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Journal

Public Health Nutrition, 21(12)

ISSN

1368-9800

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Publication Date

2018-08-01

DOI

10.1017/s1368980018000666

Peer reviewed

HHS Public Access

Author manuscript

Public Health Nutr. Author manuscript; available in PMC 2019 February 01.

Published in final edited form as:

Public Health Nutr. 2018 August ; 21(12): 2301–2310. doi:10.1017/S1368980018000666.

Widening socioeconomic disparities in early childhood obesity in Los Angeles County after the Great Recession

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Abstract

Objective—While economic crises can increase socioeconomic disparities in health, little is known about the impact of the 2008-2009 Great Recession on obesity prevalence among children, especially low-income children. This study examined whether socioeconomic disparities in obesity among preschool-aged children participating in a federal nutrition assistance program have changed since the recession.

Design—A pre-post observational study using administrative data of preschool-aged program participants from 2003 to 2014. Logistic regression was used to examine whether the relationship between obesity prevalence (BMI ≥ 95th percentile of CDC's growth charts) and three measures of socioeconomic status (household income, household educational attainment and neighborhood-level median household income) changed after the recession by examining the interaction between each socioeconomic status measure and a 5-year time-period variable (2003-07 vs 2010-14), stratified by child's age and adjusted for child's socio-demographic characteristics.

Setting—Los Angeles County, California, USA.

Subjects—Children aged 2-4 years (N=1,637,788) participating in the Special Supplemental Nutrition Program for Women, Infants and Children (WIC).

Results—The magnitude of the association of household income and household education with obesity increased after 2008-09 among 3- and 4-year-olds and 2- and 3-year-olds, respectively. However, the magnitude of the association of neighborhood-level median household income with obesity did not change after 2008-09.

Conclusions—Disparities in obesity by household-level socioeconomic status widened after the recession while disparities by neighborhood-level socioeconomic status remained the same. The

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Conflict of interest: None.

Authorship: TZN formulated the research question, carried out the analyses, and drafted the initial manuscript. SEW, CMC, MP, and MCW helped conceptualize the study, and reviewed and revised the manuscript.

Disclosure: The authors declared no conflict of interest.

widening household-level socioeconomic disparities suggest that obesity prevention efforts should target the most vulnerable low-income children.

Keywords

childhood obesity; socioeconomic disparities; Great Recession; WIC

Introduction

Unlike prior recessions, the Great Recession ("the recession") resulted in many American households experiencing multiple hardships from unemployment, reduced income, foreclosures, and loss of health insurance.[1,2] Low socioeconomic status (SES) and ethnic minority households were disproportionately affected, experiencing higher rates of unemployment and underemployment, and higher losses in income.[3,4] The impact of an economic crisis such as the recession on health and well-being especially among low-income households can exacerbate socioeconomic disparities in health.[5] In this study, we attempt to investigate the potential impact of the recession (Dec 2007-Jun 2009) on socioeconomic disparities in early childhood obesity in low-income communities in Los Angeles County (LAC), California, USA, a region that is home to some of the largest inequalities in the USA.[6]

In the U.S., economic downturns are in general associated with improved physical health,[7,8] partly due to improvements in health behaviors such as smoking, obesity and physical activity during these downturns.[9,10] Indeed, studies occurring before the recession found increased unemployment, an indicator for economic conditions, to be associated with decreased risk of obesity.[8,9] However, minority and low SES men were found to be at increased risk of obesity during an economic downturn.[11] A few studies have examined the impact of the recession on obesity among adults in the US. The results are mixed with some studies finding an increase in obesity risk,[12] other studies finding a decrease (among White adults),[13] and yet others finding no effect.[2] Even less is known about the impact of the recession on childhood obesity in the US; one study among California school-aged children found that increased county-level unemployment during the recession was associated with increased risk of overweight.[14]

It could be argued that an economic crisis could influence childhood obesity risk in either direction. The three main mechanisms posited by which recessions might affect health are changes in time use, consumption and stress.[15] Unemployment or underemployment could mean that parents have more leisure time to participate in time-intensive health behaviors like cooking home-cooked meals and engaging in physical recreational activities with children.[8-10,15–17] However, the reduced income from working fewer hours might mean eating more inexpensive, energy-dense foods like fast food, leading to excessive weight gain especially among low socioeconomic status families.[15,18] Greater leisure time might also mean more time for sedentary behaviors like watching TV.[16]

The fear of becoming unemployed and the financial strain resulting from unemployment or underemployment can increase parents' stress.[15] Economic downturns are associated with an increase in poor mental health and suicides.[7,8,11,19] Exposure to chronic stressors like

financial strain or to mothers' stress and depression, both in utero and during the early years of childhood, can increase obesity risk among young children by deregulating their stress response system, influencing the pathways that regulate body composition and metabolic function and by creating an obesogenic home environment for the child.[20]

We *hypothesize* that the recession's effect on childhood obesity risk may be greater among the most vulnerable households who live in communities with few resources[3,4] to support the successful implementation of nutrition education programs. To test this hypothesis, we examine preschool-aged participants in the Special Supplemental Nutrition Program for Women, Infants and Children (WIC). WIC provides nutritional support and education, breastfeeding support and referrals to medical and social services to low-income [≤185% Federal Poverty Level (FPL)] and nutritionally at-risk pregnant, breastfeeding, and postpartum women, and infants and children less than five years old. In the US, 40% of families with preschool-aged children are eligible to participate in WIC[21] and in LAC half of all young children participate in WIC.[22]

We use a unique dataset established in 2003 by the Public Health Foundation Enterprises WIC program (PHFE-WIC), the largest local WIC agency in the country, that merges neighborhood-level data with household-level data for children participating in WIC in LAC. This dataset allows us to examine changes in the prevalence of early childhood obesity over time while considering the influences of the communities in which they live, and provides insights into trends of early childhood obesity prevalence among low-income households. For example, despite reports of decreasing rates of early childhood obesity prevalence for the nation[23] and also for LAC,[24] an analysis of the PHFE-WIC dataset revealed that obesity prevalence has continued to climb for 2-5-year-olds in some of the poorest neighborhoods in LAC,[25] suggesting perhaps that intervention efforts made to address childhood obesity have not reached or adequately addressed the needs of the most vulnerable communities.

