Thin subsidies effects on food consumption pattern and nutritional status of Brazilian poor children

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Abstract

This paper aims to analyses the effect of a reduction in the prices of healthy foods (thin subsidies) on the nutritional status and individual acquisition of food for individuals in poverty, between 2 and 9 years old. With the data of a Brazilian family budget survey (POF / IBGE), I estimated a model that identifies the individual consumption of calories, based on aggregate household consumption, followed by the estimation of a child health production function, which verifies the effect of a set of variables on Body Mass Index (BMI), and finally, I estimated children food demand system, for various food categories (healthy and unhealthy), which allows to obtain variations in the quantities of food allocated to children, given changes in prices. The implementation of thin subsidies can be effective for the variability of food destined to children, directly affecting the basket that is to be stimulated and reduce the unhealthy food consumption. However, a combined discount, given to a basket of healthy foods, does not modify the total caloric intake. So, this intervention does not reverse the process of average BMI growth of economically vulnerable children and, consequently, it does not reduce the incidence of childhood obesity. In general, the analysis proposed was important to understand how specific policy interventions can contribute to encouraging healthy habits, giving attention to their impacts on vulnerable individuals.

Keywords: Children nutritional status. Children food demand system. Thin subsidies.

Resumo

Este estudo propõe analisar o efeito de uma redução nos preços de alimentos saudáveis sobre o estado nutricional e aquisição individual de alimentos, para indivíduos em situação de pobreza, com idade entre 2 e 9 anos. Para tanto, com os dados da POF (IBGE), estimou-se um modelo que identifica o consumo individual de calorias, por meio do consumoagregado domiciliar, seguido pela estimação de uma função de produção de saúde infantil, que verifica o efeito de um conjunto de variáveis sobre a distribuição do indicador de estado nutricional utilizado (IMC), e por fim, um sistema de demanda alimentar infantile, considerando diversas categorias alimentares. Percebe-se que a implementação de um subsídio ao preço de alimentos saudáveis pode ser eficaz para a variabilidade de alimentos destinados às crianças, por incidir diretamente na cesta que se deseja estimular, além de reduzir a quantidade de alimentos prejudiciais à saúde. No entanto, um desconto combinado dado aos preços de alimentos saudáveis, não altera o consume calórico total. Assim, essa intervenção não é suficiente para reverter o processo de crescimento do IMC médio de crianças economicamente vulneráveis e, consequentemente, não reduz a incidência de obesidade infantil. De forma geral, a análise proposta foi importante para entender como intervenções específicas podem contribuir para incentivar hábitos alimentares saudáveis, dando atenção aos seus impactos sobre indivíduos vulneráveis.

Palavras-chave: Estado nutricional infantil. Sistema de demanda de alimentos para crianças. Thin subsidies.

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1. Introduction

The nutrition transition arises in poor and developing countries, associate with the obesity prevalence, one of the risk factors of non-communicable chronic diseases (NCCD), which can be debilitating and even lethal effects (WHO, 2002; 2009). This change also affects the children, mainly responsible for the epidemic of childhood obesity in several world regions, including areas where malnutrition was prevalent (WHO, 2017), as is the case in Brazil. In this country, despite the significative reduce in malnutrition, the childhood obesity the prevalence of obesity in boys increased from 2.9% to 16.6%, and 1.8% to 11.8% in female children, in three decades (IBGE, 2010a).

The child obesity associates with the risk of remaining overweight in adulthood, in addition to the early incidence of NCCDs and psychosocial disorders. In the sense, the World Health Organization (WHO) reinforces the importance of actions that promote the healthy habits in childhood (WHITAKER et al., 1997; FRANKS et al., 2010, WHO, 2017). Programs aimed at preventing childhood obesity can start from schools, since it is the place where children and adolescents spend most of their time, and it is the responsibility of educators to promote an environment conducive to exercise and a balanced diet. However, Birch and Ventura (2009) argue that school-based intervention is ineffective in promoting healthier habits and, consequently, to reverse the increasing number of obesity cases. According to them, the nutritional status of children and adolescents is influenced by their own behavior, but is inserted within a higher behavioral pattern, coming from family. Hence there is the importance not only of childhood nutrition education, but also to promote changes that affect the population habits.

In this sense, in this paper I simulate an intervention on Brazilian children's food consumption pattern and their nutritional status, based in healthy food prices reduction (whose literature term is thin subsidies). I restrict our analysis to individual, between 2 and 9-year-olds, residing in Brazilian poor households.

The intervention on the pattern of household food consumption can be given through food production control, information policies, as well as measures that affect the budget constraint, such as the change in food prices (thin subsidies or fat taxes), cash transfer or food assistance (DREWNOWSKI et al. 2004; MAZZAOCHI, TRAILL, 2005; HIDROBO et al., 2014; FLORES, RIVAS, 2017). One of the most know food assistance program is the Special Supplemental Nutrition Program (SNAP or Food Stamps Program), whose benefits can be used to buy food in authorized retail foods. Nevertheless, the effects of receiving these benefits are ambiguous on child obesity. The household might allocate the additional money to unhealthy food, depending of the household preferences (GUNDERSEN, 2015). Changes in the price foods are another intervention on the eating habits, already implemented in several countries (SMED, 2007). It is believed that the strategy based in the modification of relative food prices, known as thin subsidies and fat taxes, can generate greater impact on the demand of food, because it directly affects the policy. Thin subsidies have redistributive effects, since the individuals with lower income start to consume more healthy foods, being able to bring more benefits in terms of improvement of the habit formation and health status than fat tax policies (CASH et al., 2005; FLORES; RIVAS, 2017). The evidence found by Hidrobo et al. (2014) also reinforce the importance of subsidies, comparing them to income transfers. Through an experiment, it has been found that giving money (represented by income transfers) or food discount coupons (representing subsidies) to households improves the quantity and quality of food purchased, but discount coupons are more important for food diversification.

