

Review

Health and nutrition economics: diet costs are associated with diet quality

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The WHO asserts that the global food price crisis threatens public health and jeopardizes the health of the most disadvantaged groups such as women, children, the elderly and low-income families. Economic factors play a crucial role and could affect personal nutrition status and health. Economic decision factors such as food price and income do influence people's food choices. Moreover, food costs are a barrier for low income-families to healthier food choices. Several studies indicate that diet costs are associated with dietary quality and also food safety. Food prices have surged over the past couple of years (2007-9) and raised serious concerns about food security around the world. Rising food prices are having severe impacts on population health and nutritional status. Therefore, people who change their diet pattern for economic reasons may develop a range of nutritionally-related disorders and diseases, from so-called over-nutrition to or with under-nutrition even within the one household. This is likely to increase with growing food insecurity. Presently, economics is not integrated with mainstream nutrition science or practice, other than in 'home economics', but it can enable greater understanding of how socioeconomic status may interplay with human nutritional status and health and how these situations might be resolved. Collaborative, cross-disciplinary nutritional economics research should play a greater role in the prevention and management of food crises.

Key Words: food prices, food choices, diet costs, nutritional economics, food security

INTRODUCTION

The relevance of the association of nutrition and its economic to human affairs has been acknowledged for decades. Economists see nutrition as an important input to economic growth. As Amartya Sen wrote in *Development as Freedom*, nutrition insufficiency is one of the major sources of 'unfreedom' and limits human development.¹ The direction of this relationship is not one way. Economic factors are also determinants of nutritional status. Economics and nutritional status interplay and both eventually influence human well-being whether directly or indirectly.

In a world whose resources are changing, and in many ways more limited, there are new challenges for nutrition scientists. The policy implications of nutrition science need to be more contextual as the interaction between nutrition and economics is now stronger than ever. Resource scarcity now puts nutritional policies in a more competitive place with a variety of public health programs. The Copenhagen Consensus of 2004, developed by a panel of economists, ranked the combat of malnutrition second among the ten best global available investments to improve human welfare; and this ranked first in 2008.^{2,3} Through the Copenhagen Consensus, we appreciate the value of an economics and nutrition synergy and

how the two disciplines can collaborate in research and policy development. If the Copenhagen consensus had used broader measures of nutritional status and outcomes measured not only in monetarist terms, the importance of the disciplinary linkage would have been even greater. 'Nutritional Economics' is a synthetic concept that deals with the interplay between economic systems, nutritional status and food security, and how changes in the former affect the latter.⁴

It must be acknowledged though that the present imperatives to think and plan in terms of nutritional economics were antedated throughout human agrarian history by women managing household budgets and food security.⁵ The field owes its professional and sociological origins to Home Economics. Ellen H Richards (1842-1911) is generally considered its founder. She, together with Wilbur O Atwater, Edward L Youmans, and Isabel

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Bevier, developed Home Economics education in the US rural sector through the Land Grant Universities under the Morrill Act signed in to effect by President Abraham Lincoln in 1862. This transformed the standards of nutritionally-related health in the US and provided increased food security. In 1894, Richards was instrumental in establishing the first school lunch program in the aftermath of the 1893 US depression at the end of the 19th century. It was a critical step towards better child health with its future benefits. The model continued through later economic and agricultural downturns, including the Great Depression of the 1930s; and enlarged its food program scope into food stamps and the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC).

The current global food price crisis, early in the 21st century, threatens public health and is also jeopardizing the health of the most disadvantaged groups.⁶ The factors which most commonly contribute to this crisis include the costs of food production, processing, and marketing linked to sharply higher oil prices; the use of food crops for bio-fuel production in the US and Europe; growing meat consumption that stimulates increased demand for animal feed; poor harvests in certain major agriculture regions; and consistent underinvestment in agriculture over past decades resulting in agricultural production that lags behind population growth or broader economic growth.⁷⁻¹⁰ Nevertheless, the impact of increasing food prices now focuses the attention of national governments.

Economic factors play a crucial role within households (the place of commensality or where food is shared) and for individuals and, as in previous crises, could affect personal nutrition status and health.¹¹ This paper aims to be declarative about the association between diet costs and dietary quality from these dimensions: 1) consumer behavior: how food pricing affects food choice; 2) provider behavior: the influences of material cost and trade on food safety and availability; 3) how diet cost relates to dietary quality; 4) what impact surging food price has on health; and 5) future work in nutritional economics.