Leveraging LAC's unique characteristics, our primary objective is to determine whether socioeconomic disparities in obesity prevalence among preschool-aged children widened in the years following the 2008-2009 recession compared to the years prior to the recession. Understanding this is key to developing and implementing effective obesity prevention efforts that address the specific needs of this socially and economically vulnerable population.

Methods

Administrative data from WIC preschool-aged participants from 2003 to 2014 for LAC were used for this study. The data belong to the State of California WIC Program and are maintained by the WIC Data Mining Project, a research partnership which is funded by First 5 LA (http://www.first5la.org/). Sociodemographic and anthropometric information on all participants since 2003 are included in the database. Height and weight measurements for children are obtained every six months by trained WIC clinic staff who follow a standardized protocol; as a result, measurements have high validity.[26] One unique aspect of this WIC dataset is that WIC participants' addresses are geocoded into census tracts. As a

result, we were able to link census tract-level socioeconomic data from the U.S. Census Bureau's American Community Survey (ACS) to the WIC participants. Because ACS tract-level data provide only five-year estimates, the 2003-09 WIC administrative data were linked to 2005-09 estimates; and the 2010-14 administrative data were linked to 2010-14 estimates.

For this pre-post observational study, we excluded the years when the recession occurred (2008 and 2009) so as to allow for a comparison of disparities before and after the recession. The analyses were stratified by child's age (2, 3, and 4 years) since, due to rapid growth, young children are developmentally and nutritionally different at every age.[27]

Observations were included if they represented a child's first weight/height measurement in a calendar year and if the measurement occurred in the years 2003-07 or 2010-14. Children with complete information were included in the final sample (N=1,637,788 with 597,506 2-year-olds, 577,069 3-year-olds, and 463,213 4-year-olds). To avoid issues of dependency, if twins or triplets participated in WIC, only one of the children was included in our sample. Since children can participate in WIC up until their fifth birthday, the same child could be included in multiple samples. Fifty-three percent of children were in one sub-sample, 33% were in two and 15% were in three. The UCLA Institutional Review Board approved the protocol for this study.

Variables

BMI (=weight(kg)/height(m)^2) was calculated from child's measured weight and height. *Obesity status* was determined by the child having a BMI ≥ 95th percentile of CDC's gender- and age-specific growth reference values.[28]

Three indicators of a child's SES were examined, two at the household level and one at the neighborhood level. *Household income*, the total income of the child's household from all sources, is determined by WIC. It was operationalized as a percentage of the FPL (≤50.0% FPL, 50.1-100.0% FPL, 100.1-133.0% FPL, 133.1-185.0% FPL). *Household education*, a more stable measure of SES, is the highest grade completed by the child's parent [less than high school, high school, some college, college or more]. *Median household income*, is an indicator of neighborhood resources, and is a 5-year estimate of median household income of residents in the child's census tract; it was categorized according to quartiles of its distribution among WIC participants (≤$32,738; $32,739-$40,278; $40,279-$51,534; ≥ $51,535). As a reference, the highest neighborhood income group has a lower median income than that of all of LAC ($55,746 in 2014 dollars).[29] For these three socioeconomic measures, dummy variables were used in the analyses with the highest SES group as the reference.

A binary 5-year time-period variable (2003-07 vs. 2010-14) based on the calendar year the child was weighed and measured was used to indicate period of measurement relative to the recession. Analyses were stratified by child's age and adjusted for child's gender and parent's race/ethnicity. Dummy variables of parent's race/ethnicity (Hispanic, non-Hispanic (NH) White, NH Black and Asian) were created with Hispanic as the reference group since the majority of the sample had Hispanic parents.

Statistical Analysis

Chi-square tests were used to determine whether participants' sociodemographic characteristics were different during the two time periods. To determine the best way to model the secular trends, calendar year was entered into the regression models as a binary time-period variable (2003-07 vs 2010-14), as dummy variables for each year in comparison to the reference, 2003 (for example, 2004 vs 2003), and as linear, quadratic, and cubic terms. Based on Akaike information criterion and predicted probability charts, the binary year variable which excluded the recession years provided one of the best fits for the data since it allowed for the flexibility to model the increasing trends up until 2008 and the decreasing trends beginning in 2010. Logistic regression analysis was then applied to examine the association of childhood obesity with each socioeconomic measure, stratified by child's age and adjusted for time period, child's gender and parent's race/ethnicity. To determine if the impact of the socioeconomic measure on childhood obesity increased after the recession, an interaction term (socioeconomic measure × time period) was included in the regression model. The equation for child *i* is:

$$\text{logit}[P(Y=1)] = \beta_0 + \beta_1(\text{SES}_i) + \beta_2(\text{Gender}_i) + \beta_3(\text{Race/ethnicity}_i) + \beta_4(\text{time period}_i) + \beta_5(\text{SES}_i \times \text{time period}_i) + e_i$$

where Y is the log odds that child *i* is obese, β_0 is the intercept across the sample of children, $\beta_{1\ldots}\beta_5$ are the effects of the predictors (regression coefficients) on obesity, and e_i is random error.