There are a several studies that analyses the Food Stamps effect and the food price effects on food demand, but this analysis is restricted to developing countries and they consider household food consumption, which does not allow a specific analysis for the different age groups, especially for children (PAN; JENSEN, 2008; HIDROBO et al., 2014; GUNDERSEN, 2015; LIN et al., 2011; FLORES; RIVAS, 2017). So, that is necessary to investigate the police effects that can influence eating habits, not only by the average, because it ignores the impact on most vulnerable individuals, such as children, who have special dietary needs. In addition, it is necessary to verify incentives for individuals to improve their eating habits in a vulnerability scenario where income inequality reflects inequalities in food acquisition, limiting the range of consumption possibilities of poorer individuals, like Brazil. In this country, the growth childhood obesity accompanies the deterioration of the dietary pattern in households, especially in poor households. Foods considered healthy (fruits and vegetables) are less consumed than the high-fat foods, sugars and processed products, emphasizing the preference of Brazilians for less healthy foods, in all income levels (IBGE, 2010b). However, the data limitation in the child food consumption does not allow for a specific analysis of the determinants of the amount of food destined for children and its effects on nutritional status. In the disponible last data base (POF 2008/2009), there are information on food consumption for individuals over 10-year-olds.

For this limitation, I disaggregate the household food consumption, by approach proposed by Chesher (1997, 1998) and applied by Bonnet et al. (2014), De Agostini (2005), Parkin (2002) e Miquel e Lasney (2001). So, I find the amount of food allocated to the public of interest and I estimate the magnitude and significance of price-elasticities of BMI and demand for healthy and unhealthy food categories, by specification of a health production function and a demand system theoretical consistent. The relationship between calorie acquisition rate and nutritional status, along with price elasticities of demand, also enabled to find the sensitivity degree of nutritional status to a reduction in healthy food prices (thin subsidies). The simulation of the thin subsidies' implementation has proved to be effective and significative for the variety of foods intended for poor children, in addition to reducing the amount of some foods unhealthy.

This paper is divided into five sections, include this introduction. The next section, I present the theoretical model on which I based the estimation of price effects on nutritional status. Section 3 presents the econometric models, variables and database used. The results obtained and the discussion is presented in the Section 4, while Section 5 presents the final comments.

2. Theoretical Framework

In a behavior model, it supposes rational individual has an ideal weight, so that being below or above generates disutility. The welfare derived to the nutritional status is based in subjective evaluation on the individual physical appearance. It is not chosen directly, so the individual will determine an optimal level of consumption and expenditure of calories to achieve it. Therefore, the individual nutritional status (H_i) is a health production function, in which the inputs are the calorie consumption (q_i) and the health endowment (ξ_i). The nutritional status results in food choices and calorie expenditure (PHILIPSON; POSNER, 2003; CAWLEY, 2003). For children, the welfare maximization depends on choices mother and her health cares for her children (BEHRMAN; DEOLALIKAR, 1988; REICHMAN et al., 2009). The optimal nutritional status and food destined for the child will be determined by a utility maximization process:

$$max\, U^M \left(H^M(q_{Mk}, I_{Mk},\ \xi_{Mk}), H^i(q_i,\ I_M, \xi_i\ ), y_i, y_M, O_M\right),$$
$$\text{s.a. } \sum_{l=1}^{L} p_{kl} y_{Mlk} + \sum_{l=1}^{L} p_{kl} y_{ilk} = m_{Mkr} + m_{ikr}, \tag{1}$$

where H^M e H^i are the mother and child health production function, respectively; I_M are the mother characteristics, that influence the owner and child health status; O_M are the non-food consumption. y_{ilk} is the quantity of food l and p_{kl} is the price; C_k is a vector of mother and household characteristics. The solution of this problem allows find the optimal quantity destined to each member of household k. It is assumed that purchasing decisions are based in physical quantities of each food, and not necessarily in nutrients that compose them. Consumer behavior is based in purchased goods, which is a good measure to access and variability (FAO, 1997; SMED et al., 2007). However, in (1) the nutritional status will depend of the caloric composition, which is a linear function of the quantity of food purchased. Since c_l is the caloric quantity for each kilogram of y_{ilk}, the total food converts in calories is $q_{ik} = \sum_{l=1}^{L} c_l y_{ilk}$.

Utility maximization in (1) can be constrained by budget, biological, and time constraints (CAWLEY, 2003), with budget constraints being the most significant limitation perceived by the individual in making their consumption decision. I assume that food expenditures are weakly separated from spending in other goods and that individuals decide how much to spend on food at a separate stage of other goods, and that decision will influence their nutritional status. Thus, it should be considered that only the expenditure (m_{ikr}) and the food prices (p_{ikl}) constitute the constraint that the individual faces to maximize its utility (DEATON; MUELLBAUER, 1980a).

