular sugar-sweetened beverage consumption between meals increases risk of overweight among preschool-aged children. J Am Diet Assoc. 2007;107:924–34, discussion 34–5.
91. Welsh JA, Cogswell ME, Rogers S, Rockett H, Mei Z, Grummer-Strawn LM. Overweight among low-income preschool children

associated with the consumption of sweet drinks: Missouri, 1999–2002. Pediatrics. 2005;115:e223–9.
92. Warner ML, Harley K, Bradman A, Vargas G, Eskenazi B. Soda consumption and overweight status of 2-year-old Mexican-American children in California. Obesity (Silver Spring). 2006;14:1966–74.
93. Nielsen SJ, Popkin BM. Patterns and trends in food portion sizes, 1977–1998. JAMA. 2003;289:450–3.
94. Guthrie JF, Lin BH, Frazao E. Role of food prepared away from home in the American diet, 1977–78 versus 1994–96: changes and consequences. J Nutr Educ Behav. 2002;34:140–50.
95. Lin BH, Guthrie JF, Blaylock J. The diets of America's children: influence of dining out, household characteristics, and nutrition knowledge. Agricultural Economics Report no. 746. Washington, DC: USDA; 1996.
96. Taveras EM, Berkey CS, Rifas-Shiman SL, Ludwig DS, Rockett HRH, Field AE, Colditz GA, Gillman MW. The association of fried food consumption away from home with body mass index and diet quality in older children and adolescents. Pediatrics. 2005;116:e518–24.
97. Ebbeling CB, Pawlak DB, Ludwig DS. Childhood obesity: public-health crisis, common sense cure. Lancet. 2002;360:473–82.
98. U.S. Department of Health and Human Services. Physical activity and health: a report of the Surgeon General. Atlanta: CDC, National Center for Chronic Disease Prevention and Health Promotion; 1996.
99. Atkin LM, Davies PS. Diet composition and body composition in preschool children. Am J Clin Nutr. 2000;72:15–21.
100. Moore LL, Gao D, Bradlee ML, Cupples LA, Sundarajan-Ramamurti A, Proctor MH, Hood MY, Singer MR, Ellison RC. Does early physical activity predict body fat change throughout childhood? Prev Med. 2003;37:10–7.
101. Trost SG, Sirard JR, Dowda M, Pfeiffer KA, Pate RR. Physical activity in overweight and nonoverweight preschool children. Int J Obes Relat Metab Disord. 2003;27:834–9.
102. Dennison BA, Russo TJ, Burdick PA, Jenkins PL. An intervention to reduce television viewing by preschool children. Arch Pediatr Adolesc Med. 2004;158:170–6.
103. Gable S, Chang Y, Krull JL. Television watching and frequency of family meals are predictive of overweight onset and persistence in a national sample of school-aged children. J Am Diet Assoc. 2007;107:53–61.
104. Anderson SE, Whitaker RC. Household routines and obesity in US preschool-aged children. Pediatrics. 2010;125:420–8.
105. Chu SY, Callaghan WM, Bish CL, D'Angelo D. Gestational weight gain by body mass index among US women delivering live births, 2004–2005: fueling future obesity. Am J Obstet Gynecol. 2009;200:271.e1–7.
106. Rich-Edwards JW, Kleinman K, Abrams A, Harlow BL, McLaughlin TJ, Joffe H, Gillman MW. Sociodemographic predictors of antenatal and postpartum depressive symptoms among women in a medical group practice. J Epidemiol Community Health. 2006;60:221–7.
107. Savitz DA, Janevic TM, Engel SM, Kaufman JS, Herring AH. Ethnicity and gestational diabetes in New York City, 1995–2003. BJOG. 2008;115:969–78.
108. Kahn RS, Certain L, Whitaker RC. A reexamination of smoking before, during, and after pregnancy. Am J Public Health. 2002;92:1801–8.
109. Taveras EM, Gillman MW, Kleinman K, Rich-Edwards JW, Rifas-Shiman SL. Racial/ethnic differences in early-life risk factors for childhood obesity. Pediatrics. 2010;125:686–95.