To determine if disparities changed in the years following the recession compared to the years prior to the recession, the statistical significance of the interaction term was examined using the omnibus Wald chi-square test statistic which tests for overall statistical difference. Tests for statistical significance were based on a p-value < 0.05. Analyses were conducted using SAS version 9.4 (SAS Institute, Cary, NC).

Results

Between 2003-07 and 2010-14, obesity prevalence increased for all three age groups (Table 1, and supplementary Table A1 for the confidence intervals). At the same time, the sociodemographic make-up of the WIC population in LAC also changed. The percentage of children from the poorest households (household income ≤ 50% FPL) increased by over 35% (Table 1). Interestingly, the percentage of children with parents who had at least high-school education increased by over 20% during this time (Table 1).

A statistically significant negative relationship between childhood obesity and each of the SES measures was observed (Table 2, and supplementary Table A2 for the confidence intervals). The magnitude of the gradient varied according to SES measure, age and time period and was greatest by household education (Table 2).

Multivariate analyses

Household income—Among 2-year-old children, living in lower-income households was associated with significantly higher odds of obesity after adjusting for child's gender, parent's race/ethnicity and time period (Table 3, Model 1). Notably, those living in the poorest households (≤ 50% FPL) experienced the highest odds of being obese [OR (95% CI): 1.18 (1.15, 1.21)]. The odds of obesity were greater in 2010-14 than in 2003-07. To determine if the association between household income and childhood obesity was different between the two time periods, an interaction term between household income and time period was examined (Table 3, Model 2). The regression coefficient for this interaction term was not statistically significant suggesting that the effect size of household income on childhood obesity did not change after 2008-09. In other words, disparities in obesity did not change over time (Table 3, Model 2).

Results for 3-year-olds were generally similar to those for 2-year-olds. However, the interaction term (household income × time period) was statistically significant (Table 3, Model 2). For children living in the lowest-income groups (≤100% FPL), the odds of being obese, compared to children from higher-income households, increased by about 5% from 2003-07 to 2010-14. The greater effect size of household income on obesity after 2008-09 among 3-year-olds translates into widening disparities in obesity. Specifically, between 2003-07 and 2010-14, a greater increase in obesity prevalence occurred among children from the poorest households than among children from the less poor households. Similar results were found among 4-year-old children as those found among 3-year-old children (Table 3).

Household education—Among 2-year-olds, living in lower-educated households was associated with a statistically significant increase in the odds of obesity compared to children living in college-educated households. Children living in households with less than a high school education experienced the highest odds of obesity [OR (95% CI): 1.37 (1.31, 1.44)] (Table 4, Model 1). Based on the statistically significant interaction term, household education × time period (Table 4, Model 2), the effect of household education on childhood obesity increased after 2008-09. Children living in households with less than a high school education experienced the greatest increase in the odds of obesity (from OR=1.30 in 2003-07 to OR=1.43 in 2010-14). The increasing effect size of household education on obesity among 2-year-olds translates into widening disparities in obesity after 2008-09.

Similar results were found among 3-year-olds. However, the magnitude of the effect of household education on obesity was not as great as for 2-year-olds. There was no meaningful change in the odds of obesity from 2003-07 to 2010-14 for children with parents with some college education (Table 4, Model 2). Among 4-year-olds, the associations of household education with obesity were similar to those found among the younger children; however, the magnitude of the effect size was smaller among 4-year-olds. The effect size of household education on obesity did not change after 2008-09 suggesting that disparities in obesity by household education did not widen between the two time periods for 4-year-olds. Further study is needed as the individual t-statistics of the parameters were statistically significant (data not shown).

Median household income—Among 2-year-olds, living in lower-income neighborhoods was associated with a statistically significant increase in the odds of obesity (Table 5, Model 1), with those living in the poorest neighborhoods (≤ $ 32,738) experiencing the highest odds [OR (95% CI): 1.15 (1.13, 1.18)]. To determine if the effect size of median household income on childhood obesity was significantly different between the two time periods, the interaction term (median household income × time period) was examined and was found to be statistically insignificant (Table 5, Model 2). The odds of obesity for children living in the lower-income neighborhoods did not significantly change between 2003-07 and 2010-14 suggesting that the disparities in obesity by median household income did not change between the two time periods (Table 5, Model 2). Similar results were found among the 3- and 4-year-olds (Table 5).

Discussion

Among preschool-aged children participating in WIC, we found that household-level socioeconomic disparities widened after 2008-09, a time period that included the recession, but neighborhood-level disparities remained the same. Our findings are consistent with studies among older children which found an increase in household-level socioeconomic disparities in obesity over time.[30-33] However, two recent studies found that disparities in childhood obesity by household income have not changed.[34,35] Despite using multiple disparity indices, Rossen and Schoendorf (2012) did not find that income disparities in obesity among children aged 2-18 years changed from 2001 to 2010.[34] The second study examined the effect of household income on obesity among preschool-aged children and found that while the overall effect on obesity did not change between 2003-04 and 2011-12, it did weaken among boys.[35] The difference in findings between our study and these two could be due to the different study samples. Both of these studies examined a nationally representative sample using NHANES data while our sample was of children living in low-income households. Household income may have a greater effect on obesity risk among low-income families with scarce financial resources. Rossen and Schoendorf (2012) also examined disparities among 2-18-year-old children and not solely preschool-aged children. Neither study examined disparities through 2014. Even after the official end of the recession, household income continued to fall,[36] income inequality continued to increase and low SES families' financial situation still had not returned to the levels seen prior to the recession,[37] potentially contributing to the widening socioeconomic disparities we found. Lastly, the difference in findings could be because our study occurred in California which was one of the states most affected by the recession.[38]

