

Exploring a fiscal food policy: the case of diet and ischaemic heart disease

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Diet determines cholesterol concentrations, and cholesterol concentrations determine the prevalence of ischaemic heart disease. This paper explores the potential effects of fiscal measures on diet and ischaemic heart disease. There is a clear economic rationale for this approach: the correction of market failure caused by externalities. Externalities are said to occur when some of the costs of consumption are not borne by the consumer. When ischaemic heart disease strikes, there are costs to the community (productivity losses or indirect costs) and to the health service (direct costs). A case can therefore be made for using taxation to compensate for the external costs of an atherogenic diet.

Diet, cholesterol concentrations, and ischaemic heart disease

The relation between diet, serum cholesterol concentrations, and ischaemic heart disease is relatively well understood. In individuals, serum cholesterol concentrations—or more specifically, the ratio of low density lipoprotein to high density lipoprotein—are a major determinant of the risk of ischaemic heart disease. Serum cholesterol concentrations are largely determined by the proportion of dietary energy derived from saturated or polyunsaturated fats and by dietary intake of cholesterol. The Keys equation (box), which has recently been corroborated, describes this in a simple mathematical relationship.¹⁻³

In populations, average cholesterol concentration predicts the incidence of ischaemic heart disease. A rise of 0.6 mmol/l is associated with 38% increase in ischaemic heart disease mortality; an equivalent fall results in a 25-30% fall in the incidence of ischaemic heart disease within five years.^{4,5} In a meta-analysis, 80% of international variation in ischaemic heart disease was attributed to variation in serum cholesterol concentrations.⁴ Where average cholesterol concentra-

The Keys equation

Change in serum cholesterol concentration (mmol/l) = $0.031 \times (2D_s - D_{pu}) + 1.5vD_{ch}$
 D_s = change in percentage of dietary energy from saturated fats
 D_{pu} = change in percentage of dietary energy from polyunsaturated fats
 D_{ch} = change in dietary cholesterol intake

Summary points

Current dietary patterns are partly responsible for the high risk of ischaemic heart disease in Britain, in particular among low income groups; these dietary patterns are reinforced by the material constraints of poverty

Pricing of foodstuffs encourages the purchase and consumption of a cholesterol raising diet, particularly among people with tight food budgets

By extending value added tax to the main sources of dietary saturated fat, between 900 and 1000 premature deaths a year might be avoided

The additional tax revenue could finance compensatory measures to raise income for low income groups

Econometric and health policy research should investigate the effects of price changes on diet and health

tions have changed, the incidence of ischaemic heart disease has fallen by the predicted amount.⁶ The fall in relative risk of ischaemic heart disease is greater in younger age groups (an estimated 54% at age 40, 39% at age 50, 27% at age 60, 20% at age 70, and 19% at age 80 for an 0.6mmol/l fall in cholesterol concentration), and the effects in women seem to be broadly similar to those in men.⁴ Because lowering cholesterol from any initial value has benefits, all income groups would experience some benefits.⁷

Sources of saturated fat in the British diet

The main sources of saturated fat in the diet in the United Kingdom are whole milk, butter, and cheese (table 1).⁸ Isocaloric substitution of these foodstuffs—substitution with alternatives providing the same dietary energy in the form of carbohydrate, monounsaturated fats, or polyunsaturated fats—would lower cholesterol concentrations. Table 2 illustrates the effects of replacing half of the intake of these foodstuffs with alternatives containing monounsaturated fats or

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Table 1 Main sources of saturated fat in the British diet

Foodstuff	Contribution to total dietary saturated fat (%)		
	Men	Women	All
Whole milk	11	12	11
Cheese	9	9	9
Butter	9	11	10
Biscuits	4	4	4
Buns, cakes, and pastries	5	6	6
Puddings and ice cream	4	4	4
Total from these six sources	42	46	44

carbohydrates. The effect would be to lower cholesterol concentrations by 0.2 mmol/l and the incidence of ischaemic heart disease by between 7.6% and 10.9%.