The first order to (1) allows to determine the optimal food level destined to child *i*, as a price and expenditure function. The consumer decision influences the nutritional status, so:

$$H_i^* = H^*(q_{ik}^*(p_{ikl}, m_{ikr}), I_{ik}, \xi_{ik}), \tag{2}$$

For *L* food categories, in elasticities, the change in health status due a change in prices is (SCHROETER et al., 2008):

$$e_{Hp_j} = e_{Hqj}e_{jj} + \sum_{l=1}^{J-1} e_{Hqj}e_{lj}, \tag{3}$$

where e_{Hq} is the change in nutritional status due to change in consumption in food *l*, after the prices change, e_{jj} and e_{lj} are the own and cross price elasticities, respectively. The change in H_{ik} due the change in each food (e_{Hql}) is measured by the impact in the calories total change (e_{Hq}). As $q_{ikr} = \sum_{l=1}^{L} q_{ikrl} \Rightarrow {}^{\partial q_{ikrl}}/_{\partial q_{ikr}} = 1$, so:

$$e_{Hq_l} = \frac{\partial H_{ik}}{\partial q_{irkl}} \frac{\partial q_{irk}}{\partial q_{irk}} \frac{q_{irkl}}{H_{ik}} \frac{q_{irk}}{q_{irk}} = e_{Hq} \frac{q_{irkl}}{q_{irk}}, \tag{4}$$

According to Schroeter et al. (2008), it might be interesting to promote the acquisition of healthy foods by subsidizing their prices. For two types of food, l=A, B, where $kcal_A > kcal_B$, It is expected that the percentage change in BMI resulting from the change in the consumption of foods with a high caloric content will be higher ($e_{HqA} > e_{HqB}$), in addition to $e_{Hqj} > 0$, defined in (4), for all goods *j*. If the price reduction is to be effective, then $e_{HpB} > 0$, that is, a negative variation in the price of *B* will also cause a reduction in the BMI. Contrary to taxation, one can consider that:

$$\left(\frac{e_{HqA}}{e_{HqB}}\right) e_{AB} > |e_{BB}|, \tag{5}$$

As $e_{HqA} > e_{HqB}$, to satisfy this inequality, the goods must be substitutes ($e_{AB} > 0$). Thus, a reduction of calories acquired from the relatively caloric good is incentivized and, with that, the BMI will reduce. The lower the own price-elasticity of *B* itself and the greater the relation and substitution with caloric foods, the more effective the subsidization will be. Therefore, the relationship of substitutability between high and low-calorie foods is crucial if price changes are to be effective in bringing about changes in nutritional status. The relative efficacy will depend of the magnitude of the own and cross price elasticities of demand (SCHROETER et al., 2008).

3. Methodology

3.1. Individual caloric intake estimation from household consumption and demand system estimation

As an alternative to analyze the distribution of food among household members, Chesher (1997; 1998) proposes a method in which it is possible to identify and estimate food consumption on an individual basis from the available information in any unit of measurement (calories, kilograms or nutrients). Based in the author, I estimate the individual consumption with the relationship between the household food consumption per capita and individual and household characteristics. Let $\bar{q}_k$ the average food supply in household *k* and the inequality intrahousehold allocation, I considered:

$$\bar{q}_k = q_{ik} + \theta_{ik} = \hat{q}_{ik} + u_{ik} + \theta_{ik}, \tag{6}$$

where q_{ik} is the real food consumption of individual *i* in household *k*. If the consumption is less than the $\bar{q}_k$, so $\theta_{ik} > 0$. We can consider that the quantity observed by everyone, q_{ik}, is equivalent to the average rate of intake by age-gender and characteristics that influence the intrahousehold food allocation, in addition to deviations in that average for everyone, u_{ik}. These characteristics allow to predict $\hat{q}_{ik}$, that express the food quantity destined to individual i and theu_{ik} is the non-observed preferences, that deviate the individual food consumption total in this average. $\hat{q}_{ik}$ can be represented by a function multiplicative separate between individuals and household characteristics, $g(x_{ik}, z_k) = g(x_{ik})z(z_k)$, where:

$$\hat{q}_{ik} = g(x_{ik}, z_k) = [\sum_{g=1}^{2} \sum_{a=1}^{A=max} 1({x^1}_{ik} = a,\ {x^2}_{ik} = g)\ b_i \beta_{ag}] \exp(Z'\tau), \quad (7)$$

${x^1}_{ik}$ and ${x^2}_{ik}$ represents the age and gender, $1({x^1}_{ik} = a,\ {x^2}_{ik} = g)$ is an indicator function. The consumption average rate by age-gender is β_{ag}. As the observed consumption corresponds to the supply of food only at home, the estimated rate will be a portion b_i of which would correspond to the total value. Due to the discrete age distribution, smoothed estimation is applied at all ages[2]. Chesher (1997) considers total home acquisition. However, based on (6) and if the heterogeneities that influence the household allocation are captured in the vector of household characteristics z, it is estimated (7), considering the household caloric acquisition per capita, in relation to interaction age-gender dummies. With this, $\hat{q}_{ik}$ is expressed by the predicted value of the estimation for everyone.