Factors contributing to the widening socioeconomic disparities in obesity at the household level are not clear and merit further exploration. Changes in disparities in obesity risk factors might contribute to the widening disparities in obesity. Increasing secular trends in energy intake have been observed among preschool-aged children in low-education and low-income households since the 1970s while a decreasing trend has been found among children in college-educated households.[39] Although they examined adolescents, Frederick et al. found that while most children decreased energy intake from 1999-2010, children in college-educated families experienced the greatest decrease compared to children in families with high school degree or less.[33] Socioeconomic disparities in physical activity also increased,

with children in college-educated families becoming more physically active and those in less educated households becoming less physically active.[33]

From Link and Phelan's fundamental cause theory, the widening disparities by household income and education could be because higher SES individuals are more likely to take advantage of new resources to maintain their health status.[40,41] These individuals are more likely to benefit from population-based interventions and efforts since they have greater resources, either income to spend on goods and services, or education to critically think and focus on long-term goals.[42] For instance, higher-income families may benefit more from improvements in their food environment since they have more income to spend on food.

Educated parents may experience more control and less chronic psychosocial stress during negative life events like the recession[42] thereby maintaining nurturing, stable environments for their children. Chronically stressed parents and chaotic home environments can increase a child's stress levels subsequently increasing the child's risk of obesity.[43,44] Given that income disparities in obesity increased among the 3- and 4-year-olds and education disparities in obesity increased for the 2- and 3-year-olds, it could be that parents' financial resources became more important after the recession for older children and that education became more important for younger children. While a year or two may not represent a real difference for older children, very young children develop quickly.[27] Three-and 4-year-olds need more vigorous activity than 2-year-olds[45] and income, to the extent that it can provide access to services such as recreational areas, might be more important as children's needs change. Household education might have a greater impact on obesity among younger children to the extent that it is an indicator for household chaos and chronic stress. The effect of chronic stressors on childhood obesity has been found to vary by child's age although greater age differences are generally examined.[43] Alternatively, the lack of significant findings for the widening of disparities in obesity by education among 4-year-olds may be due to inadequate statistical power.

The lack of change in disparities in obesity by median household income may be partly due to community-based obesity prevention initiatives that have occurred in LAC since 2009. To combat the high prevalence in early childhood obesity in under-resourced communities in LAC, First 5 LA, the LAC Department of Public Health and other organizations invested in Reducing Early Childhood Obesity initiatives such as the Early Childhood Obesity Prevention Initiative.[46,47] Many of these initiatives attempted to reduce early childhood obesity risk by improving diet and increasing physical activity and breast-feeding through better access to healthy, fresh foods and recreational facilities for exercise.[46,47] These initiatives may have buffered the effects of the recession on neighborhoods.

The unchanging neighborhood-level socioeconomic disparities could also be due to a major legislative change in 2009 that improved the nutritional quality of foods offered by WIC (72 F.R. 68966). This change increased the availability of healthier foods in neighborhoods where many WIC-participating families live.[48] While some food establishments closed during the recession, the food environment might have improved slightly since the density of unhealthy food establishments declined and that of healthy food establishments increased in LAC during the recession.[49,50]

To our knowledge, this is the first study to examine changing socioeconomic disparities in obesity among low-income preschool-aged children. Although socioeconomic disparities exist among these children,[51] studies have until now focused mainly on differences by race/ethnicity and have used only household-level socioeconomic indicators.[24,52] Our study uniquely adds to the literature by comparing the effects of neighborhood-level SES to those of household-level SES, and has several methodological strengths. Studies examining the relationship between economic conditions and weight have used self-reported measurements which are prone to error.[8,11] While administrative data were used, the data were of measured heights and weights that have been shown to have high validity.[26] The choice of a binary (2003-07 vs 2010-14) variable (after examining various approaches to modeling the effects of the recession) provided the flexibility necessary to model the increases in obesity until 2008 separately from the decreases after 2010. The study's large sample size provided a robust sample of very low SES households. Finally, although the findings may not be generalizable to other parts of the country, LAC's unique characteristics, such as having one of the largest WIC populations and some of the largest socioeconomic inequalities in the US[6], made it feasible to examine the effect of SES among a low-income population.

One limitation of this study is that while we found socioeconomic disparities in obesity widened over the time period that included the recession, due to our study design we are not able to conclude that the recession caused this widening. Since it is impossible to have a comparison group, that is, a group of WIC-participating children who did not experience the recession, we are not able to differentiate the impact of the recession from other factors such as secular changes in obesity, the previously-mentioned large-scale obesity prevention initiatives and the 2009 WIC legislative change. We are also missing information on the direct impact of the recession on individual households. Although household income is assessed at each WIC certification or recertification appointment, household education is determined only at child's initial enrollment in WIC and is asked of the parent who accompanies the child to WIC at the time of enrollment. Household education might therefore not accurately represent the highest household educational attainment at the time of the child's measurement.

Conclusion

To our knowledge, this is the first study to document socioeconomic disparities in obesity among low-income preschool-aged children. Though prevalence of early childhood obesity has been decreasing among low-income children, this decrease masks the experiences of children from the poorest and least-educated households. During the years following the economic recession, the disparities in obesity by household-level SES widened among low-income children while the disparities by neighborhood-level SES did not change. Although major initiatives were implemented in Los Angeles County to address childhood obesity, and these may have buffered the effects of the recession on childhood obesity risk, greater efforts are needed to target the most vulnerable children. Future population health research aiming to address childhood obesity should consider the needs of the most vulnerable children – those from the poorest and least-educated households.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

We thank Lizbeth Delatorre for assistance with formatting the manuscript, and gratefully acknowledge Dr. Evelyn Blumenberg, Dr. Judith Siegel, Kiran Saluja, Judy Gomez, Mike Whaley, and Armando Jimenez for their contributions to this work.