The limits of informed consumer choice

In recent years the dietary gap between the rich and poor has widened.⁹ This is hardly surprising. Important financial, material, and cultural constraints prevent people on low incomes from acting on dietary information. There is also considerable disinformation concerning diet and ischaemic heart disease.¹⁰ Relying on informed consumer choice alone is therefore likely to widen differentials in nutrition between the rich (who have the means to act on information) and the poor (who do not). Is there another way?

Economic models of demand for foodstuffs

As dietary foodstuffs are purchased, it follows that the total contribution of a foodstuff to diet is likely to be proportional to consumer demand. In economic models, demand for a good is a function of its own price, the price of other goods, overall purchasing power (income), and “consumer taste.” One model of demand (which is supported by empirical data) says that the demand for certain broad categories of consumption goods is “separable.”¹¹ This means that a change in the price of goods unrelated to foodstuffs (such as housing or clothes) will affect demand for foodstuffs in much the same way as a change in overall income. For example, if housing became cheaper, it would affect demand for foodstuffs in the same way as an increase in income. This means that demand for different kinds of foodstuffs is affected mainly by their relative prices and

by the “food budget,” the amount of household income available to be spent on food.

Two strategies for improving nutrition emerge from this discussion. Firstly, increasing the food budget will improve nutrition, as higher income groups in Britain typically have more nutritious food consumption patterns.⁹ Secondly, systematically altering the relative prices of different foodstuffs will affect food consumption.

Estimating the effects of price changes

Consumer goods that have near substitutes have a high price elasticity of demand—that is, a small proportionate increase in the price leads to a large proportionate change in demand. Small changes in the relative prices of near substitutes can lead to large changes in consumption patterns. For example, a small price difference (about 10%) between leaded and unleaded petrol was sufficient to cause a considerable shift to unleaded petrol and to encourage manufacturers to produce cars that could use the cheaper fuel. Using price changes to alter food consumption is therefore most likely to be effective where foodstuffs have a high price elasticity of demand. It may even stimulate manufacturers to produce cholesterol lowering or cholesterol neutral foodstuffs.

There is little information in the public domain on the specific price elasticities of whole milk, butter, cheese, biscuits, buns, cakes and pastries, puddings, and ice cream. In the absence of empirical data we have to make some judicious estimates. In general, foodstuffs tend to have price elasticities of a magnitude of less than one.¹² Price elasticities are likely to be larger where there are near substitutes. Given that reduced fat milks are near substitutes for whole milk, let us assume that the price elasticity of demand for whole milk is near to -1.0 . This means that a 1% increase in price would lead to a 1% fall in consumption. Margarine is an acceptable substitute for butter: we can assume a smaller price elasticity for butter, perhaps -0.7 . Reasonable substitutes—with more polyunsaturated fat and less saturated fat—for biscuits, buns, cakes and pastries, puddings, and ice cream can be manufactured. We can assume a high price elasticity of demand, perhaps -1.0 . There is, however, no cholesterol neutral substitute for cheese, and it is likely that the price elasticity is low, perhaps -0.5 .

Table 2 Effect of a 50% isocaloric substitution of key foodstuffs with alternatives containing no saturated fat^a

Foodstuff	% Dietary saturates*	% Dietary calories†	% Reduction in saturates‡	Fall in serum cholesterol§		% Reduction in ischaemic heart disease¶	
				Clarke	Keys	Minimum	Maximum
Whole milk	11	1.75	0.88	0.046	0.054	1.9	2.7
Cheese	9	1.44	0.72	0.037	0.045	1.6	2.2
Butter	10	1.60	0.80	0.041	0.049	1.7	2.5
Biscuits	4	0.64	0.32	0.017	0.020	0.7	1.0
Buns, cakes, and pastries	6	0.96	0.48	0.025	0.030	1.0	1.5
Puddings and ice cream	4	0.64	0.32	0.017	0.020	0.7	1.0
Total of above	44	7.02	3.51	0.182	0.218	7.6	10.9

*Percentage of saturated fat in the average UK diet accounted for by this foodstuff.

†Percentage of dietary energy derived from saturated fat of this origin.

