Economic Contextual Factors, Food Consumption, and Obesity among U.S. Adolescents\textsuperscript{1–3}

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Abstract

Adolescents have poor dietary behaviors and high overweight prevalence. Economic contextual factors such as food prices and food store and restaurant availability are hypothesized and increasingly being explored empirically as contributors to the obesity epidemic. Evidence showed that healthful compared with less healthful foods increasingly cost more and that fast food restaurants are increasingly available. In addition, racial, ethnic, and socioeconomic disparities have been documented in access to food outlets, particularly chain supermarkets, and such disparities have been shown to be increasing recently. Empirical evidence based on nationally representative U.S. adolescent data revealed that lower fruit and vegetable prices, higher fast food prices, and greater supermarket availability were related to higher fruit and vegetable consumption and lower BMI, in particular for BMI among teens who are overweight or at risk for overweight and who are low- to middle-socioeconomic status. The availability of fast food restaurants was not associated with youth BMI. Overall, this research implies that pricing interventions of taxes on energy-dense foods such as fast food and/or subsidies to healthful foods such as fruits and vegetables and policy efforts to improve access to supermarkets may help to improve adolescent weight outcomes. J. Nutr. 140: 1175–1180, 2010.

Introduction

The prevalence of obesity and poor diet among U.S. youth poses a serious public health concern. The obesity (age- and gender-specific BMI $\geq 95\text{th}$ percentile) rate was $17.6\%$ among youths 12–19 y of age in 2003–2006 with differences by race; the rates among White, Black, and Mexican-American youths were, respectively, 17.3, 21.8, and 16.3\% (1). Obese youth are at increased risk for developing type 2 diabetes mellitus (2) and cardiovascular disease risk factors (3) and obesity is shown to track from childhood to adulthood (4).

Diet is an important modifiable behavior that contributes to the positive energy balance that underlies the growing obesity epidemic among adolescents. U.S. adolescents consume excess of fat, sugar, soft drinks, and salty snacks and have too low intakes of fruits and vegetables and micronutrients compared with dietary recommendations (5,6). Data from nationwide surveys of food consumption and household expenditures show a marked upward trend in total energy intake from away-from-home sources, in particular fast food outlets, and adolescents consume the largest proportion of energy away from home at quick service restaurants (7,8).

Environmental factors are recognized as playing an important role in influencing people’s lifestyles and risks for developing obesity. Given the obesigenic environment in the U.S., adolescent dietary practices and weight outcomes are increasingly conceptualized and empirically examined as functions of not only individual- and family-level factors but also a broad range of environmental influences, including economic factors such as food prices and food-related outlet availability (9–12). This paper reviews our work from the “Bridging the Gap Program” and our “Economic, Lifestyle and Social Influences on Obesity” projects, which examine the importance of economic contextual factors in influencing adolescent food consumption and body weight. We begin by presenting our conceptual framework, followed by descriptive and multivariate analyses of food prices and food-related outlet availability. Subsequently, we present empirical evidence on the relationship between economic contextual factors and food consumption and weight outcomes. We conclude with a discussion of the policy implications of this research.

Conceptual framework

Our empirical research derives from a framework incorporating individual, economic, and environmental factors as contributors...
to food consumption and obesity. Among the complex and diverse factors that contribute to a positive energy balance, food consumption is an important individual modifiable behavior. This conceptual framework draws on economic, ecological, and social cognitive theories to help explain the complex relationship between and across multiple factors and behaviors such as food consumption that potentially contribute to a net positive energy balance and, hence, an increase in BMI and obesity. Other factors related to food consumption and related weight outcomes not accounted for in our empirical models include psychological, peer sociocultural, and media influences (9,13–15).