Financial support: This work was supported by the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD) (T.Z.N., C.C.M., M.P., M.C.W., grant number 1R01HD072296); and by First 5 LA (T.Z.N., S.E.W.), a child advocacy and grant-making organization created by California voters to invest Proposition 10 tobacco taxes to improve the lives of children from prenatal to age 5 in Los Angeles County. The study also benefited from resources provided by the UCLA California Center for Population Research, which receives core support from NICHD (P2C-HD041022). NICHD and First 5 LA had no role in the design, analysis or writing of this article.

References

1. MorinR. One Recession, Two AmericasWashington, DC: Pew Research Center; 2010http://www.pewsocialtrends.org/2010/09/24/one-recession-two-americas/ [accessed January 2018]
2. TekinE, , McClellanC, , MinyardKJ. Health and Health Behaviors during the Worst of TimesCambridge, MA: National Bureau of Economic Research; 2013http://www.nber.org/papers/w19234.pdf [accessed January 2013]
3. Hoynes H, Miller DL, Schaller J. Who suffers during recessions? J Econ Perspect. 2012; 26:27–48.
4. Pfeffer FT, Danziger S, Schoeni RF. Wealth disparities before and after the great recession. Ann Am Acad Pol Soc Sci. 2013; 650:98–123. [PubMed: 25332508]
5. Bacigalupe A, Escolar-Pujolar A. The impact of economic crises on social inequalities in health: what do we know so far? Int J Equity Health. 2014; 13(1):52. [PubMed: 25063518]
6. PolicyLink & PEREAn equity profile of the Los Angeles regionOakland, Ca: PolicyLink and PERE; 2017http://dornsife.usc.edu/assets/sites/242/docs/EquityProfile_LA_Region_2017_Full_Final_Web.pdf [accessed January 2018]
7. Ruhm CJ. Good times make you sick. J Health Econ. 2003; 22:637–658. [PubMed: 12842319]
8. Ruhm CJ. Are recessions good for your health? Q J Econ. 2000; 115:617–650.
9. Ruhm CJ. Healthy living in hard times. J Health Econ. 2005; 24:341–363. [PubMed: 15721049]
10. Xu X. The business cycle and health behaviors. Soc Sci Med. 2013; 77:126–136. [PubMed: 23219162]
11. Charles KK, DeCicca P. Local labor market fluctuations and health: Is there a connection and for whom? J Health Econ. 2008; 27:1532–1550. [PubMed: 18653256]
12. Arcaya M, Glymour MM, Chakrabarti P, et al. Effects of proximate foreclosed properties on individuals' weight gain in Massachusetts, 1987-2008. Am J Public Health. 2013; 103:e50–6.
13. Currie J, Duque V, Garfinkel I. The great recession and mother's health. Econ J (London). 2015; 125:F311–F346.
14. Oddo VM, Nicholas LH, Bleich SN, et al. The impact of changing economic conditions on overweight risk among children in California from 2008 to 2012. J Epidemiol Community Health. 2016; 70:874–80. [PubMed: 27251405]
15. Burgard SA, Kalousova L. Effects of the Great Recession: Health and Well-Being. Annu Rev Sociol. 2015; 41:181–201.
16. Colman G, Dave D. Exercise, physical activity, and exertion over the business cycle. Soc Sci Med. 2013; 93:11–20. [PubMed: 23906116]
17. Todd JE. Changes in consumption of food away from home and intakes of energy and other nutrients among US working-age adults, 2005–2014. Public Health Nutr. 2017:1–9.