The individual consumption estimate is utilized in the health production function, to obtain the relationship between the *BMI* and the calorie consumption. The procedure also applies to the quantities of each food categories considered in the demand system, to obtain the price elasticities. For this, I estimate the demand system using the QUAIDS model of Banks et al. (1997), corrected for the problem of null expenses, according to Shonkwiler and Yen (1999). Thus, the estimation of a system of equations for l goods was proposed, based in the following specification:

$$w_{iklt} = \Phi({z'}_{iklt}\hat{\alpha}_l)[c_l + D_k\theta_l + \sum_j \gamma_{lj}\ lnp_{jkt} + \beta_l\ ln\left(\frac{m_{iktl}}{a(p)}\right) + \frac{\lambda_i}{b(p)}\left\{ln\left(\frac{m_{iktl}}{a(p)}\right)\right\}^2 + u_l\hat{v}_{ikt}] + \varphi_l\phi({z'}_{ikltl}\hat{\alpha}_l) + \varepsilon_{iktl}, \quad (8)$$

where, w_{ilkt} is the portion of expenditure in the *l-th* good, by *i-th* individual; m_{iktl} represents total expenditure[3]; $a(p)$ is a price index[4];and p_{jkt} is the price of the *j-th* good. The QUAIDS model is similar to the AIDS, but considers the parameter λ_i, in reference to the impact of the quadratic term of the expenditure and incorporates a Cobb-Douglas price aggregator $b(p) = \prod_j p_j^{\beta_j}$, required to maintain system integrability; D_k is a vector of variables which can characterize the eating habits of family and individuals and θ_l is a vector of associated parameters, which indicate the effect of each variable. The density function of $\phi({z'}_{iktl}\hat{\alpha}_l)$ and the cumulative distribution function $\Phi({z'}_{iktl}\hat{\alpha}_l)$ are obtained by estimating a binary choice model (Probit). Equation (8) is estimated by means of a seemingly unrelated regression (SUR). The procedures of Blundell and Robin (1999) and Deaton (1988) are used to correct the endogeneity of expenditure and unit values, respectively.

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[2]. The energy and nutrients demand varies in a complex way throughout the life cycle, increasing rapidly between childhood and adulthood and, depending on the level of activity, declines in old age. In addition, food preferences may also vary throughout the life cycle. Estimation with age smoothing is important to produce a good adjustment of data and curves without much local variation. Thus, we find a parameter of penalty, considering some values in the estimates of the caloric acquisition by age, for each gender separately and we choose the one that minimizes the local variation (CHESHER, 1997; MIQUEL, LASNEY, 2001; DE AGOSTINI, 2005). I use the penalty parameter λ = 100, as used in Chesher (1997, 1998) and De Agostini (2005), we can see curves without much variation for both genres. Therefore, this will be the value adopted as a penalty parameter.

[3] I use total expenditure on *n* goods in the 2nd stage demand equations, as it preserves the restriction of the additivity, and allows for budget separability (DEATON, MUELLBAUER, 1980a).

[4] As the AIDS price index is not linear in its parameters, Deaton and Muellbauer (1980b) suggest the Stone index, to obtain a linear model. However, Moschini (1995) proves that this index is not invariant to changes in prices and quantities, and suggests the corrected Stone index and the Laspeyres index as substitutes.

The price elasticities, which measure the direct effect of a price change in the quantity demanded, are calculated as follows:

$$e_{lj} = \Phi(z'_{ik}\widehat{\alpha_l})\mu_{lj}\overline{w}_l^{-1} - \delta_{lj}, \tag{9}$$

where $\delta_{lj} = \begin{cases} 1\ se\ l = j \\ 0\ \ se\ l \neq j \end{cases}$, $\mu_{lj} \equiv \frac{\partial w_i}{\partial lnp_j}$ and $\mu_l \equiv \frac{\partial w_i}{\partial lnm_{iktl}}$. Because it is a function of estimated parameters, its standard error is estimated by the Delta Method. Due to the various estimation steps, we correct the variance-covariance matrix by bootstrapping to minimize the inefficiency of the estimators. This method consists of an alternative to obtain asymptotic approximations of standard errors and confidence intervals (PAN; JENSEN, 2008; SAM; ZHENG, 2010).

3.2. The child health production function estimation

The body mass index (BMI_{ikt}) depends to calories intake (q_{ikt}), in addition to the aspects not observed (ξ_{ikt}): calories expenditure, health cares, metabolic shocks and genetic. In absence of true caloric intake, we have (BONNET et al., 2008):

$$BMI_{ik} = \eta + \mu\hat{q}_{ik} + \mu u_{ik} + \xi_{ik}, \tag{10}$$

where ξ_{ikt} is an independent shock, $\hat{q}_{ik}$ is the estimated calories intake and μ is the real calories effect on the BMI. So:

$$\hat{\mu} = \frac{cov(IMC_{ikt}, \hat{q}_{ikt})}{var(\hat{q}_{ikt})} = \mu + \frac{cov(\hat{q}_{ikt}, u_{ikt})}{var(\hat{q}_{ikt})} + \frac{cov(\hat{q}_{ikt}, \xi_{ikt})}{var(\hat{q}_{ikt})}, \tag{11}$$

