HHS Public Access
Author manuscript
Am J Prev Med. Author manuscript; available in PMC 2020 September 01.

Published in final edited form as:
Am J Prev Med. 2019 September ; 57(3): 338–345. doi:10.1016/j.amepre.2019.04.023.

Changes in Fast Food Outlet Availability Near Schools: Unequal Patterns by Income, Race/Ethnicity, and Urbanicity

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Abstract

Introduction: Previous research has observed income or racial/ethnic inequalities in fast food restaurant (FFR) availability near schools. The purpose of this study was to investigate changes in FFR availability near schools between 2000 and 2010 by school-neighborhood income, race/ethnicity and urbanicity.

Methods: Using data from 7,466 California public schools, negative binomial regression models estimated relative ratios to evaluate the income gradient in FFR availability, examine differences in the income gradient in FFR availability between 2000 and 2010, and investigate if FFR availability changed in 2010 versus 2000, stratified by race/ethnicity and urbanicity. Analyses were conducted in 2018 and early 2019.

Results: In urban areas, there was a negative school-neighborhood income gradient in FFR availability in both 2000 and 2010, and across all race/ethnic groups, except majority African American schools. The income gradient in FFR availability was steeper in 2010 relative to 2000 among Latino majority urban schools. FFR availability increased in 2010 relative to 2000 among majority African American, majority Latino, and majority Asian schools in the least affluent neighborhoods. Among majority white schools in similar neighborhoods FFR did not change, but declined in the most affluent school neighborhoods. In non-urban areas, the income patterns in FFR availability were less clear, and FFR availability increased among majority white and Latino schools within the middle neighborhood income tertile.

Conclusions: These findings suggest the need for future interventions to target schools in low-income urban neighborhoods. Additionally, reducing child health disparities and improving health for all children requires monitoring changes in the food environment near schools.

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No financial disclosures were reported by the authors of this paper.

INTRODUCTION

Attention to food environments[1–8] is increasing in efforts to improve diet, body weight, and overall health. Among children, the fast food environment near schools[9, 10] may be uniquely relevant, given that children spend large amounts of time in or around schools.[11, 12] Fast food restaurant (FFR) availability may be particularly important, as FFRs tend to cluster around schools,[13, 14] fast food is often calorie dense,[15] and fast food has been associated with unhealthy diets,[16–18] greater likelihood of child obesity,[19] and weight gain.[20, 21]

In the U.S., the number of FFRs has increased since 2007 to nearly a quarter million in 2018.[22] It remains unclear whether such increases have occurred evenly across neighborhoods based on income, race/ethnicity, and urbanicity. Cross-sectional studies using nationwide U.S. data[10, 23] and data within single cities (such as New York,[24] Chicago,[14] Montreal,[25] and Adelaide[26]) and Los Angeles county[27] found greater FFR concentrations among schools in socioeconomically disadvantaged neighborhoods compared with schools in affluent neighborhoods,[9, 10, 23–26] though one study did not find this pattern.[28] Furthermore, most, though not all,[10] studies have observed greater FFR concentrations near majority Latino and African American schools relative to schools attended by majority white students,[13, 29–31] and greater FFR densities near schools in urban versus non-urban areas.[10] A New Zealand study noted temporal increases in FFR concentrations around schools in socioeconomically deprived compared with less deprived neighborhoods.[32]

Little U.S.-based research has examined whether school-neighborhood income inequalities in FFR availability have changed over time, or whether income patterns in FFR availability depend on schools' racial/ethnic composition. Examining income patterns by race/ethnicity separately is important, given that they are often inter-related.

Using statewide data from California public schools linked with fast food outlets, this study: (1) investigated school-neighborhood income patterns in FFR availability, (2) examined if such patterns varied between 2000 and 2010, and (3) evaluated changes in FFR availability in 2010 (versus 2000) for each level of school-neighborhood income, all within strata defined by school racial/ethnic composition and urbanicity.

METHODS

Study Sample

Statewide public school data were obtained from the California Department of Education[33]; schools were geocoded based on addresses using ArcGIS Desktop software, version 10.3. Publicly available student enrollment data from the California Department of Education's website[34] were used to determine the racial and ethnic composition of each school's student population. Primary, middle and high schools that were open in both 2000 and 2010 and had student enrollment data were included.

Statewide FFR locations were obtained from the National Establishment Time Series database[35] for 2000 and 2010. FFR chains were identified as those that appear on the list of fast food eating places regardless of Standard Industry Classification code; non-chains were identified with codes for outlets that specialized in low preparation time foods that are eaten cafeteria style (no waiter service) or takeaway.

Census tract membership was determined for each school, and tract-level annual median household income was obtained from the 2000 and 2010 Census.[36, 37]

Proprietary Nielsen PRIZM urbanization data from 2013[38] were used to classify school locations.