Individual- and family-level factors include both genetic factors and other individual characteristics. Although genetics may predispose differential rates of weight gain, it is unlikely that genes are responsible for the dramatic rise in obesity in the U.S. given that genetic changes within a population occur slowly and the genetic pool in the U.S. has not changed dramatically during the period of increasing obesity (16). In empirical research, genetic factors are recognized as important unobserved variables and, in longitudinal analyses, researchers are able to control for these unobservables by controlling for time-constant, individual-level heterogeneity using individual fixed effect models. A number of individual and family characteristics are relevant to youths’ behavioral decisions and related weight outcomes. Important individual-level time invariant characteristics include age, gender, race, and ethnicity. In addition, a number of time-varying individual and family-level factors are expected to affect preferences for various foods and weight outcomes. For example, youths’ and family income will affect their purchasing power. Family characteristics such as household composition and parents’ education levels, marital status, and work status are likely to affect the demand for alternative types of food. Additional important individual factors include physical activity behaviors that contribute to weight outcomes.

A key focus of our empirical research is on economic contextual factors that affect obesity through their influence on individuals’ decisions and behaviors. Economic models assume that individuals make decisions that maximize their utility (happiness) based on their personal preferences and subject to constraints (17). In economic models, the demand for a given food is a function of that food’s price, the prices of other foods and goods, income (purchasing power), and individual characteristics that affect preferences. Changes in the relative prices of different foods, such as healthy compared with unhealthy items, are expected to affect the demand for these products. Total cost refers to both the monetary cost (price) and other costs (such as time cost related to availability). Ecological models also highlight economic and physical access as important environmental factors that underlie behaviors. Social cognitive theory addresses both individual factors and environmental factors with reciprocal determinism as a key component. According to this theory, behavior is dynamic, depending on aspects of the environment and the individual; therefore, an individual’s behavior is determined by interactions among personal factors, behavior, and the environment (18). Social ecological models recognize that a complex recursive interplay exists between social system components, from the individual to broad social institutions at the policy and environmental levels (19,20).

**Trends in food prices and availability and differential access**

Based on theory and empirical evidence, economists argue that technological change has contributed to the U.S. obesity epidemic by altering incentives; specifically, the relative price of energy consumption has fallen over time while production efficiency has raised the cost of physical activity and work has become more sedentary (21,22). In particular, both the low cost and high convenience of energy-dense food have been hypothesized as key contributors to obesity (22,23).

Increases in the gap between the relative prices of healthy compared with unhealthy foods were expected to contribute to changes in consumption patterns that result in poorer diet quality, increased energy intake, and consequent increases in weight. Using price data obtained from the American Chamber of Commerce Researchers Association (ACCRA), we examined real (inflation-adjusted) prices averaged over 300 U.S. cities for fruits and vegetables, dairy products, and meat and found that the prices for these products were generally flat from 1990 through 2007. However, we found that the real prices of fast foods and soft drinks fell by 12 and 32%, respectively, over this period, making it increasingly less expensive to consume such forms of energy-dense foods.

We conducted several studies assessing the extent to which the availability of restaurants and food stores vary by neighborhood socioeconomic status (SES), race, and ethnicity. These studies have linked outlet density data obtained from Dun and Bradstreet (D&B) for 28,050 zip codes to Census 2000 data on neighborhood racial and ethnic characteristics and SES, along with measures of population, urbanization, and region. Food-related outlet density measures based on standard industry classification (SIC) codes were developed for chain supermarkets, nonchain supermarkets, convenience stores, grocery stores, fast food restaurants, and full-service restaurants. In our multivariate analysis of food store availability, we found that the availability of chain supermarkets in African-American neighborhoods was only 52% of that in White neighborhoods, with even less relative availability in urban areas (24). Further, Hispanic populations had one-third the access of non-Hispanics. Smaller grocery stores and nonchain supermarkets were significantly more prevalent in racial and ethnic minority zip codes. Controlling for race, ethnicity, and other covariates, low-income neighborhoods had fewer chain supermarkets, whereas nonchain supermarkets and grocery stores were more prevalent in low-income neighborhoods. In our research on restaurant availability, we found that low- to middle-income neighborhoods had roughly 1.25–1.3 times the number of fast food restaurants compared with high-income neighborhoods (25). This study also showed that although restaurants of all types were less available in predominantly racial or ethnic minority communities, a significantly higher proportion of restaurants were fast food restaurants in these communities. Further, we found that the proportion of fast food restaurants out of total restaurant availability in the U.S. has increased substantially: in 1997 fast food restaurants made up 17% of all restaurants; by 2006, they constituted 30% of all restaurants. Finally, Zenk and Powell (26) documented the ready availability of fast food restaurants and convenience stores around U.S. secondary schools, particularly high schools, with greatest availability around schools in larger cities and/or lower income neighborhoods.

