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Food prices and body fatness among youths

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ABSTRACT

We examine the effect of food prices on clinical measures of obesity, including body mass index (BMI) and percentage body fat (PBF) measures derived from bioelectrical impedance analysis (BIA) and dual energy X-ray absorptiometry (DXA), among youths ages 12 through 18 in the National Health and Nutrition Examination Survey. This is the first study to consider clinically measured levels of body composition rather than BMI to investigate the effects of food prices on obesity outcomes among youths classified by gender and race/ethnicity. Our findings suggest that increases in the real price per calorie of food for home consumption and the real price of fast-food restaurant food lead to improvements in obesity outcomes among youths. We also find that a rise in the real price of fruits and vegetables leads to increased obesity. Finally, our results indicate that measures of PBF derived from BIA and DXA are no less sensitive and in some cases more sensitive to the prices just mentioned than BMI, and serve an important role in demonstrating that rising food prices (except fruit and vegetable prices) are indeed associated with reductions in obesity rather than with reductions in body size proportions alone.

1. Introduction

The prevalence of childhood obesity has increased at an alarming rate in the U.S. over the last three decades. Since the mid-1970s, the proportion of children aged 12–19 who are obese has grown from 5.0 to 18.1 percent and has grown more rapidly among non-Hispanic black adolescents than among Hispanic or non-Hispanic white adolescents (Ogden et al., 2010a,b). The growing prevalence and the racial/ethnic disparities in childhood obesity are of major concern to public health, given that obese children are more likely to develop health problems, such as high blood pressure, hypertension, gallbladder disease, and Type 2 diabetes as early as adolescence (Serdula et al., 1993; Freedman et al., 1999, 2007; Hill et al., 2006). Furthermore, obese children are more likely to experience negative long-term psychological and labor market outcomes ranging from poor self-esteem and depression to discrimination and lower wages (Daniels, 2006; Mocan and Tekin, 2011; Dietz, 1998; Strauss, 2000). Wang and Dietz (2002) estimate that hospital expenditures related to childhood obesity rose from $35 million in the late-1980s to $127 million (in 2001 constant dollars) in the late-1990s. Both the Institute of Medicine (2004) and *Healthy People 2020* (U.S. Department of Health and Human Services, 2010) identify the prevention of childhood obesity, particularly among disadvantaged groups, as a top public health priority.

Public interventions for improving child and adolescent health typically take the form of policies that limit access and provide price incentives and disincentives (Grossman, 2005). Raising price through taxation has been shown to be highly effective at reducing substance use among adolescents (e.g., Grossman, 2005; Brownell and Frieden, 2009; Engelhard et al., 2009). Likewise, selective applications of

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taxation and subsidies may shift food consumption away from unhealthy food and toward healthier alternatives (Cawley, 2010; Powell and Chaloupka, 2009). The falling real cost of food has been suspected of being a contributing factor in the recent epidemic of obesity (e.g., Lakdawalla and Philipson, 2002; Chou et al., 2004, 2008). In general, empirical studies that recently examined the effects of prices on obesity (e.g., Chou et al., 2004, 2008; Rashad et al., 2006; Powell and Yanjun, 2007; Powell, 2009; Powell et al., 2007; Auld and Powell, 2009; Sturm and Datar, 2005) found larger and more significant effects than studies that examined the effects of food taxes (Powell et al., 2009; Fletcher et al., 2010).

These studies typically attach location and year-specific prices or taxes to a variety of micro data sets and further include location and year fixed effects in regression analyses. The geographic unit of analysis is mostly states, but several studies focus on counties, cities, or even zip codes. These price variables usually include price indices of meals in fast-food and full-service restaurants, and an index of the price of food prepared at home. Prices of foods for consumption at home are decomposed into prices of foods with low energy densities, defined as low calories per pound of consumption (for example, fruits and vegetables) and those with high energy densities (for example, fast food). There is reasonably consistent evidence that fruit and vegetable prices, particularly non-starch variety, are associated with lower weight outcomes while fast-food prices are associated with higher weight outcomes for the adolescent population (Powell et al., 2013). These effects tend to be larger for minorities, children in lower-income families, and children whose mothers have less than a high school education. Some, but not all, of these results are based on BMI-measures of obesity calculated from self- or parental-reports of height and weight. A child or youth is classified as obese if his or her BMI is at or above the 95th percentile based on age- and gender-specific growth charts.