‡Reduction in saturated fat from substituting half of this foodstuff with an alternative.

§Clarke=fall in cholesterol (mmol/l) resulting from this change in diet (Clarke coefficients)³; Keys=fall in cholesterol (mmol/l) resulting from this change in diet (Keys coefficients).¹

¶Minimum calculated using Clarke's coefficients and Law's lower estimate of effect on ischaemic heart disease^{3,4}; maximum calculated using Keys' equation and Law's upper estimate of effect on ischaemic heart disease.^{1,4}

Table 3 Effect of extending value added tax at 17.5% to the main sources of dietary saturated fat on the incidence of ischaemic heart disease

Foodstuff	Price elasticity of demand	% Reduction in dietary calories from saturates	Fall in serum cholesterol		% Reduction in ischaemic heart disease*	
			Clarke	Keys	Minimum	Maximum
Whole milk†	-1.0	0.15	0.010	0.012	0.4	0.6
Cheese	-0.5	0.13	0.008	0.010	0.3	0.5
Butter	-0.7	0.20	0.013	0.015	0.5	0.8
Biscuits	-1.0	0.06	0.004	0.004	0.2	0.2
Buns, cakes, and pastries†	-1.0	0.08	0.005	0.006	0.2	0.3
Puddings and ice cream†	-1.0	0.06	0.004	0.004	0.2	0.2
Total	—	0.67	0.044	0.052	1.8	2.6

*Minimum calculated using Clarke's coefficients and Law's lower estimate of effect on ischaemic heart disease^{3, 4}; maximum calculated using Keys' equation and Law's upper estimate of effect on ischaemic heart disease.^{1, 4}

†Substitutes for these foodstuffs are assumed to contain half as much saturated fat, eg whole milk is substituted with semiskimmed milk.

At present most foodstuffs are exempt from value added tax. The simplest way of changing prices within the existing taxation framework would be to extend value added tax (currently 17.5%) to the principal sources of dietary saturated fat while exempting cholesterol neutral foods that are currently taxed (such as orange juice and low fat frozen yoghurt). Whole milk is likely to be substituted with semiskimmed milk, so that saturated fat intake will fall by half the overall reduction in consumption. Margarines rich in polyunsaturates have a neutral effect on cholesterol, so substitution reduces cholesterol concentrations proportionately. Biscuits, buns, cakes and pastries, puddings, and ice cream could be taxed if they raised cholesterol concentrations but exempt if the ratio of polyunsaturates to saturates (and *trans* fatty acids) were more favourable. Realistically, substitutes would also be likely to be cholesterol raising, so intake of saturated fat would fall by half the overall reduction in consumption. As table 3 shows, with these substitutions the incidence of ischaemic heart disease falls by between 1.8% and 2.6%. Given a proportionate fall in ischaemic heart disease mortality, this would prevent between 1800 and 2500 deaths a year, between 900 and 1300 of these in people aged under 75.¹³ Using the age specific reductions in ischaemic heart disease given above (a proxy for age specific mortality reductions) gives a similar estimate: about 900 to 1000 deaths are avoided in people under 75 (table 4).⁴

Equity

Taxation is a blunt instrument. Because poor people spend a greater proportion of their income on food than rich people, they are likely to be more sensitive to price changes. They are also at higher risk of ischaemic heart disease. The health benefits of such a policy are

therefore likely to be progressive. Paradoxically, this also means that the effects on material wellbeing are likely to be regressive. Most consumers will end up by spending more on food and this will disproportionately affect the poor. An important part of such a strategy should therefore be to compensate low income groups by raising their incomes. The most directly targeted approach would be to simultaneously raise the value of welfare benefits, particularly those intended for children in low income groups, who are in any case not the target of this policy. Since food taxation would raise revenue, the overall effect on government finances would be neutral.