Recently, we extended this work to examine relative changes in availability of various food stores by race and SES from 1997 to 2008. We found that predominantly (≥70% population in zip code) African-American neighborhoods had the smallest in-
crease in food store availability and the largest decrease in grocery store availability (Fig. 1). Similarly, low-income neighborhoods had the smallest increase in food store availability and the greatest reduction in the number of available grocery stores (Fig. 2) (27). These data suggest an increasing gap in access to supermarkets, particularly chain supermarkets, between African-American and White neighborhoods and lower- compared with higher-income neighborhoods.

**Links to adolescent food consumption and weight outcomes**

To examine the relationships between economic contextual factors and consumption and weight outcomes, we have linked food price and outlet density data to several individual-level cross-sectional and longitudinal surveys with adolescent populations. The individual-level surveys included important individual- and family-level covariates that differed somewhat across surveys but generally allowed us to control for measures, e.g., of race, gender, youths’ income, and parental/household characteristics such as marital status, education, income, and work status. We conducted the empirical analyses using econometric estimation techniques such as multiple linear regression analysis, nonlinear estimation methods such as probit models, and longitudinal analyses with individual fixed- and random-effects to control for individual-level unobserved heterogeneity, and all models included year fixed effects and implemented appropriate clustering methods. The price data were obtained from ACCRA and were matched by year to the surveys based on closest city match to the available survey geographic identifier (either the zip code or county identifier). Outlet density count measures obtained from D&B were matched by year at the geographic unit available in the survey data.

Our earliest study linked the price and outlet data to the annual, nationally representative Monitoring the Future (MTF) cross-sectional surveys of middle and high school students from 1997 to 2003. In cross-sectional regression analyses of 8th and 10th grade adolescents, we found that fruit and vegetable consumption was significantly lower when fruit and vegetable prices were higher or when the price of fast food was lower, suggesting both a significant own-price and cross-price effect (28). In this study, we also found a weakly significant association between higher fast food prices and lower BMI levels (elasticity of −0.04) and a significant association with a lower probability of obesity (elasticity of −0.59) (where the elasticity measures the percent change in the outcome, e.g., BMI, associated with a 1% change in price). The price of fruit and vegetables was positively but not significantly associated with BMI and obesity. Also, fast food and full-service restaurant outlet density and youth weight outcomes were not significantly associated.

Given the substantially higher fast food price elasticity for obesity compared with BMI in our first study (28), we used cross-sectional quantile regression methods in a subsequent study of the same MTF surveys to assess the differential relationship of prices across the whole BMI distribution, controlling for restaurant and supermarket availability (29). Results suggested that fast food and fruit and vegetable prices have significant but small effects on adolescents of normal weight but substantially larger effects among overweight teens. The effects of fruit and vegetable and fast food prices at the 90th or 95th quantile were 3–5 times greater than across the whole distribution: e.g., for male and female adolescents, the BMI fast food price elasticities were −0.10 and −0.11, respectively, at the 90th BMI quantile and the BMI fruit and vegetable price elasticities were 0.05 and 0.06, respectively, at the 95th BMI quantile. Again, we found no significant associations between fast food or full-service restaurant availability and adolescent weight. However, we found that increased supermarket availability was significantly associated with lower BMI (29). In a subsequent study using the same MTF surveys, we found that this was particularly true for increased availability of chain supermarkets (30).

In 2 recent studies, we used longitudinal data linked with fruit and vegetable and fast food prices and measures of the availability of supermarkets, grocery stores, and convenience stores, and fast food and full-service restaurants. One study used the 1998, 2000, and 2002 waves of the child-mother merged files from the 1979 cohort of the National Longitudinal Survey of Youth to examine children aged 6–17 y old with external data linked by county-level identifiers (31). In this study, using an individual-level random-effects model, we found that a 10% increase in the price of fruits and vegetables was associated with a 0.7% increase in child BMI. Fast food prices were not significant in the full sample but were significantly negatively associated with BMI among adolescents with an estimated price

![Figure 1](image-url)
elasticiy of $-0.12$. We found a significant association between increased supermarket availability (defined on a per land area basis) and lower BMI. The impact of prices on BMI was stronger both in magnitude and significance for children of low compared with high-SES.