110. Giammattei J, Blix G, Marshak HH, Wollitzer AO, Pettitt DJ. Television watching and soft drink consumption: associations with obesity in 11- to 13-year-old schoolchildren. Arch Pediatr Adolesc Med. 2003;157:882–6.
111. Bowman SA, Gortmaker SL, Ebbeling CB, Pereira MA, Ludwig DS. Effects of fast-food consumption on energy intake and diet quality among children in a national household survey. Pediatrics. 2004;113:112–8.
112. Andersen RE, Crespo CJ, Bartlett SJ, Cheskin LJ, Pratt M. Relationship of physical activity and television watching with body weight and level of fatness among children: results from the Third National Health and Nutrition Examination Survey. JAMA. 1998;279:938–42.
113. Kimm SY, Glynn NW, Kriska AM, Barton BA, Kronsberg SS, Daniels SR, Crawford PB, Liu K. Decline in physical activity in black girls and white girls during adolescence. N Engl J Med. 2002;347:709–15.
114. Krieger N, Williams DR, Moss NE. Social class in US public research: concepts, methodologies, and guidelines. Annu Rev Public Health. 1997;18:341–78.
115. Wang Y. Cross-national comparison of childhood obesity: the epidemic and the relationship between obesity and socioeconomic status. Int J Epidemiol. 2001;30:1129–36.
116. Wang Y, Zhang Q. Are American children and adolescents of low socioeconomic status at increased risk of obesity? Changes in the association between overweight and family income between 1971 and 2002. Am J Clin Nutr. 2006;84:707–16.
117. Ogden CL, Flegal KM, Carroll MD, Johnson CL. Prevalence and trends in overweight among US children and adolescents, 1999–2000. JAMA. 2002;288:1728–32.
118. Miech RA, Kumanyika SK, Stettler N, Link BG, Phelan JC, Chang VW. Trends in the association of poverty with overweight among US adolescents, 1971–2004. JAMA. 2006;295:2385–93.
119. Kimm SY, Obarzanek E, Barton BA, Aston CE, Similo SL, Morrison JA, Sabry ZI, Schreiber GB, McMahon RP. Race, socioeconomic status, and obesity in 9- to 10-year-old girls: the NHLBI Growth and Health Study. Ann Epidemiol. 1996;6:266–75.
120. Singh GK, Kogan MD, Van Dyck PC, Siahpush M. Racial/ethnic, socioeconomic, and behavioral determinants of childhood and adolescent obesity in the United States: analyzing independent and joint associations. Ann Epidemiol. 2008;18:682–95.
121. Whitaker RC, Orzol SM. Obesity among US urban preschool children: relationships to race, ethnicity, and socioeconomic status. Arch Pediatr Adolesc Med. 2006;160:578–84.
122. Braveman PA, Cubbin C, Egerter S, Chideya S, Marchi KS, Metzler M, Posner S. Socioeconomic status in health research: one size does not fit all. JAMA. 2005;294:2879–88.
123. Williams DR, Collins C. Racial residential segregation: a fundamental cause of racial disparities in health. Public Health Rep. 2001;116:404–16.
124. Lovasi GS, Hutson MA, Guerra M, Neckerman KM. Built environments and obesity in disadvantaged populations. Epidemiol Rev. 2009;31:7–20.
125. Allen ML, Elliott MN, Morales LS, Diamant AL, Hambarsoomian K, Schuster MA. Adolescent participation in preventive health behaviors, physical activity, and nutrition: differences across immigrant generations for Asians and Latinos compared with Whites. Am J Public Health. 2007;97:337–43.
126. McArthur LH, Anguiano R, Gross KH. Are household factors putting immigrant Hispanic children at risk of becoming overweight: a community-based study in eastern North Carolina. J Community Health. 2004;29:387–404.
127. Popkin BM, Udry JR. Adolescent obesity increases significantly in second and third generation U.S. immigrants: the National Longitudinal Study of Adolescent Health. J Nutr. 1998;128:701–6.
128. Balistreri KS, Van Hook J. Socioeconomic status and body mass index among Hispanic children of immigrants and children of natives. Am J Public Health. 2009;99:2238–46.