Conclusions

The assumptions in this paper are somewhat conservative. No account is taken of the effect of raising low incomes or the likelihood that people at highest risk would benefit most. Price changes might increase the consumption of fruit and vegetables or reduce levels of obesity, but these considerations are beyond the scope of this paper. Given that there are potential benefits to a fiscal food policy, how politically feasible would such a policy be? In the short term the answer is probably "not at all," as the present government has pledged not to extend value added tax to foodstuffs. But in the longer term? The notion that taxation might be used to adjust for externalities is gaining currency among policymakers—for example, the "polluter pays" principle and road pricing to reduce congestion. Nor is the use of taxation to influence health new: since 1993 it has been policy to increase the real level of tobacco duties by 3% every year.¹⁴ Cigarette taxation raises the same dilemma regarding equity. Low income groups tend to smoke more and are more price sensitive than high income

Table 4 Estimated numbers of deaths due to ischaemic heart disease avoided by extending value added tax to sources of dietary saturated fat

Age band	% Fall in risk per 0.6 mmol/l fall in cholesterol	Total No of deaths*		Estimated No of deaths avoided†					
		Men	Women	Minimum			Maximum		
				% Fall in risk	Men	Women	% Fall in risk	Men	Women
35-44	54	865	157	4.0	34	6	4.7	40	7
45-54	39	3 662	715	2.9	104	20	3.4	124	24
55-64	27	9 332	2 900	2.0	184	57	2.3	218	68
65-74	20	21 507	10 915	1.5	315	160	1.7	372	189
75-84	19	24 788	23 018	1.4	345	320	1.6	407	378
Total		60 154	37 705		982	564		1161	666

*England and Wales, 1996.

†Minimum calculated using fall in cholesterol derived from Clarke's coefficients; maximum calculated using fall in cholesterol derived from Keys' equation.

groups. They therefore benefit the most from taxation, but disproportionately bear the tax burden.¹⁵

The nutritional and physiological parts of this model are relatively robust. The assumed relation between purchase of foodstuffs and food consumption is probably reasonable. The weak link is undoubtedly the assumed effects of price changes on purchase of foodstuffs. How reasonable are these assumptions? Could the impact of price changes be even greater? Neither searching economic research databases (Econ-Lit, BIDS IBSS) nor writing to major supermarkets produced estimates of price elasticities of demand for these foodstuffs. One supermarket hinted that the data existed but were commercially sensitive. Yet this information is essential. If we are serious about improving nutrition a fiscal food policy is worth exploring. Interdisciplinary collaboration is needed between economists and nutritionists to investigate empirically the effects of price changes on the purchase of foodstuffs.

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- 1 Keys A, Anderson J, Grande R. Serum cholesterol response to changes in the diet. IV. Particular saturated fats in the diet. *Metabolism* 1965;14:776-86.
- 2 Tang JL, Armitage JM, Lancaster T, Silagy CA, Fowler GH, Neil HAW. Systematic review of dietary intervention trials to lower blood total cholesterol in free-living subjects. *BMJ* 1998;316:1213-20.

- 3 Clarke R, Frost C, Collins R, Appleby P, Peto R. Dietary lipids and blood cholesterol: quantitative meta-analysis of metabolic ward studies. *BMJ* 1997;314:112-7.
- 4 Law MR, Wald NJ, Thompson SG. By how much and how quickly does reduction in serum cholesterol concentration lower risk of ischaemic heart disease? *BMJ* 1994;308:367-73.
- 5 Holme I. An analysis of randomized trials evaluating the effect of cholesterol reduction on total mortality and coronary heart disease incidence. *Circulation* 1990;82:1916-24.
- 6 Jousilahti P, Vartiainen E, Pekkanen J, Tuomilehto J, Sundvall J, Puska P. Serum cholesterol distribution and coronary heart disease risk: observations and predictions among middle-aged population in eastern Finland. *Circulation* 1998;97:1087-94.
- 7 Law MR, Thompson SG, Wald NJ. Assessing possible hazards of reducing serum cholesterol. *BMJ* 1994;308:373-9.
- 8 Gregory J, Foster K, Tyler H, Wisemann M. *The dietary and nutritional survey of British adults*. London: HMSO, 1990. (Office of Population Censuses and Surveys, Social Survey Division.)
- 9 James WPT, Ralph A, Leather S. Socioeconomic determinants of health: the contribution of nutrition to inequalities in health. *BMJ* 1997;314:1545-8.
- 10 Tunstall-Pedoe H. Did MONICA really say that? *BMJ* 1998;317:102.
- 11 Moschini G, Moro D, Green RD. Maintaining and testing separability in demand systems. *Am J Agric Econ* 1994;76:61-73.
- 12 Van Driel H, Nadall V, Zeelenberg K. The demand for food in the United States and the Netherlands: a systems approach with the CBS model. *J App Econometrics* 1997;12:509-23.
- 13 Office for National Statistics. *Mortality statistics: cause. England and Wales, 1996*. London: Stationery Office, 1998.
- 14 Townsend J. Policies to halve smoking deaths. *Addiction* 1993;88:37-46.
- 15 Townsend J, Roderick P, Cooper J. Cigarette smoking by socioeconomic group, sex, and age: effects of price, income, and health publicity. *BMJ* 1994;309:923-7.