CONSUMER BEHAVIOUR: PRICE AND INCOME EFFECTS ON FOOD CHOICE

People consume healthy food or better quality of food through a series of food selection processes. The determinants of food choice are complex and multifactorial and not well understood.^{12,13} Recent studies have focused on structural factors such as access to grocery stores, transportation, and neighborhood safety as well as inequities in access to healthy foods.^{12,14-17} There is also an increasing awareness that healthier foods are associated with monetary factors.^{18,19}

Individual food choices interplay with environmental and individual factors. Environmental factors which influence eating behavior include a changing food supply, increased eating out, food advertising, healthy eating promotion, education and food pricing.^{19,20} For individuals, taste, perceived value (such as price and portion size) and perceived nutrition value are the three main dimensions related to food choice.^{21,22} Presumably, confidence in a food's safety is a key determinant as well. Thus, food prices can operate as both environmental and individual factors, which can affect people's food choices.

Food prices have a strong effect on food choices and price reduction intervention strategies can increase healthful food purchases.²³⁻²⁶ French et al. conducted research referred to as CHIPS (Changing Individuals' Purchase of Snacks) and examined a range of price reductions and point-of-purchase promotions on sales of lower-fat vending machine snacks in 12 worksites and 12 secondary schools in Minnesota. All vending machines in each of the sites were stocked with lower fat snacks (about 17% of the machine inventory). Prices on lower-fat snacks were reduced relative to the higher-fat snacks, by 10%, 25%, and 50%. Price reductions of 10%, 25%, and 50% on low-fat snacks were associated with significant increases in low-fat snack sales; percentages of low fat snack sales increased by 9%, 39%, and 93%, respectively.²⁴

Another study aimed to use price reduction strategy for fruits and vegetables in two high school cafeterias. One school was located in a primarily white, middle-income suburban area, whereas the other school was located in an urban area with a mixed ethnic and socioeconomic population. Fresh fruit and baby carrots were targeted for 50% price reductions. During the price reduction period, sales of fresh fruit increased four-fold, from 14.4 to 63.3 items per week, and sales of baby carrots increased two-fold, from 35.6 packets per week to 77.6 packets per week. Sales returned to baseline levels with the reinstatement of usual prices.^{25,27}

Most of the studies of this kind are conducted in cafeteria settings and it is not clear if the findings are relevant in the community. Food choice practice and its relation to food pricing among free-living community-based people remain unclear.

From an economic perspective, personal or household income and food prices are important determinants of food choice.²⁸ Low income households spend a higher proportion of their income on food than do higher income households. In 2003, US urban households with incomes in the lowest quintile (bottom 20 percent of the income distribution) spent 1,769 dollars per person for total food, or 37.3 percent of total household income. Households in the highest quintile spent 2,737 dollars per person for food, or 6.6% of total household income. Wealthier households, however, spent more of their food budgets on away-from-home food than other households.²⁹

Food costs are a barrier for low income-families to healthier food choices. Bowman's study showed that food price was very important for 46.8% of women and these women were more likely to live in low-income, food-insecure households and to have more energy-dense diets.³⁰ Lower income groups are less likely to make food purchasing choices consistent with dietary guideline recommendations.³¹

In short, food consumption behaviors are complex in an economic system. From an economic perspective, people eat food to acquire biological, psychological or social well-being, and they value the food-relevant well-being by a comparison with other uses of their manageable resources as opportunity costs that are reflected in a monetary unit. Economical factors like income and food price shape consumers' food choice behaviors, and eventually influence nutritional status.

