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Family income, food prices, and household purchases of fruits and vegetables in Brazil

ABSTRACT

OBJECTIVE: To analyze the influence of family income and food prices on the participation of fruits and vegetables in the food purchases of Brazilian households.

METHODS: Data analyzed refers to the Household Budget Survey conducted by the Instituto Brasileiro de Geografia e Estatística on a probabilistic sample of 48,470 Brazilian households between 2002 and 2003. Fruit and vegetable participation in total food purchases was expressed as a percentage of total calories purchased and as calories from fruit and vegetables adjusted for total calories purchased. A multiple regression analysis was employed to estimate elasticity coefficients, controlling for sociodemographic variables and price of other foods.

RESULTS: Fruit and vegetable participation in total food purchases increased as the price of these foods decreased, or as income increased. A 1% decrease in the price of fruit and vegetables would increase their participation by 0.79%, whereas a 1% increase in family income would increase participation by 0.27%. The effect of income tended to be smaller among higher income strata.

CONCLUSIONS: Reducing the price of fruit and vegetables, either by supporting their production or through fiscal measures, is a promising public policy instrument, capable of increasing the participation of these foods in the diet of the Brazilian population.

DESCRIPTORS: Food, economics. Income. Food Consumption. Fruit. Greens. Diet Surveys. Prices.

INTRODUCTION

Evidence from the literature points towards an association between insufficient intake of fruits and vegetables (F&V) and higher risk of diseases such as certain types of cancer and cardiovascular disease.[14,16,a] The World Health Organization (WHO) estimates that, worldwide, approximately 2.7 million deaths per year can be attributed to insufficient F&V intake, making it one of the ten primary factors behind the global burden of disease.[18]

WHO and the Food and Agriculture Organization of the United Nations (FAO) recommend a minimum daily F&V intake of 400 g.[18] This would correspond, in Brazil, to between 6% and 7% of the total calories of a 2,300 kcal per day diet.[b] Household availability of F&V among the Brazilian population,

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[a] World Health Organization. Global strategy on diet, physical activity and health. Geneva; 2003. (WHO Technical Report Series, 916).
[b] Food and Agriculture Organization. Nutrition country profiles – Brazil. Rome; 2000 [cited 2009 Feb 18]. Available from: http://www.fao.org/ag/agn/nutrition/bra-e.stm

according to data from the 2002/03 Household Budget Survey (POF) conducted by the Instituto Brasileiro de Geografia e Estatística (IBGE), corresponded to 2.4% of total available calories, falling short of minimum recommended values in all geographic regions and economic strata.[13]

Food choices are complex decisions that are influenced by both biological factors and social, cultural, and economic variables.[9] Among the latter, family income and food prices play an important role.[5] Economic factors seem to have decisive influence on F&V intake. Studies from developed countries indicate that diets rich in F&V are more expensive than other diets,[6] and that economic restrictions (such as those faced by low-income families) favor diets with low F&V content and high energy density (due mostly to the high frequency of processed cereals, oils and fats, and sugars).[3,4]

The need to approach the issue of dietary patterns by means of public economic policies seems to be a consensus in the literature.[7,8,12] One potential intervention would be the concession of economic incentives to the consumer, reducing the price of healthy foods relative to non-healthy ones.[7,a] Interventions of this sort have the potential to reach a large share of the population while having an impact in terms of the promotion of a healthy diet.

Few studies, most of which were carried out in developed countries, have attempted to identify and quantify the influence of family income and food prices on dietary patterns.[2,c] The present study aimed to analyze the influence of family income and food prices on the participation of F&V in the diet of Brazilian families.

METHODS

The data analyzed were obtained form the POF carried out by IBGE between 1 July 2002 and 30 June 2003 on a probabilistic sample of 48,470 households.[d] POF 2002/03, a cross-sectional study, used a complex clustered sampling procedure, with probabilistic selection of census tracts as a first step, followed by the selection of households within each tract. For the selection process, the 215,790 tracts of the 2000 Demographic Census were stratified into groups that were highly homogeneous with respect to geographic and socioeconomic characteristics. Variables considered in stratification included the location of the tract (Region, State, state

capital/metropolitan area/non-capital, urban/rural) and the range of variation in socioeconomic status among the tract's households (mean years of schooling of heads of household, according to the 1996 population count) of each geographic site. This process led to 443 strata of geographically and socioeconomically homogeneous households. Households within each tract were selected by simple random sampling without reposition. Household visits were carried out uniformly throughout the study's four trimesters, so as to reproduce the seasonal variation in income and food purchases (and in purchases of other items as well) in the strata.

