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An economic analysis of community-level fast food prices and individual-level fast food intake: A longitudinal study

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ABSTRACT

Background: While dietary intake is shaped by cost, there is minimal research on the association between community-level food prices and dietary intake.
Methods: We used nationally representative, longitudinal data to examine how community-level food price variation was associated with individual-level fast food intake by race/ethnicity and income across waves II (1996) and III (2001–2002) of the National Longitudinal Study of Adolescent Health ($n=11{,}088$) from 158 baseline and 363 follow-up US counties.
Results: Negative binomial regression models predicting the number of fast food meals per week show strong relationships between fast food consumption and prices of fast food and soda that varied by gender and race/ethnicity. We found relatively stronger association between food prices and fast food intake for males and relatively greater price sensitivity for soda versus burgers. In the group with strongest associations (black males), a 20% increase in the price of soda was associated with a decrease of 0.25 visits to a fast food restaurant per week.
Conclusions: Economic incentives may be an effective mechanism to address fast food intake in an age group at high risk for obesity.

1. Introduction

Food prices are increasingly a topic of interest in terms of economic strategies or incentives for healthy dietary intake. Recently, several researchers have examined the association between food prices and obesity (Chou et al., 2004; Cawley, 2004; Lakdawalla and Philipson, 2002; Powell and Chaloupka, 2009), yet these studies are largely cross-sectional and ignore direct associations with dietary intake. Others have examined cross-sectional associations between regional food prices and consumption of selected foods (Darmon et al., 2003; Drewnowski and Darmon 2005b; Cox and Wohlgenant, 1986). One recent study examined fast food prices and obesity (Powell, 2009) and another recent study investigated the association of food prices with energy intake, weight, and diabetes risk over a 20-year period (Duffey et al., 2010).

Yet there has been minimal research linking community-level food prices to individual-level dietary behaviors and overall food consumption patterns. The earlier USDA surveys as well as the National Health and Nutrition Examination Survey do not allow food price data to be linked to individual level data at small geographic levels (e.g., many deal with state-level prices). Yet, data from experimental studies show that food price is one of the most influential factors in determining food choice, second only to taste (Shannon et al., 2002; Glanz et al., 1998; French, 2003; Epstein et al., 2006, 2007).

Further, there is a large agricultural economics literature that addresses the association of food price data with dietary behavior, food production, and overall food expenditure and consumption, yet this work is focused on commodity- and brand-level demand (Frazao, 1999; Timmer et al., 1984). Of particular relevance is the differential association between food prices and dietary intake across income levels as individuals of low income are typically more sensitive to changes in food price (Chung and Myers, 1999; Macdonald and Nelson Jr., 1991; Stewart et al., 2004; Stewart et al., 2003; Popkin, 2008) and tend to have less varied, lower quality diets compared to higher income consumers (Hulshof et al., 2003). A range of small studies suggest that food expenditure patterns for high-priced healthier products is associated with reductions in fruit, vegetable, and dairy consumption among low income families (Chung and Myers, 1999; Kirkpatrick and Tarasuk, 2003; Guo et al., 1999). However, there are still major gaps in the literature and a recent review called for studies estimating price effects and responsiveness among at risk populations, particularly low-income and ethnic minority populations (Andreyeva et al., 2009).

This study capitalizes on data from a large, ethnically diverse and nationally representative longitudinal cohort across the age

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period between adolescence and young adulthood, a period of heightened risk for obesity incidence (Gordon-Larsen et al., 2004). Individual-level survey data were spatially and temporally linked to community food price data at the county level from the Council for Community and Economic Research, a resource widely used in studies of cigarette prices and tobacco consumption (Chaloupka et al., 2002; Grossman and Chaloupka, 1997; Liang et al., 2003; Grossman, 1989; Young and Bielinska-Kwapisz, 2003) and associations between community-level prices of select foods and related individual-level dietary consumption of fast foods were estimated with attention to variation by race/ethnicity and income.