In our second longitudinal study, we used data from the 1997 and 2003 waves of the Child Development Supplement of the Panel Study of Income Dynamics to examine economic contextual determinants of BMI percentile for children aged 2–18 y (32). Estimates from individual fixed-effects models showed that higher fruit and vegetable prices were significantly related to a higher BMI percentile ranking among all children (elasticity of 0.25), with greater effects among low-income children (elasticity of 0.60). Fast food prices were negatively significantly related to child weight only in cross-sectional models among low-income children. Measuring availability based on population and land area to capture both congestion and distance, respectively, we found that increased supermarket availability and reduced convenience store availability were significantly related with lower weight outcomes among low-income children.

In our most recent study (33), we used 4 waves of the 1997 National Longitudinal Survey of Youth to examine the relationship between adolescent BMI and fast food prices and availability using fixed effects estimation methods to account for individual-level unobserved heterogeneity. We controlled for additional contextual factors, including general food prices, and the availability of full-service restaurants, supermarkets, grocery stores, convenience stores and commercial physical activity-related facilities. The longitudinal, individual-level, fixed effects results confirmed the cross-sectional findings that the price of fast food but not the availability of fast food restaurants had a significant effect on teen BMI, with an estimated price elasticity of $-0.08$ (compared with the price elasticity of $-0.10$ estimated from the cross-sectional model). We also found that the weight of teens in lower to middle-SES families was most sensitive to fast food prices. We did not find any significant relationships between food outlet density measures and adolescent BMI, although outlets were matched at the broad county level.

**Discussion**

Public policy instruments such as taxes and subsidies that alter the relative costs of healthful compared with unhealthful food and zoning policies, land use regulations, and financial incentives that address the lack of food outlets providing healthful foods in underserved communities are increasingly at the forefront of the policy debate aimed at reversing the obesity epidemic. Evidence shows that the relative costs of healthy vs. less healthful foods are higher and that this gap has increased over time. At the same time, fast food restaurants are increasingly available and are taking up a greater share of total restaurant availability. Our research and that of others (34) demonstrates that there are racial and SES disparities in access to supermarkets, in particular chain supermarkets, with our recent research showing that these disparities are rising. Given youths’ poor diets, that almost one-fifth are obese, and that obesity tracks into adulthood, a key focus of our research has been to assess how the food environment relates to adolescents’ diet and weight outcomes and the related policy implications.

For changes in economic contextual factors such as prices or outlet availability to translate into weight reductions, however, changes in specific food consumption measures must lead to improvement in overall diet quality and reduced total energy intake (i.e. reduced fast food consumption is only helpful if an individual does not substitute an equal amount of energy density from another source). Estimates from multivariate models for weight outcomes provide evidence on the net impact of changes in food prices on obesity. For example, our research and that of others using cross-sectional data consistently found that higher fast food prices were associated with lower adolescent BMI (28,29,35,36). This finding was confirmed by our longitudinal study that used individual fixed effects methods, the only research of its kind to date to our knowledge, to estimate that a 10% increase in the price of fast food would reduce adolescent BMI by just under 1% (33). These findings are consistent with the growing body of literature showing that fast food consumption among youths is associated with higher total energy intake and higher intakes of fat, saturated fat, carbohydrates, sugar, and carbonated soft drinks and lower intakes of micronutrients, fruits and vegetables, and milk (37,38). Together, this research suggests that taxes on fast food can improve adolescents’ diets and lead to modest improvements in weight outcomes. Other policy instruments that effectively raise prices on large quantities of energy-dense foods, such as regulations that limit super-sizing, may also be effective measures for addressing youth obesity.