129. Crawford PB, Gosliner W, Anderson C, Strode P, Becerra-Jones Y, Samuels S, Carroll AM, Ritchie LD. Counseling Latina mothers of preschool children about weight issues: suggestions for a new framework. J Am Diet Assoc. 2004;104:387–94.
130. Kimbro RT, Brooks-Gunn J, McLanahan S. Racial and ethnic differentials in overweight and obesity among 3-year-old children. Am J Public Health. 2007;97:298–305.
131. Contento IR, Basch C, Zybert P. Body image, weight, and food choices of Latina women and their young children. J Nutr Educ Behav. 2003;35:236–48.
132. Sherry B, McDivitt J, Birch LL, Cook FH, Sanders S, Prish JL, Francis LA, Scanlon KS. Attitudes, practices, and concerns about child feeding and child weight status among socioeconomically diverse white, Hispanic, and African-American mothers. J Am Diet Assoc. 2004;104:215–21.

133. Young-Hyman D, Schlundt DG, Herman-Wenderoth L, Bozylinski K. Obesity, appearance, and psychosocial adaptation in young African American children. J Pediatr Psychol. 2003;28:463–72.
134. Gillman MW, Rifas-Shiman SL, Kleinman K, Oken E, Rich-Edwards JW, Taveras EM. Developmental origins of childhood overweight: potential public health impact. Obesity (Silver Spring). 2008;16: 1651–6.
135. Committee on Obesity Prevention Policies for Young Children. Early childhood obesity prevention policies. Washington, DC: Institute of Medicine; 2011.
136. Moore L, Gibbs L. Evaluation of community-based obesity interventions. In: Waters E, Swinburn BA, Seidell JC, Uauy R, editors. Preventing childhood obesity: evidence policy and practice. Oxford: Wiley-Blackwell; 2010. p. 160.
137. Huang TT, Drewnoksi A, Kumanyika S, Glass TA. A systems-oriented multilevel framework for addressing obesity in the 21st century. Prev Chronic Dis. 2009;6:A82.
138. Economos CD, Hyatt RR, Goldberg JP, Must A, Naumova EN, Collins JJ, Nelson ME. A community intervention reduces BMI z-score in children: Shape Up Somerville first year results. Obesity (Silver Spring). 2007;15:1325–36.
139. de Silva-Sanigorski AM, Bell AC, Kremer P, Nichols M, Crellin M, Smith M, Sharp S, de Groot F, Carpenter L, Boak R, et al. Reducing obesity in early childhood: results from Romp & Chomp, an Australian community-wide intervention program. Am J Clin Nutr. 2010;91:831–40.
140. Ciampa PJ, Kumar D, Barkin SL, Sanders LM, Yin HS, Perrin EM, Rothman RL. Interventions aimed at decreasing obesity in children younger than 2 years: a systematic review. Arch Pediatr Adolesc Med. 2010;164:1098–104.
141. Bluford DA, Sherry B, Scanlon KS. Interventions to prevent or treat obesity in preschool children: a review of evaluated programs. Obesity (Silver Spring). 2007;15:1356–72.
142. Hammond RA. Complex systems modeling for obesity research. Prev Chronic Dis. 2009;6:A97.
143. America's Move to Raise A Healthier Generation of Kids; 2011 [cited 2011 Jul 27]. Available from: <http://www.letsmove.gov/about>.
144. White House Task Force on Childhood Obesity. Solving the problem of childhood obesity within a generation. Washington, DC: White House Task Force on Childhood Obesity, Office of the U.S. President; 2010. p. 124.
145. Dankwa-Mullan I, Rhee KB, Stoff DM, Pohlhaus JR, Sy FS, Stinson N Jr, Ruffin J. Moving toward paradigm-shifting research in health disparities through translational, transformational, and transdisciplinary approaches. Am J Public Health. 2010;100 Suppl 1:S19–24.
146. Dankwa-Mullan I, Rhee KB, Williams K, Sanchez I, Sy FS, Stinson N Jr, Ruffin J. The science of eliminating health disparities: summary and analysis of the NIH summit recommendations. Am J Public Health. 2010;100 Suppl 1:S12–8.