The u_{ik} is the individual preferences. So, an individual may have food consumption habits different from other individuals with the same age-gender. Thus, these preferences are independent of their characteristics and are not correlated with the caloric intake rate $\hat{q}_{ik}$. Food intake by children depend on the household choices, represented by the variables contained in the z_{ik}vector, used to estimate the caloric intake rate. However, ξ_{ik} contains unobserved caloric expenditure, which has a relationship of complementarity with caloric consumption, in addition to being influenced by individual characteristics. Other factors related to health care may also influence BMI and food intake, contributing to increase the bias in (11). Thus, I use proxies, related to healthier life habits, that can characterize the endowment of health of individuals.

Following Behrman and Deolalikar (1988), its important the inclusion of variables that reflects children health investments and cares, such as mother characteristics. This program requires its beneficiaries to provide medical follow-up of children, as well as guidelines and information on better eating patterns. In addition, the caloric intake rate is based on household data, requiring a variable that expresses food away-home consumptions. These two sources of food consumption have a substitution relationship and, together, are determinants of nutritional status. Thus, ignoring the effect of food away home may underestimate the effect of estimated caloric intake.

3.3. Database and variables

I use the microdata of the a Brazilian family budget survey (POF), a sample survey conducted by the Brazilian Institute of Geography and Statistics (IBGE). Two surveys are considered at two points in time: 2002/2003 and 2008/2009, with a sample of 48,568 and 55,970 households, respectively, (IBGE, 2006b; IBGE, 2010d). In both surveys, information on the household budget composition and living conditions of the population is available, in order to measure consumption structures, expenditures and income, as well as anthropometric information. Household food intake was defined as the conversion of quantities into kilograms for calories, according to the mean values specified in the Food Composition Tables, avaliable by IBGE.

As the database on individual consumption does not include individuals under 10 years old, I use the household acquisition disaggregation, suggested by Chesher (1997). The variables used in the individual consumption estimates were chosen according to Chesher (1997) and their statistics are presented in Table 1, for the complete sample. The estimation with the complete sample, for the two periods, is necessary to guarantee variability of the predicted values. Table 2 presents the descriptive statistics of health production function variables.

Table 1 – Descriptive statistics of variables used in estimating individual consumption

Variables	Mean	Standard Deviation	Min.	Max.
Household daily caloric intake per capita	1466.65	1242.85	50.25	6673.91
2008/2009	0.54	0.50	0	1
Age	30.25	19.38	2	80
Gender	0.49	0.50	0	1
Education of responsible	6.01	4.45	0	17
Number of children	1.14	1.26	0	10
Number of adolescents	0.60	0.86	0	7
Number of adults	2.30	1.14	0	13
Number of elderlies	0.32	0.63	0	6
Urban household	0.86	0.35	0	1
Income of Adult-equivalent (AE)	956.93	1105.72	8.33	9978.36

Source: Results of the research

Table 2 – Descriptive statistics of health production function variables, 2008/2009

Variables	Mean	Standard Deviation	Min.	Max.
BMI	16.42	2.43	13	34.8366
Mother responsable by household	0.20	0.40	0	1
Mother education (years)	4.81	3.36	0	15
Mother is obese	0.16	0.36	0	1
Urban household	0.58	0.49	0	1
Age	5.84	2.27	2	9
Gender	0.53	0.50	0	1
Individual consumption estimate	1182.04	77.85	835.03	1428.81
Food consumption at school				
Provided by the school	0.65	0.48	0	1
Purchased at school	0.01	0.07	0	1

Source: Results of the research

I characterize the food away-from-home by dummies which identify the food consumption at school: Provided by the school or purchased. I disregard the household food consumed at school, since this is already included in the variable *individual consumption estimate*. The individual food consumption by categories is also estimated by the equation (6). The foods are aggregate in 14 categories and the unit values are obtained by linear aggregation $UV_{rkt} = \sum_{l}^{L}(w_{lkt}UV_{lkt})$, *r=1,...,14*. I consider the amount pay on household is the same between the residents, and I obtain the category expenditure by the individual consumption estimate and the unity value for the *lth* category. I estimate the demand system by *l-1* goods (YEN et al., 2003) and consider the category *Other foods* as residual good. In the demand system, the variables that represent the characteristics of the mother were also included as controls: (if she is responsible for the household, if she is obese and its education level), and if the household is urban and if the responsible considers that the food consumed at home are always of the preferred type.

4. Results and discussion

Table 3 presents the estimated individual caloric intake averages, for the total sample, and by age groups. For comparison, the first column corresponds to observed consumption, available in the POF 2008/2009 survey on individual consumption. In the second column, I present the individual consumption estimate based on total household food acquisitions, as in Chesher (1997) and the third column, I present the estimation, based in per capita household consumption, as in equations (6). It was seen that the estimates using per capita household intake approximate observed consumption (equation 6), while the use of total household intake, as in Chesher (1997), underestimates the consumption of individuals under the age of 18 years. The individual consumption contained in the database of the survey are based on individual statements of what was consumed in two non-consecutive days. According to the author, this type of information could contain some bias, because is more susceptible to measurement errors than a disaggregation of the registry of food acquisitions at home. That could explain the differences in the standard deviations of the three measures presented. Following the same strategy of disaggregation of total household calorie acquisition, I estimate the intake rate (weekly) by age-gender and household characteristics for calories from the food categories analyzed. Due to the excessive number of tables, it was decided not to present the estimates of the function in (6), for per capita and for categories consumption.