The major information from the 2002/03 POF analyzed in the present study was a registry of food and drink purchases kept by the household members themselves (or by the interviewer, when necessary) for seven consecutive days. Such a short reference period does not allow us to determine the usual pattern of food purchases of each studied household. We therefore chose to regard as the study unit clusters of households within each of the 443 sampling strata, which ensured study units with a good range of geographic and socioeconomic variation, and whose annual food purchase patterns could be determined precisely. The mean number of households investigated within each study unit (stratum) was 109.4, ranging from nine to 804.

Purchases of the same food item by the same household were added (roughly 1.3 thousand different food items were mentioned) so as to establish the amount of foods purchased in each study unit. When appropriate, we excluded the inedible portions of food items using the appropriate correction factors.[e] The total purchased amount for each food item was converted into energy (kcal) using the Aquinut program,[f] which is based largely on the *Taco* food composition table[g] and, for foods not present in this chart, on the United States Department of Agirulture official nutrient database, version 15.[h] Following conversion to energy, records pertaining purchases of fruits and vegetables (including both, fruity vegetables - e.g., tomato and zucchini - and leafy vegetables - e.g., lettuce and spinach) were classified in the F&V category. Remaining records were classified into a single set complementary to F&V.

The amount of F&V and other food purchases was expressed in kcal per adult-equivalent (AE) per day, dividing the total of calories relative to purchases of each food group by the total AE units in the stratum

[c] Haddad L. What can food policy do to redirect diet transition? Washington: International Food Policy Research Institute; 2003. (FCND discussion papers, 165).

[d] Instituto Brasileiro de Geografia e Estatística. Pesquisa de orçamentos familiares. POF 2002/2003: análise da disponibilidade domiciliar de alimentos e do estado nutricional no Brasil. Rio de Janeiro; 2004.

[e] Instituto Brasileiro de Geografia e Estatística. Estudo Nacional da Despesa Familiar - ENDEF 1974/75. Rio de Janeiro; 1978.

[f] Conversor de Aquisições de Alimento em Energia e Nutrientes (AQUINUT), Versão 1.0 [internet]. São Paulo: Núcleo de Pesquisas Epidemiológicas em Nutrição e Saúde da Universidade de São Paulo; [s.d.] [cited 2008 Oct 6] Available from: http://www.fsp.usp.br/nupens

[g] Núcleo de Estudos e Pesquisas em Alimentação. Tabela brasileira de composição de alimentos - TACO. Campinas: Flamboyant; 2004.

[h] United States Department of Agriculture. Agricultural Research Service. USDA national nutrient database for standard reference: release 15. Beltsville; 2002.

and by the number of days in the registry (seven). The fraction of an AE unit attributed to each individual was computed by dividing recommended energy intake for the individual's sex and age group by that recommended for the 18 to 50 years group (2,550 kcal).[i] AE fractions were added to obtain the total number of AE units in the stratum.

The relative participation of F&V in total food purchases within a stratum was expressed, for descriptive purposes, as a percentage of all calories purchased. In addition, it was calculated the amount of F&V calories adjusted for total calories purchased in the stratum using the residual method.[17] This procedure allows to investigate the association between the relative participation of F&V in total food purchases (and not the absolute amount purchased) and the potential determinants of this participation, such as family income and food prices.

The mean price of F&V and other food purchases in each stratum, expressed in R$/1,000 kcal, was obtained by dividing the total expenditure with a food group by the total calories obtained and multiplying the result by one thousand.

Mean income, expressed in R$/person/month, was obtained by dividing the total monthly income of all households in the stratum by the total population of the stratum. Likewise, the mean age and mean years of schooling of all inhabitants aged 18 years or older were calculated using an analogous approach. The proportion of women and of woman heads of household, in addition to the proportion of individuals aged under five or over 64 years, were also estimated. Geographic Region (dichotomized as North/Northeast or South/Southeast/Center-West) and rural/urban status complemented our characterization of study units.