18. Dave DM, Kelly IR. How does the business cycle affect eating habits? Soc Sci Med. 2012; 74:254–262. [PubMed: 22137244]
19. Ruhm CJ. Recessions, healthy no more? J Health Econ. 2015; 42:17–28. [PubMed: 25839783]
20. MillerA, , DawsonL, , WelkerE. Stress in Early Life and Childhood Obesity RiskDurham, NC: Healthy Eating Research; 2017http://healthyeatingresearch.org/wp-content/uploads/2017/06/her_stress_obesity_5-30.pdf [accessed January 2018]
21. ThornB, , TadlerC, , HuretN. , et al. WIC Participant and Program Characteristics 2014Alexandria, VA: U.S. Department of Agriculture, Food and Nutrition Service; 2015Prepared by Insight Policy Research under Contract No. AG-3198-C- 11-0010
22. PHFE-WIC & First5LA. [accessed September 2017] Los Angeles County WIC Data. 2017http://lawicdata.org/
23. Pan L, Freedman DS, Sharma AJ, et al. Trends in obesity among participants aged 2–4 years in the Special Supplemental Nutrition Program for Women, Infants, and Children — United States, 2000–2014. MMWR Morb Mortal Wkly Rep. 2016; 65:1256–1260. [PubMed: 27855143]
24. Sekhobo J, Edmunds L, Whaley S, et al. Obesity prevalence among low-income, preschool-aged children--New York City and Los Angeles County, 2003-2011. MMWR Morb Mortal Wkly Rep. 2013; 62:17–22. [PubMed: 23325351]
25. ChaparroMP, , WangMC, , WhaleySE. Neighborhood obesity trends among 2-5 year old children participating in the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) in Los Angeles County, 2002-2011Los Angeles, Ca: First 5 LA; 2013https://www.first5la.org/files/08149_FinalReport_06302013.pdf [accessed January 2018]
26. Crespi CM, Alfonso VH, Whaley SE, et al. Validity of child anthropometric measurements in the Special Supplemental Nutrition Program for Women, Infants, and Children. Pediatr Res. 2012; 71:286–292. [PubMed: 22337260]
27. TannerJM, , JamesM. Foetus into man : physical growth from conception to maturityRev and enl, editorCambridge, MA: Harvard University Press; 1990
28. Kuczmarski RJ, Ogden CL, Guo SS, et al. 2000 CDC growth charts for the United States: methods and development. Vital Health Stat. 2002; 11:1–190.
29. U.S. Census Bureau 2014 American Community Survey 1-Year Estimates. Table B19013. Median household income in the past 12 months. 2016
30. Singh GK, Siahpush M, Kogan MD. Rising social inequalities in US childhood obesity, 2003–2007. Ann Epidemiol. 2010; 20:40–52. [PubMed: 20006275]
31. May AL, Freedman D, Sherry B, et al. Obesity - United States, 1999-2010. MMWR Suppl. 2013; 62:120–8. [PubMed: 24264501]
32. Babey SH, Hastert TA, Wolstein J, et al. Income disparities in obesity trends among California adolescents. Am J Public Health. 2010; 100:2149–55. [PubMed: 20864702]
33. Frederick CB, Snellman K, Putnam RD. Increasing socioeconomic disparities in adolescent obesity. Proc Natl Acad Sci USA. 2014; 111:1338–42. [PubMed: 24474757]
34. Rossen LM, Schoendorf KC. Measuring health disparities: trends in racial-ethnic and socioeconomic disparities in obesity among 2- to 18-year old youth in the United States, 2001–2010. Ann Epidemiol. 2012; 22:698–704. [PubMed: 22884768]
35. Kranjac AW, Wagmiller RL. Association between age and obesity over time. Pediatrics. 2016; 137:e20152096–e20152096. [PubMed: 27244784]
36. KochharR. A recovery no better than the recessionWashington, DC: Pew Research Center; 2012http://www.pewsocialtrends.org/2012/09/12/a-recovery-no-better-than-the-recession/ [accessed January 2018]
37. BohnS, , DanielsonC. Income inequality and the safety net in CaliforniaSan Francisco, CA: Public Policy Institute of California; 2016http://ppic.org/content/pubs/report/R_516SBR.pdf [accessed January 2018]
38. BohnS, , SchiffE. The Great Recession and Distribution of Income in CaliforniaSan Francisco, CA: Public Policy Institute of California; 2011http://www.ppic.org/content/pubs/report/R_1211SBR.pdf [accessed January 2018]

39. Kant AK, Graubard BI. Family income and education were related with 30-year time trends in dietary and meal behaviors of American children and adolescents. J Nutr. 2013; 143:690–700. [PubMed: 23514763]
40. Burgard SA, Hawkins JM. Race/Ethnicity, educational attainment, and foregone health care in the United States in the 2007-2009 recession. Am J Public Health. 2014; 104:e134–40. [PubMed: 24328647]
41. Link BG, Phelan J. Social conditions as fundamental causes of disease. J Health Soc Behav. 1995; Spec No:80–94.
42. CutlerDM, , Lleras-MuneyA. Education and health: evaluating theories and evidence. In: HouseJ, SchoeniR, KaplanG, , PollackH, editorsMaking Americans Healthier: Social and Economic Policy as Health PolicyNew York: Russell Sage Foundation; 20082960
43. Garasky S, Stewart SD, Gundersen C, et al. Family stressors and child obesity. Soc Sci Res. 2009; 38:755–66. [PubMed: 20645439]
44. Gundersen C, Mahatmya D, Garasky S, et al. Linking psychosocial stressors and childhood obesity. Obes Rev. 2011; 12:e54–63. [PubMed: 21054757]
45. Tremblay MS, Chaput JP, Adamo KB, et al. Canadian 24-Hour Movement Guidelines for the Early Years (0–4 years): An Integration of Physical Activity, Sedentary Behaviour, and Sleep. BMC Public Health. 2017; 17:874. [PubMed: 29219102]
46. ChooseHealthLA!Early Childhood Obesity Prevention InitiativeLos Angeles, CA: LA County Department of Public Health; 2013http://publichealth.lacounty.gov/chronic/docs/20131227_Early_Childhood.pdf [accessed January 2018]
47. First 5 LA. [accessed January 2018] Appendix A: First 5 LA projects related to childhood obesity prevention. http://www.first5la.org/files/First5Programs.pdf
48. Schultz DJ, Byker Shanks C, Houghtaling B. The impact of the 2009 Special Supplemental Nutrition Program for Women, Infants, and Children food package revisions on participants: a systematic review. J Acad Nutr Diet. 2015; 115:1832–1846. [PubMed: 26276067]
49. NobariTZ, , BlumenbergE, , Pia ChaparroM. , et al. [accessed January 2018] The Food Environment of Immigrant Enclaves in Los Angeles County. Conference proceeding. Population Association of America2014http://paa2014.princeton.edu/papers/142394
50. HsuT. LA TimesLos Angeles, CA: 2012Independent restaurants hardest hit by slow restaurant traffic. http://articles.latimes.com/2012/feb/27/business/la-fi-mo-independent-restaurant-visits-20120227 [accessed January 2018]
51. Freedman DS, Sharma AJ, Hamner HC, et al. Trends in weight-for-length among infants in WIC from 2000 to 2014. Pediatrics. 2017; 139
52. Pan L, McGuire LC, Blanck HM, et al. Racial/ethnic differences in obesity trends among young low-income children. Am J Prev Med. 2015; 48:570–574. [PubMed: 25891056]