Although the availability of fast food restaurants has grown substantially in recent years and such restaurants were relatively...
more available in low-income neighborhoods and near high schools, as discussed above, we have not found significant associations between fast food restaurant availability and youth weight outcomes, consistent with other recent studies (35,36). Together, these findings imply that it is the low cost of fast food and not its widespread availability that affects youth diet and obesity, particularly for youths at risk of overweight and those in lower to middle-SES families who are most price sensitive.

Youth obesity risk also can be reduced by increasing economic and physical access to more healthful foods. Our research demonstrated that lower fruit and vegetable prices were significantly associated with lower BMI among children and adolescents, particularly among teens at the upper end of the BMI distribution and for low-SES children. These findings are consistent with recent work that focused on younger children (39). Overall, this evidence suggests that fiscal pricing interventions to improve economic access to healthful foods, such as subsidies for fruits and vegetables, can be effective in helping to reduce the risk of obesity among youth.

In terms of the potential to reduce obesity risk by increasing physical access to healthful food outlets such as supermarkets, the evidence was mixed. In most but not all of our studies, we found that increased access to supermarkets was significantly associated with lower BMI among adolescents and children, particularly for low-SES children. There is limited comparative evidence on this for youths; however, for adults, the evidence is similarly mixed, although there appears to be a consensus that increased supermarket availability is associated with a higher quality diet and better weight outcomes (11,40). This evidence suggests that policy efforts to improve access to supermarkets may contribute to healthier weight outcomes.

Findings reviewed in this paper drew on external price and outlet density data that, although used extensively by our research team and other researchers (10) because of their national coverage, are subject to several limitations. With respect to the ACCRA price data, the data are reported for just over 300 larger cities and metropolitan statistical areas and are not available at more local geographic levels; the collection of price data is based on establishment samples that reflect a mid-management (higher) standard of living; the same cities are not necessarily continuously sampled; and only a limited number of food items are surveyed, limiting their representativeness across food groups. The outlet density data drawn from D&B are subject to both count and classification errors that may bias study findings.

In our ongoing research on these issues as part of the Bridging the Gap program, we are attempting to overcome these limitations. Our research team is currently undertaking a large-scale validation study in ~400 census tracks stratified by SES, race, ethnicity, and urbanicity where we are ground-truthing food store and restaurant outlets to assess both count and classification errors in D&B and InfoUSA, the 2 most widely used commercial outlet data sources. The findings from this study will help researchers to better assess the usefulness of such sources. In addition, beginning in 2010, we will be collecting the ground pricing and outlet availability measures (and a host of other measures) in the communities around the MTF schools for use in analyses linked to the MTF individual-level adolescent surveys to provide additional empirical evidence on the associations between prices and availability and adolescent behavior and weight outcomes. For example, not available using commercial outlet data, the on-the-ground field data collection will obtain information on the availability of healthy vs. less healthy food and beverage items within specific types of outlets.

Despite its limitations, our research and that of other researchers consistently demonstrates the importance of economic contextual factors in influencing food consumption and weight outcomes. However, given the relatively modest price elasticity measures, small taxes or subsidies are not likely to yield substantial changes in BMI or obesity prevalence, although such interventions can have a larger impact at the population level. In addition, pricing interventions may be particularly effective among low-SES children and adolescents and those most at risk for overweight. The empirical evidence supports a combined strategy of changing relative prices by both taxing less healthy energy-dense foods and subsidizing less dense healthful foods. Findings from this research are being used to support a range of policy interventions, such as taxes on sugar-sweetened beverages and junk foods, subsidies for fruit and vegetable purchases made through food assistance programs, tax breaks for supermarkets to locate in so-called food deserts, and increased acceptance of food stamps at farmers markets. The natural experiments that result from these and other policy changes are providing unique opportunities for researchers to further improve the understanding of how changes in prices and availability affect consumption choices and weight outcomes among children, adolescents, and adults. Evidence based on continued research in this area will be important for developing appropriate policies to help reverse the obesity epidemic in the U.S. and other countries.

Acknowledgments
L.P., E.H., and F.C. contributed to the research, manuscript preparation, and writing of the paper. L.P. had primary responsibility for writing the paper and the final content. All authors read and approved the final manuscript.

Literature Cited