The major variables – *per capita* income and price of F&V and other foods – as well as other variables included in the sociodemographic characterization of strata were initially described by central tendency and dispersion measures. The linear association between these variables and income was analyzed using linear regression models having the variable of interest as the outcome and income quartiles (continuous variable) as the explanatory variable.

The relationship between *per capita* income and price of F&V, with the relative participation of F&V in total calorie purchases (expressed as calories in the group adjusted for total calories) was investigated using multiple regression models by calculating elasticity coefficients. These coefficients indicate the percent variation (positive or negative) in participation of F&V given a one-percentage-point variation in family income

(income elasticity) or in the price of F&V (own price elasticity). Briefly, elasticity coefficients correspond to the regression coefficients (β) of explanatory variables in log-log multiple linear regression models.[2,11] The general model used can be defined as:

$$\ln(F\&V) = \alpha + \beta_1 \ln(I) + \beta_2 \ln(Price\_A) + \beta_3 \ln(Price\_B) + \chi_1 (CV) \ (1),$$

where:

- **F&V** is the amount of F&V-derived calories adjusted for total calories purchased;

- **I** is monthly per capita income (R$);

- **Price_A** is the price of F&V per unit of energy (R$/1,000 kcal);

- **Price_B** is the price of foods in the set complementary to F&V per unit of energy (R$/1,000 kcal);

- **CV** are confounding variables.

Variables tested as potential confounders for the association between income and prices and F&V participation in total food purchases included: geographic region and rural/urban status of the stratum; mean age of individuals and mean years of schooling of adults (age $\geq$ 18 years); proportion of woman heads of households, of women, of children younger than age five years, and of adults aged 65 or more, in addition to the mean price paid for the set of foods complementary to F&V. We included as control variables whose introduction in the model led to a variation equal to or greater than 10% on the regression coefficient of income or F&V price.

Extensions to the general regression model – including quadratic terms for family income and food prices – were tested in order to identify nonlinear relationships between these variables and F&V participation in total food purchases.

All analytical procedures were carried out using the svy family of commands in Stata v.8.2 software, which allowed to considerate the sampling strategy used in POF-IBGE 2002/03.

RESULTS

The majority of strata was situated in urban areas (8.4%), roughly two-thirds were located in the country's Southeast, South, or Center-West Regions, and one-third in the North or Northeast Regions (Table 1).

F&V corresponded to 2.5% of total calories purchased, and were four times more expensive than the complementary set of foods considering the entire population.

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[i] National Research Council. Commission of Life Sciences. Recommended dietary allowances. 10.ed. Washington, DC; 1989.

Table 1. Sociodemographic characterization of the 443 household strata studied. Brazil, 2002/03.

Indicator	Mean	Standard-error	Interquartile range		
			p25	-	p75
Monthly income *per capita* (R$)	546.6	32.0	257.4	-	528.4
Years of schooling of adult residents	6.7	0.2	5.2	-	7.8
Resident age (full years)	29.2	0.3	26.9	-	31.2
% residents ≤ 5 years	6.3	0.3	4.2	-	8.1
% residents ≥ 65 years	8.8	0.2	7.3	-	10.5

Table 2. Mean calories purchased for household consumption, relative participation of fruits and vegetables in total calories, and food prices according to per capita income distribution. Brazil, 2002/03.

Increasing quartiles of per capita income distribution	Total calories purchased (kcal/ AE/ day)	Calories from F&V(kcal/ AE/ day)	F&V participation (% of total calories purchased)	F&V price (R$/1,000kcal)	Price of other foods (R$/1,000kcal)
1°	2060.3*	32.0*	1.6*	4.13*	0.82*
2°	2231.1	42.0	1.9	4.51	0.92
3°	1936.2	49.9	2.7	4.53	1.11
4°	1884.0	75.7	4.0	5.10	1.53
Total	2028.3	49.6	2.5	4.46	1.06

AE: adult-equivalent; F&V: fruits and vegetables
*$p < 0.001$ for linear trend in variation according to increasing income class.