However, none of the results just mentioned are based on clinically measured levels of body fatness. The standard measure used in these studies is based on BMI, which is defined as weight in kilograms divided by height in meters squared. The advantage of BMI is that it is easy to calculate and readily available from many social science datasets but its reliability for use in epidemiological studies has come into question recently. Some of the weak or mixed results found by studies using BMI may be due to its limited ability to correctly distinguish body fat from lean body mass (e.g., Yusuf et al., 2004, 2005; Romero-Corral et al., 2006, 2007). Since it is body fat (and not fat-free mass) that is responsible for the detrimental health effects of obesity, several studies caution against a sole reliance on BMI and point to a need for using direct measures of body composition in obesity studies (e.g., Smalley et al., 1990; Romero-Corral et al., 2006).

Furthermore, the inability of BMI to correctly distinguish body fat from lean body mass could result in cases of false positives (Wada, 2007). That is, the previously documented relationship between BMI and food prices may be due in part to the relationship between these prices and lean body mass or external body size proportions rather than body fatness per se. Thus, it is not enough to document that rising food prices lead to smaller body size without investigating whether they lead to lower body fatness. The possibility of false positives through reductions in lean body mass is an important consideration for public health and nutrition policy given that proposed food taxes may possibly increase childhood hunger and malnutrition instead of reducing childhood obesity (Zhang et al., 2013).

These concerns of reliability and false positives are particularly relevant for children and adolescents due to the gender differences in physical growth as well as the gender and racial differences in the association of BMI with a child's body fatness (e.g., Daniels et al., 1997). Consequently, several studies tested whether measures other than BMI can be used as valid measures for the detection of the degree of obesity in obese children and adolescents. Widhalm et al. (2001) used regression methods to assess the relationship between the percentage body fat and BMI along with several demographic characteristics from a sample of 105 obese boys and 99 obese girls. The authors concluded that BMI provides only limited insight to the degree of obesity for children ages 10 and over. Skybo and Ryan-Wenger (2003) recommend the use of body fat percentage for identification of overweight status in school-age children.

Another related limitation of the previous studies is using BMI calculated from self-reported values of height and weight may induce its own bias. Previous studies show considerable evidence of misreporting in weight and height (Rowland, 1989; Gorber et al., 2007). In an effort to determine the degree of agreement between self-reported and measured values of height and weight, Gorber et al. (2007) reviewed 64 studies and concluded that there was evidence for under-reporting for weight and BMI and over-reporting for height that varies between men and women.

In this paper, we use clinically obtained body composition measures to conduct a comprehensive analysis of the effects of various food prices on body fatness among youths ages 12 through 18 and compare the sensitivity of our findings against results using BMI. This is the first study to consider clinically measured levels of body composition to investigate the effects of food prices on body fatness among youths. The body composition measure that we employ is the percentage body fat (PBF).[1] The PBF measure is derived from three separate sources, two of which rely upon bioelectrical impedance analysis (BIA) and one of which relies upon dual energy X-ray absorptiometry (DXA). We also employ clinically measured height and weight to estimate the effects of prices on BMI. We employ data from the restricted-use versions of NHANES to merge various county-level time-varying price variables.

Our findings have implications for the optimal targeting of public policies designed to prevent or reduce childhood obesity, including the extent to which changes in farm, tax,

[1] Note that $PBF \equiv 100 \times \frac{BF}{W} \equiv 100 \times \frac{W-FFM}{W}$, where W is weight, BF is body fat and FFM is fat-free mass.