Measures

The number of FFRs was calculated within each school's 0.75-mile network buffer for 2000 and 2010. Consistent with previous studies,[39, 40] the authors used a network analysis[41] at this distance because it represents a reasonable walking distance.[42]

Schools were classified into one of six "majority" racial or ethnic categories if >50% of their student enrollment from 2000 fell into one of the following groups: African American (*n*=119), Asian (*n*=128), Latino (*n*=2,560), or white (*n*=2,983). Schools with no majority racial/ethnic student enrollment were classified as no majority (*n*=1,644). Schools with majority other race/ethnicity students (*n*=32) were excluded given small sample sizes.

Income tertiles were constructed (lowest, middle, and highest) based on the distributions of school-neighborhood income level for 2000.

Schools were categorized into urban and non-urban areas; the latter combined rural, suburban, and second cities. Although population density is often a driver of commercialization and fast food availability, urbanicity levels were preferred over separately adjusting for population density because the Nielsen urbanicity data already account for population density.

Statistical Analysis

Mean counts of FFRs within schools' 0.75-mile network buffer were calculated by neighborhood income tertiles. All analyses were stratified by urbanicity because previous research found urbanicity differences in FFR availability,[43] students of color are typically concentrated in urban areas, and the analysis explicitly focused on the income gradient within racial/ethnic groups. Because the FFR counts exhibited overdispersion, negative binomial regression models were constructed to address three objectives for each racial/ethnic group: (1) separately quantify FFR availability for 2000 and 2010 across the income gradient (based on annual median household income in 2000), (2) test differences in the income gradients in FFR availability between 2000 and 2010, and (3) quantify changes in FFRs in 2010 compared with 2000 for each neighborhood income tertile. The models were fitted by school's racial/ethnic student majority using a generalized estimating equations framework to account for correlations between two observed counts (2000 and 2010) within the same schools. These models quantified the associations of interest described above by including a cross-product term between school neighborhood income and year. Combinations of regression coefficients from the interaction models were exponentiated to calculate relative ratios (RRs) to capture differences among income tertiles within each year and between years within each income group. To achieve Objective 2, tests for the significance of the interaction coefficients were conducted. Combinations of regression coefficients from these models were also used to obtain model-estimated means of FFRs for each income tertile, and means were plotted. Although the a priori interest was to address Objectives 1–3 within each racial/ethnic group, a model that included all racial/ethnic groups combined was fitted, along with a model that tested the three-way interaction among neighborhood income, time, and race/ethnicity. All *p*-values are two sided. Analyses were conducted in R, version 3.5.2_. Analyses were conducted in 2018 and early 2019. The study did not involve human subjects and therefore was exempted from IRB review.

RESULTS

A total of 7,466 public schools comprised the analytic sample; 42% and 58% were located in urban and non-urban areas, respectively (Table 1). In urban areas, mean FFR counts were highest in the lowest income tertile and lowest in the highest income tertile, and majority Latino schools made up more than half of all schools in the low (71%) and middle (55.8%) neighborhood income tertiles. In non-urban areas, mean FFR counts were roughly similar across income tertiles, and majority white schools made up nearly half of all schools in low (46.6%) neighborhood income tertiles, and more than half of all schools in middle (55.4%) and high (69.4%) neighborhood income tertiles. Majority African American and Asian schools had no or limited representation in some income tertiles and urbanicity groups.

In urban areas, there was a negative neighborhood income gradient in FFR availability among all schools combined in both 2000 and 2010 (Table 2). That is, schools in the middle and highest neighborhood income tertiles had significantly ($p<0.001$) lower concentrations of FFRs compared with the lowest neighborhood income tertile, in both years. The ratio of the number of FFRs in these tertiles relative to the lowest tertile (i.e., RR) ranged from 0.59 to 0.79. As evidenced by the estimated mean counts in Figure 1, the negative gradient was fairly linear.

The negative neighborhood income gradient in FFR availability was significantly steeper in 2010 versus 2000 (Figure 1). Within the lowest (RR=1.10) and middle (RR=1.06) neighborhood income tertiles, FFR availability near schools significantly increased in 2010 compared with 2000 (Table 3). Within the highest income tertile, FFR availability did not change.

In both 2000 and 2010, a negative neighborhood income gradient in FFR availability was present among majority Latino schools, majority white schools, majority Asian schools, and schools with no racial/ethnic majority, with smaller FFR concentrations in the middle and highest neighborhood income tertiles relative to the lowest tertile. For majority white schools and those with no racial/ethnic majority, the income differences in FFR availability were significant only between the lowest and highest neighborhood income tertiles (Figure 1, Table 2). Among majority African American schools, FFR concentrations were similar in the middle income tertile, and smaller in the highest income tertile relative to the lowest income tertile, though none of the differences were significant. Majority Asian and African

American schools had small sample sizes, thus estimates for these groups should be interpreted with caution.