Table 3– Observed and estimated household caloric intake, by age group, 2008/2009

Age	Observed consumption		Total household consumption		Per capita household consumption	
	Mean	Std dev.	Mean	Std dev.	Mean	Std dev.
Total	1473.56	705.41	1583.65	555.23	1495.44	203.80
2 - 9	-	-	898.71	217.62	1306.07	136.82
10 - 17	1581.29	739.02	990.96	251.67	1364.54	139.38
18 - 29	1435.20	676.48	1478.00	286.15	1593.05	189.27
30 - 59	1437.15	694.24	1956.20	391.03	1554.84	176.56
60 or +	1424.84	610.70	2102.84	298.14	1733.95	161.18

Source: Results of the research.

Following the same strategy of total home caloric acquisition, I estimate the individual calorie consumption (weekly) from food categories. Table 4 shows the average per capita consumption, which reflects the food supply at home, compared to the quantities per adult equivalent[5] and the estimated individual caloric consumption, for each age group. The measures that do not consider the age composition of the household, are not very informative about the allocation of food among its members. In the first case, the consumption per capita does not consider the composition of the household, while the second, is a measure in terms of a referential individual. The disaggregation proposed in subsection 3.1 allowed to visualize the average distribution of calories, according to gender, age and household characteristics.

[5] The equivalence measure is $e_k = (A_k + \alpha C_k)^{\theta}$, where A and C, correspond to the number of adults and children in the *k-th* household, respectively. The value of 0.75 for the parameters (α, θ) was considered, according to Wagstaff and van Doorslaer (1998).

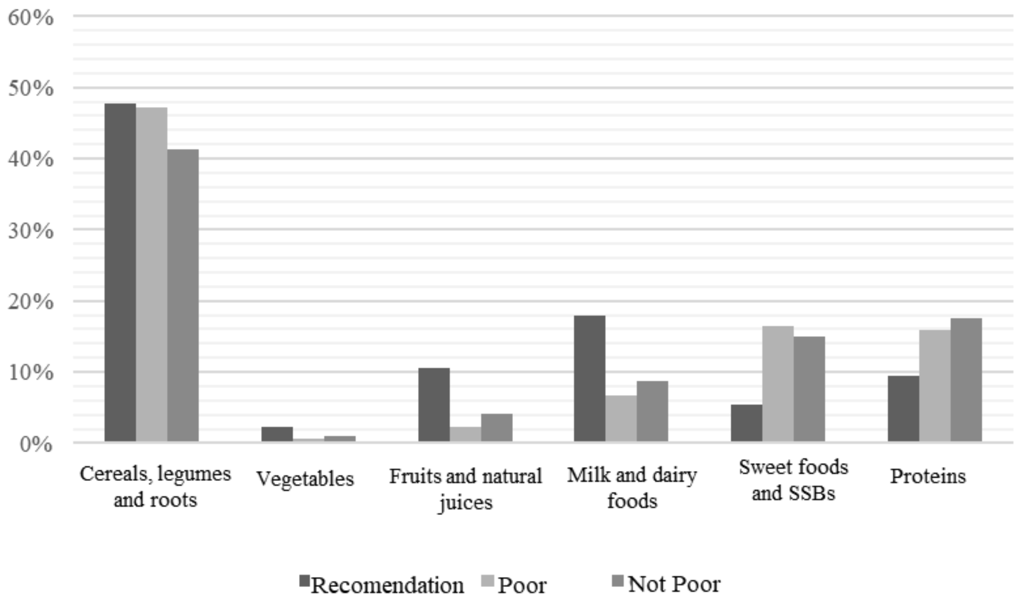
Table 4 – Household food consumption per capita, per adult equivalent (AE) and individual food consumption estimate, by age and yea

Categorias	Per capita		AE		By age							
					2002/03				2008/09			
	2002/ 03	2008/ 09	2002/ 03	2008/ 09	< 10	10 - 24	25 - 59	60 ou +	<10	10 - 24	25 - 59	60 ou +
Cereals, legumes and roots	2583.6	1866.4	3967.5	2741.6	2616.9	2750.1	2720.9	3394.5	1862.5	2002	2031.1	2411.7
Fruits and Vegetables	442.5	493.8	643.23	692.3	358.8	392.1	486.5	723.8	374.5	409.3	536.1	803.6
Beef and pork	858.1	822.6	1271.2	1182.2	747.7	835.3	975.0	1214.4	704.1	778.9	922.2	1148.3
Chicken na eggs	670.2	665.3	1003.1	963.6	594.2	635.8	691.9	858.0	608.7	659.7	738.0	898.3
Fish	276.8	45.1	397.0	66.6	243.2	244.7	285.3	358.0	49.4	46.1	47.8	53.1
Processed meats	601.8	803.6	892.7	1154.1	490.8	582.4	639.1	697.0	655.8	730.5	854.9	950.4
Milk and yogurt	620.7	537.4	914.7	764.4	655.5	538.1	657.7	785.2	535.2	461.9	563.0	643.9
Pasta and bread	1226.4	1503.7	1835.8	2173.1	1026.6	1136.1	1227.4	1361.2	1326.3	1402.8	1536.2	1699.9
Sweet foods	1638.3	1367.4	2479.0	1997.8	1463.0	1541.4	1655.3	2085.5	1264.7	1310.8	1423.3	1665.0
Soft drinks	134.8	180.5	196.1	258.0	99.6	121.5	136.8	132.5	146.0	159.6	194.6	173.3
Diet and light	12.1	67.7	17.0	94.7	5.9	8.1	11.6	23.7	49.8	50.0	73.2	118.8