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Commentary: Alternative nutrition outcomes using a fiscal food policy

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Tom Marshall lays out an intriguing approach to a complicated public health problem. However, without further analyses and field testing, we believe the ultimate result will be disappointing.

The relations of diet and disease—in particular, saturated fat and heart disease—have been well documented but are complex. The key determinant of how an individual responds to changes in fat and saturated fat is genetic. Thus there is a wide range of variation in response to lipid reduction strategies.¹ Though diet and behavioural factors (physical activity, smoking) can be modified, the net response of serum and low density lipoprotein cholesterol to dietary changes is often limited. Well controlled studies show mixed reactions to modification of diet. The recently completed multi-year dietary intervention study in children trial in high risk children aged 8-10 years illustrates this result. Children were put on a diet containing 29% of total calories as fat and 10% of total calories as saturated fat. The total diet modification had only a modest effect on total serum and low density lipoprotein cholesterol in children who participated for up to three years.² In light of this kind of evidence, one might question the levels of presumed impact contained in the Marshall article in which the dietary changes were in a small number of foods and on a more limited scale.

Marshall discusses isocaloric substitution of foodstuffs to maintain the energy density of the diet. This type of substitution often results in a more costly diet. For example, substitution of skimmed milk for full fat

milk would require about twice as much milk consumption to maintain the energy level in the diet. A recent paper indicates that individuals who reduce fat and saturated fat intake while maintaining the nutrient density of the diet do so by consuming a greater physical quantity of food.³

We also question Marshall's statement that there is a sizeable difference overall in the diets of the rich and poor. Recent nationally representative data from the United States indicates only minor differences in overall diet quality between the low income and higher income groups.⁴ The reasons for this include the increasing tendency for eating away from home for both rich and poor and the related difficulty of controlling intake of fat and saturated fat from foods either eaten or prepared outside the home.⁵

Marshall argues in favour of tax instruments for achieving public health impact. The effectiveness of the proposed extension of value added tax to the main sources of dietary fat depends on consumers' response to subsequent increases in prices of whole milk, butter, cheese, biscuits, buns, cakes and pastries, puddings, and ice cream. Price elasticities measure the response of quantities purchased to price changes. Marshall asserts there is little empirical evidence on the size of the relevant elasticities and assumes values reflecting relatively large responses to price changes. However, empirical evidence from the United States and Europe^{6,7} shows that these elasticities are much smaller (in absolute value) than Marshall assumes, implying much smaller decreases in quantities consumed in

response to an extension of value added tax. For example, Marshall's assumed elasticity of -1.0 for whole milk is eight times larger than that of Oskam.⁷ Oskam's estimated elasticity of -0.125 means that a 10% increase in the price of whole milk would decrease consumption by only 1.25%. If 17.5% value added tax were imposed on whole milk the reduction in dietary saturated fat would be 0.02% rather than the 0.15% estimated by Marshall (table 4). Further, estimates of cross-price elasticities (responses to changes in other food prices) suggest further dilution of the effect of value added tax on fat consumption as consumers adjust overall diets.