The school-neighborhood income gradient in FFR availability was significantly different in 2010 compared with 2000 among majority Latino schools (Figure 1; p=0.02), majority white schools (Figure 1; p=0.09), and majority Asian schools (Figure 1; p=0.07). These significant variations may have been driven by significant increases in FFR availability in 2010 relative to 2000 among majority Latino schools in the lowest (RR=1.12) and middle income (RR=1.07) tertile neighborhoods, among Asian schools in the lowest tertile (RR=1.10), and FFR decreases among majority white schools in the highest income tertile (RR=0.93) (Table 3, Figure 1).

The income pattern in FFR availability did not differ significantly between 2000 and 2010 among schools with no racial/ethnic majority (p=0.80) or majority African American schools (p=0.74). Nevertheless, among majority African American schools, in 2010 compared with 2000, FFR availability increased significantly in the lowest and middle income tertiles (Table 3; RR=1.19 and 1.27, respectively); the increase within the highest income tertile (RR=1.24) was not statistically significant. Among schools with no racial/ethnic majority, FFR availability increased significantly in 2010 versus 2000 in the middle and highest income tertiles (RR=1.07 and 1.07, respectively; Table 3).

In non-urban areas, among all schools combined, there was a shallow negative income gradient in FFR availability in 2000, with only the highest compared with the lowest income tertile (Table 2, Figure 1) having a significantly lower number of FFRs. In 2010, the pattern resembled an inverted V shape: Schools in the highest income tertile had significantly fewer FFRs (RR=0.86) than those in the lowest tertile; differences between the middle and lowest tertiles were not statistically significant. The neighborhood income pattern in FFR availability varied significantly (p=0.02) by year (Figure 1). A significant increase in FFR availability in 2010 (versus 2000) was found among schools within the middle neighborhood income tertile (RR=1.07; Table 3).

In both 2000 and 2010, there was a negative neighborhood income pattern in FFR availability for schools without a racial/ethnic student majority, with significant differences between the highest and lowest income tertiles. Majority Latinos schools exhibited an inverse V-shaped pattern, with significant differences between the middle and lowest income tertiles in both years. Among majority white schools, a negative gradient in FFR availability was present in 2000 and a flat pattern in 2010; none of the income differences were significant.

The neighborhood income patterns in FFR availability differed significantly between 2000 and 2010 (Figure 1, Table 3) only among majority white schools. For majority white and majority Latino schools, FFR availability respectively increased significantly by 10% and 11% in the middle tertile of neighborhood income (Table 3). Insufficient data precluded examination of these patterns among majority African American or Asian schools in non-urban areas.

DISCUSSION

This study observed a significant negative neighborhood income pattern in FFR availability near urban schools in 2000 and 2010, and across all race/ethnic groups—except schools with majority African American students. The neighborhood income pattern was significantly steeper in 2010 versus 2000 among majority Latino schools. Additionally, FFR availability increased in 2010 versus 2000 among urban schools with majority Latino, African American, and Asian student enrollment and that were located in the least affluent neighborhoods. For schools with majority white students, FFR availability declined among those in the most affluent neighborhoods but did not change in lowest and middle tertiles of neighborhood income. In non-urban areas, the school-neighborhood income patterns in FFR availability were not as clear, with evidence of a small variation in the income pattern over time among all schools and majority white schools. FFR availability increased in 2010 versus 2000 among majority white and Latino schools within the middle tertiles of neighborhood income.

To the authors' knowledge, this is one of the first studies to examine school neighborhood income patterns in FFR availability and changes in those relationships over time, within racial/ethnic composition of schools and urbanicity. As in prior research,[9, 10, 23–26] this study observed greater FFR concentrations in the lowest and middle tertiles of school-neighborhood income relative to those in the highest income tertiles. This finding contrasts with findings from a study in Chicago[14] that found clustering of FFRs near schools in the highest median (≥$43,700) but not in lower-income neighborhoods. Differences between findings from this and the present study may be related to the spatial scales (e.g., 0.5-mile circular versus 0.75-mile network buffers) and neighborhood income measures used (e.g., the Chicago study calculated area-weighted average of block groups intersecting school buffers to assign income values to schools, whereas this study used annual median household income of residents within school's Census tracts).

Novel contributions of this study include the observed changes in FFR availability near schools in 2010 compared with 2000, by school-neighborhood income and racial/ethnic composition, primarily, though not exclusively, in urban areas. The steeper neighborhood income gradient in FFR availability observed in 2010 versus 2000 among majority Latino urban schools suggests widening school neighborhood income inequalities in FFR within majority Latino schools. Furthermore, the patterning of FFR availability in 2010 appeared to be shaped by both school neighborhood income and school racial/ethnic composition. Specifically, in alignment with prior research schools[32] compared with 2000, in 2010, FFR availability increased near majority Latino and African American schools in the least affluent neighborhoods. However, there were no changes among majority white schools within similar neighborhoods, and FFR availability decreased significantly by 7% in the most affluent neighborhoods. In 2010, the mean FFR counts tended to be more similar across all racial/ethnic majority urban schools, which may be related to the aforementioned changing patterns by income and race/ethnicity.