Source: Results of research.

In the Table 4 results, I report the individual consumption provides of the household food consumption. These individual consumption averages are likely to be even greater for young people and adults, since food away from home has become a convenient option for individuals who work and study, associated with the opportunity cost between working and preparing their own food (PAN; JENSEN, 2008). This also explains the fact that means for the last age group (above 60 years old) is higher in almost all categories, since the food consumption of the elderly is predominantly at home.

Verley Jr. et al. (2013) present the recommended participation for some food categories, based on caloric reference consumption (2000 kcal / day). If the individual's caloric intake is greater than this value, the recommended portions will also be proportionally larger. Thus, the recommended caloric intake will be the same for all individuals. For each food group mentioned, the following reference participations are made: 45% of cereals and derivatives, tubers and roots; 2.8% of beans; 10.5% of fruits and natural juices; 2.3% of vegetables; 18% milk and milk products; 9.5% of meat and eggs. As for oils and fats, in addition to sweets and sugars (including soft drinks), the proportion in the diet should not exceed 3.7% and 5.5% of the total calories, respectively. Graph 1 shows the participation in the total of calories at home, for children analyzed, living in poor households, compared to those in other income level. Both groups present an inappropriate pattern of food consumption, but it is possible to observe disparities in consumption, since children in a vulnerable economic situation are more distant from the recommended levels, and interventions are needed to help reverse this situation.



Graph 1 – Recommendation and participation in individual consumption of calories estimated by poor and non-poor children
Source: Results of research.

Table 5 shows the health production function estimate. About the variables that represent the food consumption, the BMI effect of individual calorie consumption is 0.0016 (column OLS 4), after controlling for child and mother characteristics, that is, the increase in 100 kcal in the child diet, increase the BMI in 0.16 kg/m².

The distinction between price elasticities at home and individual price elasticities is important for policies that aim to reduce overweight tax, since this problem can differentiate between members. In addition, the total consumed by members of a household may be different, making analyzes based on the average per capita or per adult-equivalent small informative about the effects of changes in socioeconomic variables (DEATON, 1997). Thus, in the same household, the quantity consumed may not suffer the same variation among its members, give a price variation. Estimates of individual elasticities are needed to show how these changes contribute to reducing / increasing the acquisition of certain foods, taking into consideration how these changes influence household allocation. To verify reductions in the prices of healthier foods for children's food purchases, this section is intended to present the food-price elasticities and the BMI-price elasticities, based on the estimated caloric acquisition rates.

The impact on the quantity of each category that is destined for the children is shown in Table 6, in the form of own and cross-price elasticities, calculated based on equation (18), in average. By the delta method, the standard deviations were found, allowing statistical inference on all results. Due to the assumption of weak separability, comparisons are made only among the categories considered. Goods can be classified, according to Marshallian price elasticities, as gross complements when the increase in the price of the good *j* reduces the quantity demanded of the good *l* and gross substitutes when this increase raises the quantity demanded. In 182 cross-relationships presented in Table 6, only half were significant at 10% significance level, with 48% of the significant relationships being of complementary and 52% of substitution. Even though they are significant, the magnitudes found are low, indicating that changes in relative prices will not generate changes in children consumption food. This can be not interesting, as such behavior reflects the issue of the possibility of buying from poorer consumers. In fact, a change in prices may not be enough to get other goods. In the case of complementary goods, if prices are relatively high, joint purchasing is impossible, given the income restriction of these families.

Table 5 – Estimatives of health production function for poor children (2 to 9 years old)

Variables	MQO1	MQO2	MQO3	MQO4
Individual calorie consumption	0.00195***	0.00194***	0.00186***	0.00161***
	(0.0004)	(0.0003)	(0.0004)	(0.0004)
Food consumption at school				
Provided by school		-0.180	-0.184	-0.150
		(1.639)	(1.772)	(1.331)
Purchased at school		0.0237	-0.0339	-0.0428
		(0.0437)	(0.0467)	(0.0431)
Individual characteristics				
Age			0.0629***	0.0685***
			(0.0147)	(0.0130)
Gender			0.0102	0.00793
			(0.0431)	(0.0515)
Mother and household characteristics				
Mother responsible by household				0.0394
				(0.0617)
Mother education (years)				0.0536***
				(0.00920)
Mother is obese				0.484***
				(0.0796)
Urban household				0.225***
				(0.0612)
Constant	14.12***	14.11***	13.87***	13.68***
	(0.455)	(0.392)	(0.474)	(0.442)

Note: Standard deviations in parentheses are estimate by booststrap and clustered by psu; significance level: * p<0,10, ** p<0,05, *** p<0,01.
Source: Results of research.