Table 1

Sociodemographic characteristics of WIC-participating children in Los Angeles County by age and time period, 2003-2014

	2 year-olds N=597,506 % (95%CI)		3 year-olds N=577,069 % (95%CI)		4 year-old N=463,213 % (95%CI)	
	2003-07 N=319,754	2010-14 N=277,752	2003-07 N=305,320	2010-14 N=271,749	2003-07 N=244,132	2010-14 N=219,081
Child's gender (female)	49.0	49.0	48.9	48.9	48.9	48.9
Children who are obese†	15.8	16.6***	18.4	19.2***	20.1	20.6***
Parent race/ethnicity						
NH White	4.3	3.3***	4.2	3.1***	4.2	3.0***
NH Black	7.2	7.6	7.1	7.1	6.9	6.4
Asian	4.3	3.8	4.2	3.6	4.0	3.5
Hispanic	84.1	85.3	84.6	86.3	84.8	87.2
Household income						
≤ 50.0% FPL	22.6	31.9***	22.6	30.8***	22.6	30.1***
50.1 – 100.0% FPL	45.7	44.7	45.8	45.9	46.1	47.2
100.1 – 133.0% FPL	17.9	13.7	17.8	13.6	17.8	13.5
133.1 – 185.0% FPL	13.8	9.8	13.8	9.7	13.5	9.4
Household education						
< High school	59.2	49.0***	60.5	50.6***	61.6	52.5***
High school	30.0	36.2	29.2	35.5	28.6	34.3
Some college	8.3	10.7	7.9	10.2	7.7	9.6
College or more	2.5	4.0	2.3	3.7	2.2	3.6
Median Household Income						
≤ $ 32,738	24.8	25.7***	24.9	25.8***	24.9	25.9***
$32,739 - 40,278	26.1	23.2	26.2	23.5	26.2	23.7
$40,279 - 51,534	25.3	24.4	25.3	24.5	25.5	24.6
≥ $51,535	23.9	26.8	23.6	26.2	23.4	25.8

FPL, Federal poverty level.

†Obesity is having a BMI ≥ 95th percentile of CDC's gender- and age-specific growth reference values

Chi-square test measuring differences by time period

* $p < 0.05$;

** $p < 0.01$;

*** $p < 0.001$

Table 2

Prevalence of obesity† among WIC-participating children in Los Angeles County by age and socioeconomic indicators, 2003-2014

	2 year-olds N=597,506 % (95%CI)		3 year-olds N=577,069 % (95%CI)		4 year-olds N=463,213 % (95%CI)	
	2003-07 N=319,754	2010-14 N=277,752	2003-07 N=305,320	2010-14 N=271,749	2003-07 N=244,132	2010-14 N=219,081
Household income						
≤ 50.0% FPL	16.6***	17.5***	18.6***	19.6***	20.2**	20.7***
50.1 – 100.0% FPL	15.8	16.6	18.5	19.5	20.3	21.2
100.1 – 133.0% FPL	15.5	15.9	18.2	18.4	20.2	19.5
133.1 – 185.0% FPL	14.8	15.0	17.6	17.3	19.4	18.9
Household education						
< High school	16.5***	17.7***	19.2***	20.3***	21.0***	21.7***
High school	15.2	16.3	17.4	18.7	19.1	19.9
Some college	13.7	14.6	16.6	17.1	17.7	18.8
College or more	11.1	11.4	13.9	14.4	16.2	15.8
Median Household Income						
≤ $ 32,738	16.9***	17.6***	19.5***	20.4***	21.1***	21.7***
$32,739 - 40,278	16.2	17.2	19.0	19.8	20.9	21.3
$40,279 - 51,534	15.3	16.5	17.9	19.1	19.9	20.4
≥ $51,535	14.6	15.2	16.9	17.6	18.5	19.0

FPL, Federal poverty level.

†Obesity is having a BMI ≥ 95th percentile of CDC's gender- and age-specific growth reference values
Chi-square test measuring differences within time periods

*p < 0.05;

**p < 0.01;

***p < 0.001.

Table 3

Multiple logistic regressions: Effects of household income on obesity in WIC-participating children in Los Angeles County†

	2-year-old children N=597,506		3-year-old children N=577,069		4-year-old children N=463,213	
	Model 1 OR (95%CI)	**Model 2 OR (95%CI)**	**Model 1 OR (95%CI)**	**Model 2 OR (95%CI)**	**Model 1 OR (95%CI)**	**Model 2 OR (95%CI)**
Income						
≤ 50.0% FPL	**1.18 (1.15, 1.21)**		**1.13 (1.10, 1.16)**		**1.09 (1.06, 1.12)**	
50.1-100.0 % FPL	**1.06 (1.04, 1.09)**		**1.08 (1.05, 1.10)**		**1.06 (1.04, 1.09)**	
100.1-133.0% FPL	**1.04 (1.01, 1.07)**		**1.04 (1.01, 1.06)**		1.02 (.99, 1.05)	
(133.1-185.0% FPL, Ref)						
2010-14 time period	**1.05 (1.03, 1.06)**		**1.04 (1.03, 1.05)**		1.01 (1.00, 1.03)	
(2003-07, Ref)						
Income × time period						
≤ 50.0% FPL						
in 2003-07		**1.18 (1.14, 1.22)**		**1.11 (1.07, 1.14)**		**1.08 (1.04, 1.12)**
in 2010-14		**1.19 (1.15, 1.24)**		**1.16 (1.12, 1.21)**		**1.11 (1.06, 1.15)**
50.1-100.0 % FPL						
in 2003-07		**1.05 (1.02, 1.09)**		**1.05 (1.02, 1.08)**		**1.03 (1.00, 1.07)**
in 2010-14		**1.08 (1.04, 1.12)**		**1.12 (1.08, 1.16)**		**1.11 (1.07, 1.15)**
100.1-133.0% FPL						
in 2003-07		1.03 (1.00,1.07)		1.03 (.99, 1.06)		1.03 (.99,1.07)
in 2010-14		**1.05 (1.00, 1.09)**		**1.06 (1.01, 1.10)**		1.02 (.97, 1.07)
Wald chi-square test of interaction p-value		*0.75*		*0.017*		0.0005