The present study results have implications for programs and policies intended to reduce inequalities in physical environments and eliminate health disparities—major public health goals in the U.S.[44] If income gradients in FFR availability continue to widen, particularly among schools with high concentrations of students of color, one might expect to observe pronounced racial/ethnic disparities in exposure to FFRs. The Institute of Medicine recommended that local governments enact policies limiting the number of FFRs near schools.[45] These efforts must simultaneously consider neighborhood income, school racial/ethnic composition, and urbanicity. As shown in this study, the income pattern in FFR availability near urban schools was present regardless of the school's racial/ethnic majority of students and time period. When school type (i.e., elementary/primary, middle, and high schools) or school majority race/ethnicity was included in the models, the gradient in FFR availability and the patterns of results remained unchanged (data not shown). Programmatic efforts to improve the food environment and promote health equity may prioritize low-income urban neighborhoods, given that the greatest concentrations of FFRs were observed near schools in these areas, irrespective of school's racial/ethnic student majority. Moreover, a high proportion of schools serving students of color in California were concentrated in socioeconomically disadvantaged urban areas.

Limitations

This study has several limitations. First, FFR location information tends to be less accurate in lower-income neighborhoods[46]; however, owing to under-reporting of FFRs in these neighborhoods, the urban income differences in FFR availability reported here are likely conservative. Second, non-urban areas were combined into a single group (suburban, rural areas, and second cities).[38] Sensitivity descriptive analyses showed that although FFR availability was smallest in rural areas, the pattern for rural and suburban areas was similar to non-urban areas combined. An income gradient in FFR availability was observed near schools in "second cities," although it was less pronounced than for urban areas. Third, to increase sample sizes, and to strengthen the reliability of the estimates, 2000 school enrollment data were used to categorize schools based on student racial/ethnic majority, though demographic changes in California have implications for school's racial/ethnic student enrollment. In the present study, agreement in the classification of school majority racial/ethnic composition between 2000 and 2010 was 86%. In results from a sensitivity analysis restricted to schools with the same majority racial/ethnic classification in both years, the negative neighborhood income patterns in FFR availability were largely the same as the those reported here, and in some cases the gradient was steeper (results available upon request). Fourth, FFRs were grouped into a single category, thus it was not possible to fully distinguish outlets by food quality offered. A study found limited temporal changes in improvements in food nutrition quality marketed across four major chain FFRs.[47] Future research should examine changes in FFR availability by specific brands. Fifth, the service areas computed here may include highways and did not consider walkability as this is beyond the scope of the study. However, schools are relatively rarely placed close to highways. Finally, previous studies have found differences in the concentration of FFRs near schools with greater availability among high schools.[10, 27] The authors had insufficient data to further stratify analyses by school level. In a sensitivity analysis that included school level as a predictor, the patterns of results presented here remained the same for all non-white majority groups and became slightly stronger among majority white schools; thus, the overall conclusions remain unchanged.

CONCLUSIONS

This study found a negative income gradient in FFR availability near urban schools, a steeper gradient in 2010 relative to 2000 among majority Latino schools, and increases in FFR availability among urban majority minority schools within the least affluent neighborhoods. Reducing child health disparities and improving health for all children requires assessing longitudinal changes in the food environment near schools.

ACKNOWLEDGMENTS

We thank Erin Flores, MPH and Jillian Botkin, MPH (San Francisco State University) for their valuable research assistance. The authors acknowledge salary support by grants from the National Heart, Lung and Blood Institute of the National Institutes of Health (K01HL115471 and R01HL136718, Dr. Sanchez-Vaznaugh and Dr. Sánchez; R01HL131610, Dr. Sánchez) and the Robert Wood Johnson Foundation (74375, Sanchez-Vaznaugh). The content in this article is solely the responsibility of the authors and does not necessarily represent the official views of the funding institutions.