Both relative participation of F&V and its price and other foods tended to increase along with the economic level of families (Table 2).

Income elasticity in the model controlling for food prices and sociodemographic variables (model 3) was 0.27, indicating that a one-percentage-point increase in *per capita* monthly income would increase the participation of F&V in total food purchases by 0.27%. In the same model, price elasticity was -0.79, indicating an opposite effect 2.5 times greater than that of income, with a one-percentage-point reduction in price of F&V leading to a 0.79% increase in participation of this group in total household calorie purchases (Table 3).

The Figure presents the curve of predicted values for relative participation of F&V in total calorie purchases according to variations in *per capita* income, given by a fourth regression model that, in addition to controlling for food prices and sociodemographic variables, includes a simple and a quadratic term for *per capita* income (both significant at $p < 0.05$). The slope of the curve is greater when variations in income occur in the segment of households with lower income, and decreases progressively until almost disappearing in the higher-income segment. Unlike what we found for income, there was no evidence of significant nonlinear relationships between food prices and F&V participation in total calorie purchases.

DISCUSSION

We found an increase in the participation of F&V in the total food purchases of Brazilian households along with decreases in F&V price or increases in family income. The magnitude of income-elasticity tended to be smaller in higher income strata, since the participation of food in household expenditures decreases as income increases.[j] F&V price-elasticity showed no consistent relationship with income stratum.

The association with income and food prices detected in the present study do not refers to absolute purchases of fruits and vegetables, but to their relative participation in the total of foods purchased. There is not reason to believe that the results obtained would be substantially altered if we had been able to evaluate also food consumed outside home. The proportion of food that is acquired for consumption in the household represents 76% of total food purchases in urban households and 88% in rural ones.[15] If we assume that the price of foods for consumption outside the household is not lower than that of foods consumed at home, our data would encompass at least four-fifths of total food purchases.

A further limitation is the short reference period for collection of food purchase data in each household of the 2002/03 POF. To circumvent this problem, the present study adopted as the analysis unit groups of households that were homogeneous in terms of geographical

[j] Engel E. Die Productions-und Consumtionsverhältnisse des Konigreichs Sachsen. Königlich Sächsischen; 1857. (Zeitschrift des Statistischen Bureaus des Königlich Sächsischen Ministeriums des Innern, 8, 9).
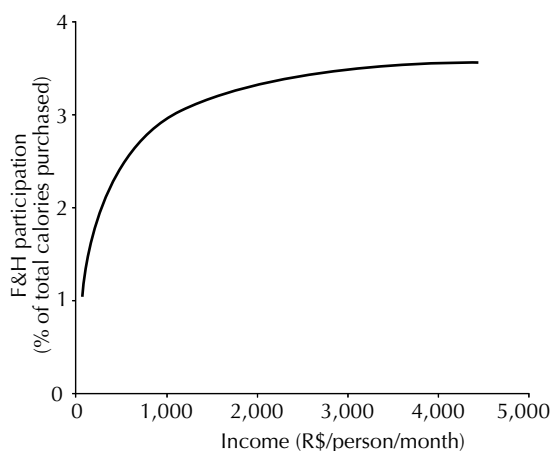
Note: model controlled for food price and sociodemographic variables, with simple and quadratic terms for family income

Figure. Predicted values in a regression model for relative participation of fruit and vegetables in total calories according to variations in the magnitude of family income. Brazil, 2002/03.

Table 3. Elasticity of relative participation of fruit and vegetables in household calorie purchases in relation to per capita family income and fruit and vegetable price, obtained using regression models. Brazil, 2002/03.

Explanatory variables	Models		
	1	2	3
Per capita income (R$)	0.52	0.62	0.27
Price of fruit and vegetables (R$/1,000 cal)	a	-0.77	-0.79
R²	0.64	0.73	0.79

Note: All regression coefficients presented are statistically significant at $p < 0.001$.
[a] Variable not used in the model.
Model 1: adjusted for per capita income;
Model 2: adjusted for per capita income and mean F&V price;
Model 3: adjusted for per capita income, mean F&V price, Region, and urban/rural status of the household stratum, mean schooling of adults residents, proportion of residents aged ≥ 65 years, and mean price of the set of foods complementary to F&V.

location and socioeconomic characteristics, which were studied uniformly throughout the year.