PROVIDER BEHAVIOUR: INFLUENCES OF MATERIAL COST AND TRADE ON FOOD SAFETY AND AVAILABILITY

The prices of food products available in the retail market can be affected by costs of food production and process. Retail food cost is composed of the price of raw food product (farm gate price) and costs of marketing and advertising along with transportation, processing, packaging and preparation. In the US, the farm proportion of food product retail price, on average, was about 21% while marketing costs were 79%.³² The proportion of return to farm varied among foods. In general, farm gate value on animal products enjoy a greater share of retail price than those for crop-based foods, and those foods which require more manufacturing processes yield a lower return to the farm gate.³² For example, farm gate price ranged from 7% for white bread to 62% for eggs.³³ Moreover, the distribution of food cost between production and marketing components varies with time. There was a long term trend for increasing marketing costs that obscured the decline of farm costs in the US.³⁴ Together with marketing costs, increased payouts for labor and energy with economic growth kept retail food prices at a higher level than would otherwise have obtained. On average, labor costs in food manufacturing are about 40%, twice as high as farm costs.³⁵ When the national average wage increased along with GDP, labor costs of food production unavoidably increased. Then, higher oil prices made it more expensive to operate machinery in food production and to transport agricultural products.³⁶ At the same time, high oil prices encouraged the energy industry to produce biofuels instead of petrol, which diverted maize and other feed and food crops to biofuel production and eventually forced up crop prices.¹⁰

The demand side also plays a role in the costs of food production. There have been major shifts in the sources and types of agricultural products destined for different foods. Much of this made possible by innovative food technology where extrusion techniques and taste profiling can enable sophisticated food product simulation. With rising incomes, millions of people in developing countries, especially China and India, have experienced significant changes in food patterns from grains and staple crops to animal products sometimes with higher nutrient densities like meat, dairy, and fish and plant foods like fruits, vegetables and nuts.³⁶ They also have allowed a proliferation of processed foods of lesser nutritional value using inexpensive ingredients like refined carbohydrates, fat, salt and sugar. Production costs of those foodstuffs which are more nutritious are generally more than those which are less nutritious. Moreover, processed foods are more and more dominant in the food market. On the one hand, food companies are more likely to develop and promote pre-packaged foods which allow for added 'value' (ie profit and commercial advantage) through processing. Examples include breakfast cereals, fruit juices, canned fruits or frozen vegetables.³⁷ The societal value of such processing has more to do with reduced post-harvest loss, increased storage times without hazardous preservatives (like salt and curing) and availability at a distance from source. On the other hand, there is a trend for consumers to devote less time to food preparation and to seek more processed

and prepackaged foods for convenience.³³ More food processing requires more labor and capital inputs. Thus, increased food costs are driven directly by the supply side and indirectly from the demand side.

Costs are also related to food safety because it requires investment and maintenance expenditure. Efficiencies with better outcomes are being achieved through new methodologies and regulatory regimes like those offered by HACCP (Hazard and Critical Control Point procedures). The problems arise when food companies pursue and gain financial benefits by reducing costs through cheaper, but less safe methods or materials. There is growing circumstantial evidence that recent food price hikes in Taiwan have affected food safety. According to the Bureau of Statistics, the price index of edible oil in 2008 and 2009 surged and dairy prices have inched upwards.³⁸ Foods with the greatest price increment include milk and dairy products and edible oils. Shortly after these price hikes, melamine as an adulterant was found in imported dairy products to simulate protein nitrogen. The demand for milk, at cheaper prices, was being met by unscrupulous suppliers through dilution with water and a tailor-made non-protein nitrogen source from plastics industry waste, to meet the required standard. In the case of cooking oils, over used, and over acidic oils have been identified in major convenience food chains; again, compromises have been made to avoid price hikes.³⁹ The same phenomenon namely cost-saving by greater recycling of deep-frying oils in households and by small vendors are also likely as prices rise.

DIET COST AND DIETARY QUALITY

Healthy diets cost more if healthy food costs more. Thus, higher food prices would have a greater impact on the most vulnerable groups. As indicated by the studies discussed above, low-income families are more sensitive to price than those with higher incomes and are more likely to choose less healthy foods. Food diversity, reported as an index of dietary quality, health outcome^{40,41} and food security⁴² by the International Food Policy Research Institute, might be relevant to diet costs.

Cade et al.⁴³ investigated the direct and indirect cost differences associated with eating a 'healthy' or 'unhealthy' diet by using the UK Women's cohort Study. A healthy diet indicator (HDI), with values from 0 (lowest) to 8 (highest) was developed based on the WHO dietary recommendations. For direct costs, the difference between the most extreme HDI groups was 1.48 English pounds per day (equivalent to 540 pounds per year). Forty-nine percent of the food budget was spent on fruit and vegetables in HDI group 8 compared to 29% in HDI group 0.