REFERENCES

1. Institute of Medicine. Committee on Prevention of Obesity in children and youth, food and nutrition board, Prevenion of Obesity in Children and Youth Washington, D.C.: The National Academies Press; 2004.
2. The National Academies of Sciences Engineering and Medicine. Accelerating Progress in Obesity Prevention: Solving the Weight of the Nation. Washington, DC: The National Academies Press; 2012.
3. Kumanyika SK, Obarzanek E, Stettler N, Bell R, Field AE, Fortmann SP, et al. Population-based prevention of obesity: the need for comprehensive promotion of healthful eating, physical activity, and energy balance: a scientific statement from American Heart Association Council on Epidemiology and Prevention, Interdisciplinary Committee for Prevention (formerly the expert panel on population and prevention science). Circulation 2008;118(4):428–64. [PubMed: 18591433]
4. Sallis JF, Glanz K. The role of built environments in physical activity, eating, and obesity in childhood. Future Child 2006;16(1):89–108. [PubMed: 16532660]
5. Sallis JF, Glanz K. Physical activity and food environments: solutions to the obesity epidemic. Milbank Q 2009;87(1):123–54. [PubMed: 19298418]
6. Sallis JF, McKenzie TL, Conway TL, Elder JP, Prochaska JJ, Brown M, et al. Environmental interventions for eating and physical activity. American Journal of Preventive Medicine 2003;24(3): 209–217. [PubMed: 12657338]
7. Story M, Kaphingst KM, French S. The role of schools in obesity prevention. Future Child 2006;16(1):109–42. [PubMed: 16532661]
8. Story M, Kaphingst KM, Robinson-O’Brien R, Glanz K. Creating Healthy Food and Eating Environments: Policy and Environmental Approaches. Annual Review of Public Health 2008;29(1): 253–272.
9. Simon PA, Kwan D, Angelescu A, Shih M, Fielding JE. Proximity of fast food restaurants to schools: do neighborhood income and type of school matter? Prev Med 2008;47(3):284–8. [PubMed: 18448158]
10. Zenk S, Powell L. US secondary schools and food outlets. Health Place 2008;14(2):336–46. [PubMed: 17881277]
11. Dale D, Corbin CB, Dale KS. Restricting opportunities to be active during school time: do children compensate by increasing physical activity levels after school? Res Q Exerc Sport 2000;71(3): 240–8. [PubMed: 10999261]

12. Hofferth S, & Sandberg J. How american children spend their time. Journal of Marriage and Family 2001;63(2):295–308.
13. Kwate N, Loh J. Separate and unequal: the influence of neighborhood and school characteristics on spatial proximity between fast food and schools. Prev Med 2010;51(2):153–6. [PubMed: 20457178]
14. Austin SB, Melly SJ, Sanchez BN, Patel A, Buka S, Gortmaker SL. Clustering of fast-food restaurants around schools: a novel application of spatial statistics to the study of food environments. Am J Public Health 2005;95(9):1575–81. [PubMed: 16118369]
15. Tate EB, Unger JB, Chou CP, Spruijt-Metz D, Pentz MA, Riggs NR. Children's executive function and high-calorie, low-nutrient food intake: mediating effects of child-perceived adult fast food intake. Health Educ Behav 2015;42(2):163–70. [PubMed: 25194147]
16. Cutumisu N, Traore I, Paquette MC, Cazale L, Camirand H, Lalonde B, et al. Association between junk food consumption and fast-food outlet access near school among Quebec secondary-school children: findings from the Quebec Health Survey of High School Students (QHSHSS) 2010–11. Public Health Nutr 2017;20(5):927–937. [PubMed: 27881202]
17. Borradaile KE, Sherman S, Vander Veur SS, McCoy T, Sandoval B, Nachmani J, et al. Snacking in children: the role of urban corner stores. Pediatrics 2009;124(5):1293–8. [PubMed: 19822591]
18. Seliske L, Pickett W, Rosu A, Janssen I. The number and type of food retailers surrounding schools and their association with lunchtime eating behaviours in students. Int J Behav Nutr Phys Act 2013;10:19. [PubMed: 23391296]
19. Williams J, Scarborough P, Matthews A, Cowburn G, Foster C, Roberts N, et al. A systematic review of the influence of the retail food environment around schools on obesity-related outcomes. Obes Rev 2014;15(5):359–74. [PubMed: 24417984]
20. French SA, Harnack L, Jeffery RW. Fast food restaurant use among women in the Pound of Prevention study: dietary, behavioral and demographic correlates. Int J Obes Relat Metab Disord 2000;24(10):1353–9. [PubMed: 11093299]
21. Jeffery RW, French SA. Epidemic obesity in the United States: are fast foods and television viewing contributing? Am J Public Health 1998;88(2):277–80. [PubMed: 9491022]
22. Statista. Number of establishments in the United States fast food industry from 2004 to 2018. [cited 2018 8/22/18]; Available from: https://www.statista.com/statistics/196619/total-number-of-fast-food-restaurants-in-the-us-since-2002/
23. Powell LM, Chaloupka FJ, Bao Y. The availability of fast-food and full-service restaurants in the United States: associations with neighborhood characteristics. Am J Prev Med 2007;33(4 Suppl):S240–5. [PubMed: 17884571]
24. Neckerman K, Bader M, Richards C, Purciel M, Quinn J, Thomas J, et al. Disparities in the food environments of New York City public schools. Am J Prev Med 2010;39(3):195–202. [PubMed: 20709250]
25. Kestens Y, Daniel M. Social inequalities in food exposure around schools in an urban area. Am J Prev Med 2010;39(1):33–40. [PubMed: 20537844]
26. Coffee NT, Kennedy HP, Niyonsenga T. Fast-food exposure around schools in urban Adelaide. Public Health Nutr 2016;19(17):3095–3105. [PubMed: 27297639]
27. Simon PA, Kwan D, Angelescu A, Shih M, Fielding JE. Proximity of fast food restaurants to schools: Do neighborhood income and type of school matter? Preventive Medicine 2008;47(3): 284–288. [PubMed: 18448158]
28. Austin S, Melly S, Sánchez N, Patel A, Buka S, Gortmaker S. Clustering of fast food restaurants around schools: a novel application of spatial statistics to the study of food environments. American Journal of Public Health 2005;95:1575–1581. [PubMed: 16118369]
29. Howard PH, Fitzpatrick M, Fulfrost B. Proximity of food retailers to schools and rates of overweight ninth grade students: an ecological study in California. BMC Public Health 2011;11:68. [PubMed: 21281492]
30. Sanchez BN, Sanchez-Vaznaugh EV, Uscilka A, Baek J, Zhang LD. Differential Associations Between the Food Environment Near Schools and Childhood Overweight Across Race/Ethnicity, Gender, and Grade. American Journal of Epidemiology 2012;175(12):1284–1293. [PubMed: 22510276]

