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Food prices and blood cholesterol☆

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ABSTRACT

Cardiovascular diseases (CVD) cost Americans billions of dollars per year. High cholesterol levels, which are closely related to dietary habits, are a major contributor to CVD. In this article, we study whether changes in food prices are related to cholesterol levels and whether taxes or subsidies on particular foods would be effective in lowering cholesterol levels and, consequently, CVD costs. We find that prices of vegetables, processed foods, whole milk and whole grains are significantly associated with blood cholesterol levels. Having analyzed the costs and benefits of government interventions, we find that a subsidy of vegetables and whole grains would be an efficient way to reduce CVD expenditures.

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1. Introduction

It is well known that Americans consume too much fat (especially saturated fat), sodium, and sugar, and not enough fiber, fresh fruits and vegetables, and whole grains. The effects of these dietary patterns are evident in the prevalence of adverse health conditions in the United States, including obesity, diabetes, and heart disease, all of which come with substantial direct costs. By one recent estimate, for example, the direct cost of obesity alone in the United States in 2006 was roughly $85 billion (Finkelstein et al., 2009).[1] The American Diabetes Association estimates direct costs due to diabetes in 2007 at $116 billion (American Diabetes Association, 2003). Although none of these conditions can be said to arise from the food environment alone, policy discussions aimed at addressing them have focused on the food environment – and particularly food prices – as a way of affecting behavior. Studies of the effect of food prices on obesity have been particularly prominent in this context (Sturm and Datar, 2005; Buttet and Dolar, 2008; Schroeter et al., 2008; Duffey et al., 2010; Apovian, 2004).

Perhaps because obesity is a kind of "oracle condition" that presages the development of a host of serious chronic conditions – diabetes, hypertension, heart disease, some kinds of cancer – there has been less research on the relationship between food prices and these conditions or their mediating factors, notable exceptions notwithstanding (Meyerhoefer and Leibtag, 2010). A case in point that we address here is dyslipidemia, an imbalance in blood fats, particularly cholesterol. Although there is some debate about what measure of cholesterol best registers the risk of cardiovascular disease (CVD) and cardiovascular events (CVE) such as heart attacks, there is no disagreement about the strong correlation between cholesterol levels and heart disease. In fact, the relationship between obesity and CVD is often mediated by dyslipidemia (Ogden et al., 2007).

To date, the policy implications of this question have largely been addressed through proposals for a "fat tax"; studies focused on this possibility have usually concluded

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[1] See, for alternate measures of indirect and direct costs of adult obesity in Germany, Wolfenstetter (2011); estimates of differences in child healthcare usage and spending have been found to be higher also. See Breitfelder et al. (2011).

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that most reasonable fat tax regimes would lead to a modest improvement in health (Powell and Chaloupka, 2009). (This result is not surprising given more recent studies of trends in food prices during the time in question – which appear to be flat or only modestly declining (Christian and Rashad, 2009).) Rather than focusing on a "fat tax" exclusively, however, in this paper we focus on the way that prices for a broad array of food at home (FAH) products might affect blood serum cholesterol levels. We focus on this because levels of blood cholesterol depend not only on the price of fat and fat substitutes, but also on prices for other foods such as whole grains or fresh vegetables. From a policy perspective, we are interested in the most effective method for addressing blood cholesterol, which may involve a subsidy on healthy foods as well as a tax on less healthy foods and may be applied to other than the usual food suspects (i.e. meat and dairy products).

Our results suggest, first, that levels of bad cholesterol are sensitive to the prices of vegetables, whole grains, processed foods and whole milk products. For example, we find that a 10% increase in the price of vegetables is associated with an increase of about one-half a standard deviation of serum non-HDL-C, our measure of unhealthy blood cholesterol. Based on our results, we calculate the costs and benefits of price interventions using the estimated effects of serum cholesterol on the risk of CVD from the medical literature, estimates of national CVD expenditures, and estimates of the price elasticity of each of these food groups drawn from the demand literature. We conclude that a subsidy of whole grains would be the most effective way to reduce CVD expenditures and that a subsidy of vegetables would also be effective: both of these interventions would require relatively minor government intervention in food markets. Taxation of processed foods and whole milk products would also lead to large reductions in CVD expenditure, but at the cost of much larger government intervention.