FPL, Federal poverty level; Ref, reference group.

†All models adjusted for child's gender and parent race/ethnicity.

Statistically significant ORs at $p < 0.05$ are in bold.

Table 4

Multiple logistic regressions: Effects of household education on obesity in WIC-participating children in Los Angeles County†

	2-year-old children N=597,506		3-year-old children N=577,069		4-year-old children N=463,213	
	Model 1 OR (95%CI)	**Model 2 OR (95%CI)**	**Model 1 OR (95%CI)**	**Model 2 OR (95%CI)**	**Model 1 OR (95%CI)**	**Model 2 OR (95%CI)**
Education						
Less than high school	**1.37 (1.31, 1.44)**		**1.25 (1.20, 1.31)**		**1.19 (1.14, 1.25)**	
High school	**1.32 (1.26, 1.38)**		**1.19 (1.14, 1.24)**		**1.13 (1.08, 1.19)**	
Some college	**1.21 (1.15, 1.28)**		**1.15 (1.09, 1.20)**		**1.09 (1.04, 1.15)**	
(College or more, Ref)						
2010-14 time period	**1.07 (1.06, 1.09)**		**1.06 (1.04, 1.07)**		**1.03 (1.01, 1.04)**	
(2003-07, Ref)						
Education × time period						
Less than high school						
in 2003-07		**1.30 (1.21, 1.40)**		**1.20 (1.12, 1.28)**		**1.11 (1.03, 1.19)**
in 2010-14		**1.43 (1.35, 1.52)**		**1.29 (1.22, 1.37)**		**1.25 (1.18, 1.34)**
High school						
in 2003-07		**1.26 (1.17, 1.36)**		**1.14 (1.06, 1.22)**		1.05 (.98, 1.14)
in 2010-14		**1.36 (1.28, 1.44)**		**1.22 (1.15, 1.29)**		**1.18 (1.11, 1.26)**
Some college						
in 2003-07		**1.18 (1.09, 1.28)**		**1.14 (1.06, 1.23)**		1.02 (.94, 1.11)
in 2010-14		**1.23 (1.15, 1.32)**		**1.14 (1.07, 1.21)**		**1.14 (1.06, 1.22)**
Wald chi-square test of interaction p-value		0.043		0.0066		0.082

Ref, reference group.

† All models adjusted for child's gender and parent race/ethnicity.

Statistically significant ORs at $p < 0.05$ are in bold.

Table 5

Multiple logistic regressions: Effects of median household income on obesity in WIC-participating children in Los Angeles County†

	2-year-old childre N=597,506		3-year-old children N=577,069		4-year-old children N=463,213	
	Model 1 OR (95%CI)	**Model 2 OR (95%CI)**	**Model 1 OR (95%CI)**	**Model 2 OR (95%CI)**	**Model 1 OR (95%CI)**	**Model 2 OR (95%CI)**
Median household income						
≤ $ 32,738	**1.15 (1.13, 1.18)**		**1.16 (1.14, 1.18)**		**1.14 (1.12, 1.17)**	
$32,739 - 40,278	**1.10 (1.08, 1.12)**		**1.11 (1.09, 1.13)**		**1.11 (1.09, 1.14)**	
$40,279 - 51,534	**1.05 (1.02, 1.07)**		**1.05 (1.03, 1.07)**		**1.06 (1.04, 1.09)**	
(≥ $51,535, Ref)						
2010-14 time period	**1.06 (1.05, 1.08)**		**1.05 (1.04, 1.06)**		**1.02 (1.01, 1.04)**	
(2003-07, Ref)						
Median household income × time period						
≤ $ 32,738						
in 2003-07		**1.15 (1.12, 1.18)**		**1.15 (1.12, 1.18)**		**1.13 (1.10, 1.16)**
in 2010-14		**1.16 (1.13, 1.19)**		**1.17 (1.14, 1.20)**		**1.15 (1.12, 1.19)**
$32,739 - 40,278						
in 2003-07		**1.08 (1.06, 1.11)**		**1.11 (1.08, 1.14)**		**1.11 (1.08, 1.14)**
in 2010-14		**1.11 (1.08, 1.15)**		**1.11 (1.08, 1.14)**		**1.11 (1.08, 1.15)**
$40,279 - 51,534						
in 2003-07		1.02 (.99, 1.05)		**1.03 (1.01, 1.06)**		**1.06 (1.03, 1.09)**
in 2010-14		**1.07 (1.04, 1.10)**		**1.08 (1.05, 1.11)**		**1.07 (1.04, 1.10)**
Wald chi-square test of interaction p-value		0.10		0.14		0.76

Ref, reference group.

†All models adjusted for child's gender and parent race/ethnicity.

Statistically significant ORs at $p < 0.05$ are in bold.