31. Sturm R Disparities in the food environment surrounding US middle and high schools. Public Health 2008;122(7):681–90. [PubMed: 18207475]
32. Day PL, Pearce JR, Pearson AL. A temporal analysis of the spatial clustering of food outlets around schools in Christchurch, New Zealand, 1966 to 2006. Public Health Nutr 2015;18(1):135–42. [PubMed: 24192224]
33. California Department of Education. Public Schools and Districts Data Files 2014. available from: http://www.cde.ca.gov/ds/si/ds/pubschls.asp
34. California Department of Education. Enrollment by School 2014. available from: http://www.cde.ca.gov/ds/sd/sd/filesenr.asp
35. Walls DW. National Establishment Time-Series Database©: Data Overview In: 2007 Kauffman Symposium on Entrepreneurship and Innovation Data; 2007.
36. US Census Bureau. Profile of Selected Economic Characteristics 2000. available from: https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_00_SF4_DP3
37. US Census Bureau. Selected Economic Characteristics. 2006–2010 American Community Survey 5-Year Estimates. 2010 available from: https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_10_5YR_DP03
38. The Nielsen Company. 2013 Selected PRIZM Segment Distributions Data (Census Tract Level). In: Company TN, editor. New York, NY: The Nielsen Company; 2013.
39. Davis B, Carpenter C. Proximity of fast-food restaurants to schools and adolescent obesity. Am J Public Health 2009;99(3):505–10. [PubMed: 19106421]
40. Langellier BA. The food environment and student weight status, Los Angeles County, 2008–2009. Prev Chronic Dis 2012;9:E61. [PubMed: 22360872]
41. ESRI. ArcGIS Desktop: Release 10.3. In. Redlands, CA: Environmental Systems Research Institute; 2014.
42. Yang Y, Diez-Roux AV. Walking Distance by Trip Purpose and Population Subgroups. American Journal of Preventive Medicine 2012;43(1):11–19. [PubMed: 22704740]
43. Chen H, Wang Y. The changing food outlet distributions and local contextual factors in the United States. BMC Public Health 2014;14:42. [PubMed: 24433323]
44. Healthy People 2020. Secretary's Advisory Committee on National Health Promotion and Disease Prevention Objectives for 2020. January 3, 2018; Available from: Available from: http://www.healthypeople.gov/sites/default/files/PhaseI_0.pdf.
45. IOM (Institute of Medicine) and National Research Council. Local Goverment Actions to Prevent Childhood Obesity. In. Washington, DC.: The National Academies Press; 2009.
46. Powell LM, Han E, Zenk SN, Khan T, Quinn CM, Gibbs KP, et al. Field validation of secondary commercial data sources on the retail food outlet environment in the U.S. Health Place 2011;17(5):1122–31. [PubMed: 21741875]
47. Soo J, Harris JL, Davison KK, Williams DR, Roberto CA. Changes in the nutritional quality of fast-food items marketed at restaurants, 2010 v. 2013. Public Health Nutrition 2018;21(11):2117–2127. [PubMed: 29580301]