2. Background: cholesterol

Cholesterol is necessary for maintaining life and is used in all cells of the body; it helps to absorb and digest fat and plays a crucial role in the formation of Vitamin D. However, higher cholesterol levels have long been associated with a higher risk of CVD. If there is too much serum (blood) cholesterol, it tends to accumulate on the walls of the blood vessels, forming plaque and narrowing the blood vessels, which in some cases produces heart attack, stroke, and blood clotting (Greenly, 2002).

Although cholesterol is frequently spoken of in general terms, there are two kinds of cholesterol, conventionally defined. High-density lipoprotein cholesterol (HDL-C) is sometimes called good cholesterol because it is usually carried from the cells to liver for excretion or reutilization. Low-density lipoprotein cholesterol (LDL-C), on the other hand, is bad cholesterol because it is carried to the cells in the body and frequently adheres to the walls of the arteries. LDL-C, together with very-low density lipoprotein cholesterol (VLDL-C) and intermediate density lipoprotein, forms non-HDL cholesterol, held by many authorities to be the best cholesterol predictor of CVD (Sniderman et al., 2010). While the human body naturally produces cholesterol for normal functions, diet has a significant effect on the amount of serum cholesterol. Consumption of saturated and trans-fats tends to increase LDL cholesterol, while the consumption of whole grains and fiber modestly decrease it (Lichtenstein et al., 2006). Consumption of plant-based foods, including vegetables, fruits and nuts, also tends to decrease LDL cholesterol (Hu, 2009). Foods with simple carbohydrates (such as refined flour) tend to increase VLDL-C (McKeown et al., 2009).

3. Data

To assess the effect of food prices on the blood cholesterol levels, we combine individual information from the National Health and Nutrition Examination Survey (NHANES) and food price information from the Quarterly Food At Home Price Database (QFAHPD).

The QFAHPD was constructed using Nielsen Homescan data in which households report all of their food-at-home purchases from all store outlets, including grocery stores, discount stores, mass merchandisers, club stores, and convenience stores (Todd et al., 2010). Nielsen Homescan survey tracks the food purchases by 40,000 US households, and also provides weights to make the sample nationally representative for a given year. Households were grouped into 35 geographic market groups from 48 contiguous states. The QFAHPD is formed using prices reported by households in their respective regions (see Fig. 1).

Foods items in QFAHPD are divided into 52 groups based on USDA Dietary Guidelines for Americans and convenience premiums for certain kinds of processing – i.e. frozen and ready-to-cook. The database provides the average price per 100 g for each food group for each quarter in each market group. We drop two food groups, whole grain mixes and frozen whole grains, from the analysis because consumers rarely purchase these products and their inclusion would result in a large number of missing observations.

We aggregate QFAHPD foods into 14 groups: fruits, vegetables, sweets, eggs, nuts and oils, regular fat red meat, low-fat red meat, fish, poultry, refined grains, processed foods, low-fat milk products, regular-fat milk products and whole grains.[2] To arrive at a price for each of these goods, we use a weighted mean of the price of each component of the QFAHPD goods, where the weights are annual shares of total expenditure on the QFAHPD good within our 14 categories. As an example of the aggregation process, consider the case of vegetables, of which the QFAHPD has 6 categories: dark green, orange, starchy, select nutrient, legumes, and other. For all but legumes, these groups are further divided into fresh/frozen and canned; legumes are divided into fresh/dried and canned. To get a market price for a particular quarter and market group of vegetables, we use a weighted average of all the prices in the vegetable group. Total yearly national expenditure for each of the 12 categories of vegetables is the weight applied to each.

[2] The price for each of these twelve food groups is constructed as the expenditure-weighted average of the component prices, by quarter and market group. For more on the QFAHPD, see Todd et al. (2010).