The major advancement in the present study, in relation to the available literature, resides in the application of nutrition-related procedures to a nationwide database. Few prior studies have estimated income-elasticity and F&V price-elasticity in the diet of populations from developing countries, especially with the intent to promote healthy dietary practices. In most studies, F&V intake is evaluated according to its participation in total household expenditures or based on the absolute amount purchased.[k,l] This does not allow one to evaluate the most important aspect of F&V intake, namely whether F&V are added to the diet in replacement of foods with higher energy density and lower nutritional value. A study[2] of data generated by a POF carried out by the Fundação Instituto de Pesquisas Econômicas (Fipe), on a representative sample of the population of the city of São Paulo, Southeastern Brazil, and using methods similar to those adopted in the present study, found a similar relationship between elasticity coefficients. As in the present one, the study conducted with Fipe data found a weaker influence of income on F&V participation when compared to that exerted by F&V price, though the magnitude of both elasticity values was lower, 0.03 and -0.20, respectively.[2]

The results of the present study indicate that income increases, especially among poorer families, and reduction in F&V prices are an effective form of increasing the participation of F&V in the diet of Brazilian households (from 2.5% of total calories to the recommended 6-7%). The primary means to increase the income of the poorest strata of society in a direct and immediate manner seems to be the direct transfer of income.[10] Successful income transfer programs have been implemented in Brazil in recent years.[m] The participation of F&V in the diet of poorer families is likely to have been even lower in the absence of such programs.

Policies that lead to reduction of the price of F&V relative to that of other foods are not in operation in Brazil. Such a measure is highly likely to obtain effective results in the short term, since it directly influences consumers' choices. Reducing the tax burden on F&V – which is currently at around 28% for fruits and 22% for vegetables[n] – is a potentially successful intervention, given that it does not require great financial investments from public administration (it is based on renouncing due taxes), in addition to targeting the reduction in price to the consumer. Our results show that reducing the mean price of F&V by 20% would raise the participation of these foods in the Brazilian diet by about 16% (or from current levels to approximately 3% of total calories). The obvious disadvantage of tax exemption is the risk of an imbalance in the relationship between

[k] Hoffmann R. Elasticidades-renda das despesas com consumo físico de alimentos no Brasil metropolitano em 1995-1996. *Agric São Paulo.* 2000;47(1):111-22.
[l] You Z, Epperson JE, Huang CL. Consumer demand for fresh fruits and vegetables in the United States. Research Bulletin. Athens; 1998 [cited 2009 Apr 4]. (Research Bulletin University of Georgia, 431). Available from: http://pubs.caes.uga.edu/caespubs/pubs/PDF/RB431.pdf
[m] Ministério da Saúde. Avaliação do programa Bolsa Alimentação. Brasília, DF; 2005.
[n] Amaral GL, Olenike JE, Viggiano LMFA. Estudo sobre o verdadeiro custo da tributação no Brasil. Curitiba: Instituto Brasileiro de Planejamento Tributário, [s.d.] [cited 2009 Apr 4]. Available from: http://www.ibpt.com.br/img/_publicacao/9169/142.pdf

supply and demand for these foods, in case that supply is not equally stimulated.

Creating special lines of credit aimed at F&V production could constitute an alternative for promoting its price reduction. This alternative has the advantage of stimulating supply and demand simultaneously, minimizing the risk of shortages and consequent price increases. The disadvantage of this type of process is the possibility that the price reduction could be absorbed during the chain from production to commercialization of F&V and never reach the final consumer. The imposition of a small tax on unhealthy foods or food groups – such as, for instances, foods with high sodium or sugar content – could provide a solution for obtaining resources for subsidizing F&V. In the present study, we analyze the impact of variations in the price of specific food groups on F&V intake; however, we did not detect a pattern capable of conclusively indicating the best candidates for these taxations.

In conclusion, our results show that reducing prices can have a positive influence on the participation of F&V in the diet of the Brazilian population, suggesting that public policies aimed at achieving such reduction would results in increase in their consumption in the country.

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