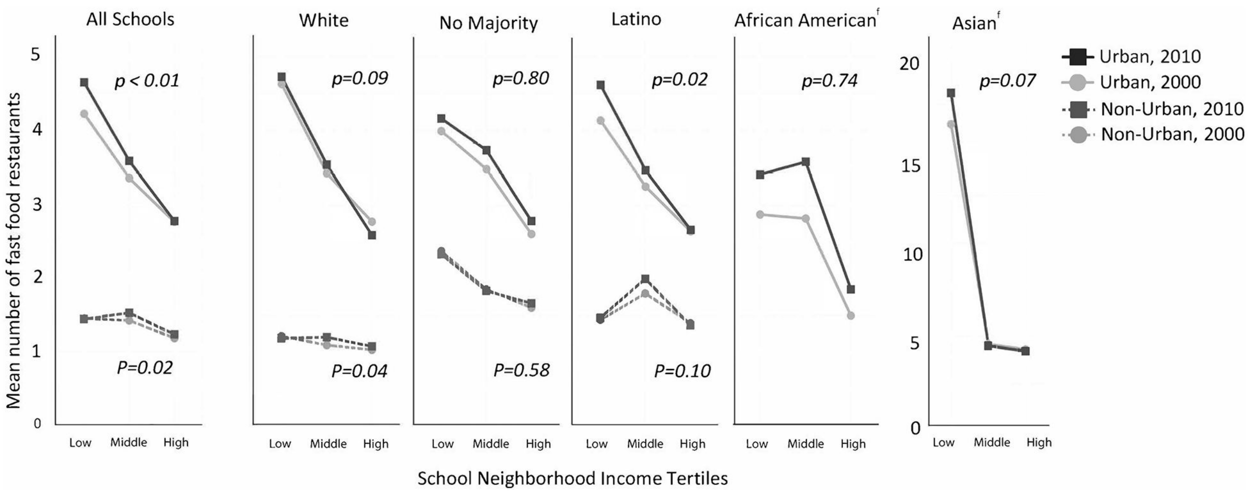

Figure 1. Mean number[a] of fast food restaurants near schools,[b] according to neighborhood income tertiles,[c] for all schools and stratified by school racial/ethnic composition of the student body[d] and urbanicity.[e]

Notes: These *p*-values are for test of interaction assessing differences in school-neighborhood income gradient in fast food restaurant availability between 2000 and 2010 for schools overall and within each racial/ethnic majority group of schools.

[a]Estimated from negative binomial regression models that included the main effects of neighborhood income tertiles and year, plus a cross-product term between the two.

[b]Data source: California public school data files, available on the California Department of Education's website.[33,34]

[c]Neighborhood income tertiles are based on median annual household income tertiles (based on U.S. Census 2010 data).[36,37]

[d]Majority racial/ethnic composition of the student body refers to >50% of the student body in a racial/ethnic classification (based on data from the California Department of Education, 2010).[34]

[e]Urbanicity refers to urban or non-urban (rural, suburban, second city) households in the census tract in which schools were located (based on data from Nielsen PRIZM urbanization measures, 2013).[38]

[f]This group has small sample sizes (n≤25) in some of the income tertiles in non-urban and/or urban areas, thus estimates should be interpreted with caution.

Table 1.

Mean Number of Fast Food Restaurants and Percentage of Schools by School Majority Racial/Ethnic[a] Student Enrollment, Urbanicity,[b] and Neighborhood Income Tertiles[c]

Measure	Urban neighborhood income tertiles (n=3,130)			Non-urban neighborhood income tertiles (n=4,336)			Overall
	Lowest ($\bar{x}$=$28,988)	Middle ($\bar{x}$=$46,803)	Highest ($\bar{x}$=$72,510)	Lowest ($\bar{x}$=$30,770)	Middle ($\bar{x}$=$46,932)	Highest ($\bar{x}$=$79,402)	
FFR availability, Mean (Standard Deviation)							
2000	4.42 (4.30)	3.45(3.11)	2.75 (2.92)	1.4 (2.43)	1.46 (2.28)	1.20 (2.01)	2.23 (3.06)
2010	4.55 (4.74)	3.80 (3.42)	3.06 (3.19)	1.61 (2.54)	1.44 (2.30)	1.23 (2.12)	2.36 (3.21)
Schools by majority race/ethnicity of student body,[a] % (n)							
African American	4.9 (54)	3.4 (38)	1.5 (14)	0.3 (4)	0.1 (1)	0.5 (8)	1.6 (119)
Asian	1.2 (13)	1.9 (21)	5.9 (54)	0.0 (0)	0.0 (0)	2.5 (40)	1.7 (128)
Latino	71.0 (777)	55.8 (623)	16.1 (148)	38.4 (537)	25.0 (342)	8.5 (133)	34.3 (2,560)
No majority	19.2 (210)	28.0 (313)	40.8 (375)	13.3 (186)	19.1 (262)	19.0 (298)	22.0 (1,644)
White	3.7 (41)	10.7 (120)	35.1 (322)	46.6 (652)	55.4 (759)	69.4 (1,089)	40.0 (2,983)
Total	14.7 (1,095)	15.0 (1,117)	12.3 (918)	18.7 (1,398)	18.3 (1,369)	21.0 (1,569)	100.0 (7,466)

[a] >50% of the student body (based on data from the California Department of Education, 2010; www.cde.ca.gov/ds).[34]

[b] Urban or non-urban (rural, suburban, second city) households in the census tract (based on data from Nielsen PRIZM urbanization measures, 2013).[38]

[c] Median household income tertiles (based on Census 2000).[36–37]

FFR, fast food restaurants.