There are more consumer friendly interventions for improving diet that Marshall does not consider, such as the introduction of functional or fabricated foods that do not require a change in consumer dietary behaviour. A modified food is simply substituted for the traditional food. One recent possibility is new margarine produced using plant sterols derived from naturally occurring plant extracts. Hendriks et al recently found that consumption based on one to two servings of spread per day in adults decreased serum

cholesterol by 7-10%.⁸ At a similar cost, the functional foods provide an attractive means of reaching the consumer.

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- 1 Dreon DM, Fernstrom HA, Miller B, Krauss RM. Low-density lipoprotein subclass patterns and lipoprotein response to a reduced-fat diet in men. *FASEB J* 1994;8:121-6.
- 2 Writing Group for the DISC Collaborative Study. Efficacy and safety of lowering dietary intake of fat and cholesterol in children with elevated low-density lipoprotein cholesterol: the dietary intervention study in children (DISC). *JAMA* 1995;273:1429-36.
- 3 Kennedy ET, Ohls J, Carlson S, Fleming K. The healthy eating index: design and application. *J Am Diet Assoc* 1995;95:1103-8.
- 4 Kennedy ET, Bowman S, Powell R. Trends and patterns of fat consumption in the United States. *J Am Coll Nutr* 1999;18:207-12.
- 5 Lin B, Guthrie J, Frazao E. *Nutrient contribution of food away from home in America's eating habits: changes and consequences*. Washington, DC: US Department of Agriculture, 1999. (Economic Research Service Agricultural Information Bulletin No 750.)
- 6 Huang KS. *How economic factors influence the nutrient content of diets. An economic research service report*. Washington, DC: US Department of Agriculture Economic Research Service, 1997. (Technical bulletin No 1864.)
- 7 Oskam A. Principles of the EC dairy model. *Eur Rev Agric Econ* 1989;16:483-7.
- 8 Hendriks HFJ, Weststrate JA, Van Bliet T, Meijer GW. Spreads enriched with three different levels of vegetable oil sterols and the degree of cholesterol lowering in normocholesterolaemic and mildly hypercholesterolaemic subjects. *Eur J Clin Nutr* 1999;53: 319-32.

The home treatment enigma

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Why is home treatment for acute psychiatric illness generally ignored as an alternative to conventional admission to hospital in the United Kingdom? Despite evidence showing that home treatment is feasible, effective, and generally preferred by patients and relatives, its widespread implementation is still awaited. Furthermore, no study has shown that hospital treatment is better than home treatment for any measure of improvement. In general, patients are denied the option of home treatment as a realistic, less restrictive alternative to formal admission under the Mental Health Act 1983, although the recent white paper *Modernising Mental Health Services* recommends that it should be provided.¹

In any economic analysis, hospital admission remains the most expensive element of psychiatric care. Although the pressure on acute beds in inner city psychiatric hospitals in the United Kingdom is increasing—and it has reached breaking point in some areas²⁻³—it is claimed that managing these patients outside hospital would be out of the question.⁴ The pressure on hospital beds has been linked indirectly with the practice of discharging psychiatric patients too early and with well publicised reports of official inquiries into “psychiatric scandals.” In a recent article that was critical of the current state of British psychiatry, it was alleged that the Department of Health and health authorities had misconstrued research into home treatment and that this had resulted in a reduction in the provision of acute beds.⁴ We aim to examine the issues, real and imagined, that are behind the resistance to treatment at home.

Summary points

Home treatment is a safe and feasible alternative to hospital care for patients with acute psychiatric disorder, and one that they and their carers generally prefer

Hospital treatment has not been shown to have major advantages over home treatment and is more expensive

Home treatment has not been widely supported and adopted in the United Kingdom

This delayed implementation reflects criticism that is largely unfounded

Home treatment is valuable in its own right, but its ultimate usefulness is as part of an integrated comprehensive community strategy that includes assertive outreach services

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What is home treatment?

By home treatment we mean a service for people with serious mental illness who are in crisis and are candidates for admission to hospital. A home treatment team does not stand alone. It is an integral part of the overall provision for psychiatric care and plugs a gap between community mental health teams and inpatient units. The features of an effective home treatment team are set out in the box.