An observational study of the relationship between diet quality and diet cost among 837 French adults concluded that diets high in fats and sweets represent a low-cost option to the consumer, whereas the recommended 'prudent' diets cost more.⁴⁴

The energy density (ED) of individual foods is a function principally of their water and dietary fiber contents on the down side and of fat on the up side. Low-ED foods are vegetables and fruits whereas high-ED foods are fatty spreads, oils, and other fats.⁴⁵ Ledijwe et al.⁴⁶ and other groups have shown that a low-ED diet was associated with

lower energy intakes, higher food intakes, and higher diet quality than a high-ED diet. An exception to this might be sugary drinks, of lower ED than fatty foods, but without the restraints of intact food on intake.⁴⁷ Hence, low-ED diets can be regarded as ones of high dietary quality. Moreover, Townsend et al.⁴⁸ investigated 112 low-income women aged 18-45 years in US California and found that dietary ED was inversely associated with diet quality and low-ED diets of higher nutrient content were associated with higher energy-adjusted diet costs.

That disparities in dietary quality may result from economic gaps has raised public concern globally. On July 6th 2009, the UN Secretary-General Ban Ki Moon and the Chief of WHO, Dr Margaret Chan released the findings of the UN Economic and Social Council, published on the UN Radio web-site indicating that rising food prices were adversely affecting healthy food choices for the most vulnerable.^{49,50}

If consumer behavior in food choice is greatly influenced by food price and household income, then when certain foods are price sensitive, people are likely to make food choices related to their current economic status or, with time and advocacy, force changes in provider or market price structures. This is most evident and consequential when food prices are rising and elastic and when demand is determined by health considerations as well as basic energy needs.

FOOD PRICE AND HEALTH

Food prices have surged over the past couple of years and raised serious concerns about food security around the world. In 2007, the international food price index rose by nearly 40 percent, compared with nine percent the year before. In the first three months of 2008, prices increased further, by about 50 percent.⁵¹ Although, world food prices are 2.2 percent lower in 2009 than they were at the beginning of 2008, according to the Economist's food-price index, they have fallen by only about a quarter since the peak in July 2008. Moreover, food prices are moving up again and are expected to continue to do so.⁵² These overall increases in food prices have pushed at least 100 million more people into poverty and associated hunger.⁵³

Rising food prices can have severe impacts on population health and nutritional status. Households respond to increasing food prices by eating more monotonous diets, of lower nutritional quality. Characteristically, less fresh produce, fish, lean meat, less fruits and vegetables are eaten, which are rich in essential micronutrients, as the cheapest sources of calories is sought.^{10,54} People who change their dietary patterns due to financial considerations may develop complex nutritionally related disorders, which may be referred to, simplistically, as over-nutrition (especially of energy) and under-nutrition (especially of biologically active protective food components). This phenomenon tends to increase in precarious transitional economies and is seen within communities, households and even individuals.⁵⁴ Furthermore, other critical household expenditures are affected, such as those on education and health care, while efforts are made to maintain income sources through expenditure on work-related travel.⁵⁵

The world is facing another surge in food prices and a global food crisis, which will add to the burden of vulner-

able groups such as: women, children, the elderly, and low-income families, and those already reliant on food assistance in the most disadvantaged situations.^{7,55} Leaders should ensure that groups likely to see a change in well-being because of rising global food crisis are identified.⁷ Monitoring and surveillance is essential to track data on price, food expenditure, dietary diversity and nutritional status to anticipate and prevent the consequences of food deprivation in susceptible groups.⁵⁶ Regrettably, even advanced economies are not investing the relatively small budgets required for such measures so as to avert these eventualities. As public debt and poor governance grows so must the concerns about economically driven food insecurity.⁵⁷

The adequacy and quality of the food supply depends first on the combination of local production and trade, with more or less of one or the other.⁵⁸ In Poland, after the fall of the Berlin Wall in 1989, food trade developed quickly. There was a brisk increase in exotic fruit consumption (citrus and bananas) and a change in the quality of edible fat. Coronary heart disease dramatically decreased against a history of progressive increase to rates which had been among the highest globally.⁵⁹