2. Methods

2.1. Study population

Data are from waves II (1996) and III (2001–2002) of the National Longitudinal Study of Adolescent Health (Add Health), a cohort study of 20,745 adolescents representative of the U.S. school-based population in grades 7 to 12 (11–22 years of age) in 1994–1995 followed into wave II (12–22 years) and wave III (18–28 years). Add Health included a core sample plus subsamples of selected minority and other groupings collected under protocols approved by the Institutional Review Board at the University of North Carolina at Chapel Hill. The survey design and sampling frame, which includes following the school-aged population at waves I and II and the full baseline sample at wave III have been discussed elsewhere (Gordon-Larsen et al., 1999; Miller et al., 2004). A Geographic Information System (GIS) was used to link time-varying community-level data at the county-level to Add Health respondent residential locations at each wave as reported elsewhere (Boone-Heinonen et al., 2010a). Respondent residential locations were linked to attributes from time-matched price data (described below), which were merged with individual-level Add Health interview responses. We include measures from 18,405 unique individuals seen at one or both waves II and III (16,604 in wave II and 14,569 in wave III), with a total of 11,088 who were seen at both waves II and III. Data are available at the census tract level, which average approximately 4000 inhabitants and are designed to be relatively homogeneous in terms of population characteristics. Data are also available at the county level, a county is a geographic subdivision of a state that is generally assigned governmental authority. In the U.S., the average number of counties per state is 62. These geographic coverage increases over time from baseline counties [$N=158$] and tracts [$N=850$] into follow up counties [$N=363$] and tracts [$N=2714$]. The average number of respondents per county was 131.3 at wave I and 133.3 at wave III.

2.2. County-level food prices

County-level food price data were compiled by, and downloaded from, the Council for Community and Economic Research (C2ER, formerly the American Chamber of Commerce Research Association). Conducted quarterly for approximately 300 U.S. communities, this survey provides price levels for more than 60 consumer goods and services across participating metropolitan and nonmetropolitan areas. The C2ER data represent the most comprehensive national community-level food price data available and have been used widely in studies of tobacco pricing and smoking behavior (Chaloupka et al., 2002; Grossman and Chaloupka, 1997). Grocery items (i.e., specific foods, beverages), fast food items, cost of living and overall price indices, and cigarette prices have been collected as part of the Inter-City Cost of Living Index, published quarterly since 1968 for 300 U.S. cities (Christian and Rashad, 2009). For cities across the country, prices are collected for a variety of goods and services, including grocery prices, average utility costs, health care, and miscellaneous items such as the price of a haircut or cost of dry cleaning. From the available price data, we used: soda (cost for a 2 L (L) bottle) and hamburger (1.4 pound (lb) burger, purchased away-from-home) since these foods are related to fast food intake. We also include the consumer price index (CPI) as a control measure. The CPI represents changes in prices of all goods and services purchased for consumption by urban households, including user fees and sales and excise taxes, but excluding income taxes (Gordon-Larsen et al., 2009). The overall CPI is typically preferred to food specific CPI values because it controls for total cost of living (Christian and Rashad, 2009; Duffey et al., 2008). The mean CPI across all analytical communities was 1.86 at baseline (1996) and 1.78 at follow-up (2001), which is interpreted in relative terms of a one-dollar purchase at the index base period (1982–1984) versus at each study period: 1996: $1.86 and 2001: $1.78. Given that we follow individuals over time regardless of residential movement and a portion of the sample moves residences over time, some of the changes in prices simply reflect changes in community of residence over time, rather than true declines in prices (the number of countries represented more than doubled between wave II and wave III). However, there is evidence of variation in food prices over time, with disproportionate stability of specific types of foods, such as carbonated drinks, fats and oils, and sugar and sweets, while prices of fresh fruits and vegetables have had a steep increase over the past two decades in the U.S. (Popkin, 2011) .

We also include a selection of prices of hypothesized complimentary and substitution (replacement) foods and beverages, which differ based on the food being examined, and include: whole milk (cost for one-half gallon), pizza (12–13 inch cheese, thin crust purchased away-from-home), steak (cost of 1 lb., USDA choice), and fried chicken (cost of 2 pieces, thigh and drumstick, purchased away-from-home). We use these complimentary and substitution food price data as control variables in the models. In addition, we include the consumer price index as another price control in statistical models.

All prices were expressed in real terms using 2006, quarter 3 (index=100%) as the baseline. The C2ER price data were linked to Add Health respondents temporally (based on the year and quarter of Add Health exam dates) and spatially at the county level (based on the respondent's residential location at each time point). For respondents for whom there was not a direct match between residential location, C2ER county, and year in which food price data were collected, prices were imputed (6344 observations, 30%) using food price data at larger aggregate level (county-averaged C2ER values in counties with more than one C2ER centroid) and adjacent quarter using a method that takes into account spatial and temporal missing data and has been published widely (Duffey et al., 2010; Chou et al., 2004; Grossman, 1989; Grossman and Chaloupka, 1997; Raper, 1999). For example, if a respondent's residential location had a single matching county indicator code and price data were available for the year and quarter in which the respondent was surveyed, prices from that matching county were assigned to the respondent. Model-based tests of statistical significance of imputed price data showed no statistical difference based on imputed versus non-imputed price data; thus both were retained in the final models.

2.3. Individual-level self-reported behaviors and sociodemographics

Consumption of fast food was quantified from participant responses to the following question at waves II and III: in the last