Table 2.

Relative Ratios[a] Comparing Fast Food Restaurant Availability[b] by Neighborhood[c] Income[d] Tertile Within Year and School Racial or Ethnic Student Majority,[e] Stratified by Urbanicity[f]

	Racial/ethnic majority of students in schools											
	All schools combined		Latino		White		No racial/ethnic majority		African American[g]		Asian[g]	
School neighborhood income tertiles	**2000**	**2010**	**2000**	**2010**	**2000**	**2010**	**2000**	**2010**	**2000**	**2010**	**2000**	**2010**
Urban												
Lowest (ref)	1	1	1	1	1	1	1	1	1	1	1	1
Middle	**0.79*** **	**0.77*** **	**0.78*** **	**0.75*** **	0.74	0.75	0.87	0.9	0.98	1.05	**0.28*** **	**0.25*** **
Highest	**0.65*** **	**0.59*** **	**0.64*** **	**0.57*** **	**0.58*** **	**0.55*** **	**0.65*** **	**0.67*** **	0.53	0.55	**0.26*** **	**0.23*** **
Non-urban												
Lowest (ref)	1	1	1	1	1	1	1	1	—	—	—	—
Middle	0.98	1.06	**1.25***	**1.36** **	0.89	1.01	0.78	0.79	—	—	—	—
Highest	**0.82** **	**0.86***	0.97	0.93	0.84	0.91	**0.68** **	**0.71** **	—	—	—	—

Note: Boldface indicates statistical significance (*p<0.05; ** p<0.01; ***p<0.001).

[a]Calculated as relative ratios, denoting the difference in the mean count of fast food restaurants in the middle and highest school neighborhood income tertiles relative to the lowest income tertile separately within each year (2000 or 2010).

[b]Availability was defined as the number of chain and non-chain fast food restaurants within a 0.75 mile service area of a school.

[c]Defined based the census tract in which the school was located.

[d]Median annual household income, classified into tertiles (based on U.S. Census data, 2000).[36–37] The reference group is the lowest neighborhood income tertile.

[e]>50% of the student body in each racial/ethnic classification (based on data from the California Department of Education, 2010).[34]

[f]Urban or non-urban (rural, suburban, second city) households in the census tract (based on data from Nielsen PRIZM urbanization measures, 2013).[38]

[g]Sample sizes for non-urban areas for these groups were insufficient to generate stable estimates, thus estimates were excluded or not available.

Table 3.

Changes[a] in Fast Food Restaurant Availability[b] from 2010 to 2000 Within Each Neighborhood Income[c] Tertile by School Racial or Ethnic Student Majority,[d] Stratified by Urbanicity[e]

		Racial/ethnic majority of students in schools				
Neighborhood income tertiles	**All schools combined**	**Majority Latino**	**Majority white**	**No racial/ethnic majority**	**Majority African American[f]**	**Majority Asian[f]**
Urban						
Lowest	**1.10*** **	**1.12*** **	1.02	1.04	**1.19** **	**1.10** **
Middle	**1.06*** **	**1.07*** **	1.03	**1.07** **	**1.27*** **	0.98
Highest	1.00	1.01	**0.93***	**1.07** **	1.24	0.98
Non-urban						
Lowest	0.99	1.02	0.97	0.98	—	—
Middle	**1.07*** **	**1.11** **	**1.10** **	0.99	—	—
Highest	1.04	0.98	1.05	1.04	—	—

Note: Boldface indicates statistical significance (*$p<0.05$; **$p<0.01$; ***$p<0.001$).

[a]Calculated as relative ratios to quantify the difference in the mean count of fast food restaurants in 2010 compared with 2000 for each neighborhood income tertile within each majority racial/ethnic school subgroup.

[b]Availability was defined as the number of chain and non-chain fast food restaurants within 0.75 mile service area of school.

[c]Median annual household income, classified into tertiles (based on U.S. Census 2000 data).[36–37]

[d]>50% of the student body in each racial/ethnic classification (based on data from the California Department of Education, 2010).[34]

[e]Urban or non-urban (rural, suburban, second city) households in the census tract (based on data from Nielsen PRIZM urbanization measures, 2013).[38]

[f]Sample sizes for non-urban areas for these groups were insufficient to generate stable estimates, thus estimates were excluded or not available.