FUTURE WORK IN NUTRITIONAL ECONOMICS

There are opportunities for further synergy between nutrition and economics. The first one is the behavioral area which considers individual and collective behaviors in food production and consumption.⁶⁰ Microeconomic analysis is appropriate for this area. Policy tools are the subject of public and welfare economics and include regulation, licensing, taxation and subsidization, which are employed by governments to influence food markets. In response, consumers and providers may adjust their behaviors to these changes in the policy environment. Moreover, policy implementation comes with varying degrees of competent governance and activity (even none) with societal results. Analysis through nutritional economics promise to discover how the behavioral consequences of policies affect the food system from producers to consumers and their food markets work and fail. Such analysis also allows a consideration of the equality with which diets and health outcomes distribution might be addressed in different populations with various food systems.

Another opportunity is the evaluation of policy alternatives in nutrition by decision models such as cost-effectiveness (CEA), cost-benefit analysis (CBA) and cost-utility analysis (CUA).⁶¹ Because of resource scarcity, policy-makers have to make choices between alternative nutritional intervention programs. It is crucial to establish comparable criteria and standards for alternative health interventions aimed at improvements in various health outcomes with varying degrees of resource input. As advances in theory and evaluation techniques accumulate from food-health outcomes research, nutrition programs or interventions can be prioritized by comparison and ranking of health outcomes and related costs.

Therefore cooperation between economists and nutritionists might be expected to answer at least two questions. The first would be whether, if food is available and consumed in an efficient way, its nutritional value to society from a utilitarian perspective would be realized.

This is an 'efficient-frontier' problem about the pursuance of maximized health outcomes for various combinations of resource inputs. The second is whether food could be provided and consumed in a way to equalize nutritional status, this would achieve egalitarian goals. According to Culyer's notion in the field of health economics,⁶² people more in need ought to be allocated more resource than those less in need (vertical equity), and people at the same level of need ought to be allocated the same resources (horizontal equity). The equity theory applied to nutrition could help to develop benchmarking between populations of interest at a time when the gap in nutrition and health continues to widen across the world.

CONCLUSIONS

Food prices represent both environmental and individual factors that effect people's food choices. Moreover, food prices are a barrier for low income-families to healthier food choices. Several studies show that diet costs are associated with diet quality. Economics is not currently part of mainstream nutrition, although home economics has been in the past. It can help to understand how socioeconomic status interplays with human nutritional status and health.

Rapid increases in food prices along with a financial crisis, are contributing to a global food security crisis, threaten population nutrition and health presently. The converse has also been evident as with the example of changing terms of trade in Poland and their effect on coronary heart disease. As envisaged in the International union of Nutritional Sciences 'New Nutrition Science' initiative⁶³ the co-development of economics and nutrition through collaborative cross-disciplinary research will help to understand some of the basic issues in human security. These include the consequences of hunger, disease and natural disasters which are intertwined with the affordability and sustainability of food systems.⁶⁴

AUTHOR DISCLOSURES

No conflicts of interest.

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Review

Health and nutrition economics: diet costs are associated with diet quality

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衛生與營養經濟學：飲食花費與飲食品質之相關性

世界衛生組織聲稱，全球糧食價格危機已經影響到大眾的健康，危及弱勢族群如：婦女、小孩、老人與低收入戶家庭的健康。經濟因素扮演一個重要的角色，並且影響個人營養狀態和健康。經濟上的因素，如食物的價格和收入，皆會影響到人們對於食物的選擇。再者，食物的花費是低收入家庭選擇較健康的食物的一個障礙。研究指出飲食的花費與飲食的品質和安全有關。食物的價格在近幾年(2007-9)劇烈的上升，已經引起全世界對於糧食安全的高度重視。持續不斷攀升的食物價格，對大眾的健康和營養狀態造成嚴重的衝擊。因此，家戶內個人可能會因為經濟因素的考量，而改變其飲食型態，進而產生一些營養過剩或營養不良之相關症狀和疾病，這可能更加重糧食不安全之情勢。目前除了家政學以外，經濟學並未整合於主流的營養學之科學與實務的研究領域。然而，經濟學讓我們瞭解社經狀況如何與營養和健康狀態交錯影響，並且尋求其解決方案。我們期許透過經濟學與營養學跨領域的合作，可以預防和管理現今的糧食危機。

關鍵字：糧食價格、食物選擇、飲食花費、營養經濟學、糧食安全