Table 6 – Marshallian Own and cross-prices elasticities of demand food for poor children (2 to 9 years old)

	q1	q2	q3	q4	q5	q6	q7	q8	q9	q10	q11	q12	q13
p1	-0.980***	-0.017***	-0.009***	-0.017***	-0.008*	-0.009***	0.0013	0.0254***	0.0063	-0.0014	-0.011***	0.0021	-0.004***
p2	-0.0089	-0.991***	0.0001	-0.0001	-0.0067*	-0.0016	-0.0041*	0.0088	0.005	-0.0005	0.0038	0.0009	0.0015
p3	0.0242***	-0.012***	-1.028***	-0.0014	-0.009***	-0.0015	-0.0012	0.0018	-0.0012	0.0012*	0.0011	0.0015	-0.004***
p4	-0.0085	-0.0024	-0.006*	-1.071***	0.0225***	0.0038*	0.0058	0.0473***	0.0196***	-0.0022	0.0093*	0.0035*	0.0009
p5	0.0489***	-0.020***	-0.001	0.0191***	-1.020***	0.0043*	-0.019***	0.0113	0.0474***	0.0029**	-0.034***	-0.0033	-0.0003
p6	0.0336***	0.016***	-0.008***	0.0358***	-0.016***	-0.998***	0.0128***	-0.046***	0.0318***	0.0008	0.0109**	-0.0010	0.0020
p7	-0.0085	-0.001	0.013***	0.009*	-0.0019	0.0032	-1.040***	0.0047	0.0176***	-0.0004	-0.030***	0.0011	0.0002
p8	0.0119***	-0.008***	-0.008***	-0.007***	-0.008***	-0.002***	-0.005***	-0.993***	-0.0026	-0.0004	0.0071***	-0.002***	0.0003
p9	-0.026***	0.0013	0.0055*	-0.0084	-0.0076	-0.0044*	-0.014***	-0.0077	-0.911***	-0.0017*	0.0340***	-0.0004	0.0013
p10	-0.030***	-0.009***	0.0040	0.0017	0.0110*	-0.0004	-0.0050	0.0006	-0.0101	-1.001***	-0.0037	-0.0003	0.0043***
p11	-0.055***	-0.002	0.005***	0.0144***	0.0072***	0.0044***	0.0009	0.0119***	0.0155***	0.0002	-1.077***	0.0023***	0.0009
p12	0.0637***	0.0101**	-0.017***	0.0079	-0.0020	0.0013	-0.019***	0.0021	-0.0105	0.0004	-0.040***	-1.026***	0.0060*
p13	-0.0003	0.0126***	0.0185***	-0.0072	-0.0095	-0.014***	0.0071*	0.0135	-0.027***	0.0009	0.0470***	0.0046*	-1.011***

Note: Significance level: * p<0.10. ** p<0.05. *** p<0.01, obtained by Delta Method and standard deviations estimate by bootstrap and clustered by psu

Source: Results of research

Some healthy foods are inelastic, which would make the application of a thin subsidy ineffective. Nevertheless, if the reduction affects one or more food groups, it is also necessary to verify how the demand for a given good behaves given the variation in the price of other goods. When analyzing the effectiveness of any policy that proposes changes in food prices, the impact on other categories should be verified. Depending on the policy, the amount of expenditure allocated to each group will also change, so that spending on infant feeding will be reallocated in response to changes in relative prices (SCHROETER et al., 2008). So, I calculate the thin subsidies effects on the food average quantity destined to child (Table 7) . Based on the estimated elasticities, I simulate the thin subsidies effects on the prices of categories that contain foods considered to be healthy: Cereals (including legumes and roots), Vegetables, Fruits, Fish and Milk, on the total quantity of each category analyzed (Table 7). Scenarios based on a 20% price reduction are proposed, in addition to the combination of subsidies for Fruits and Vegetables and all healthy categories (except Cereals), which has low participation in the food consumption of the analyzed individuals. Despite the few significant relationships, healthy foods (Cereals, Vegetables, Fruits, Milk and Yogurts) have a predominance of complementary relationships. That is, a subsidy on the price of these foods can contribute to increase the quantity of other foods, contributing to a more varied diet, especially due to the existence of complementary healthy foods.

For Cereals, that it is essential to diets of poor children, since it is complementary to most categories. A reduction in its price would also contribute to increase consumption of vegetables, fruits, chicken and fish. However, it would also contribute to the consumption of Sweet foods and contribute in a small way to reduce the acquisition of Pasta, which would be its main substitute in terms of carbohydrate acquisition.

As for the other foods considered essential for children's health and development, I highlight the relationship between the price of Fruits and the quantity demanded of Vegetables and Chicken, which classify them as complementary. This is important to improve food consumption through subsidies, since the fall in their price will encourage not only more than a proportional consumption variation in the quantity of fruit, but also increase consumption of other healthy foods. It is also important to note that the reduction in the price of fish can not only encourage its acquisition, but also discourages consumption of processed meats, since they are substitutes. This impact reflects the importance of subsidizing healthier protein sources, such as encouraging consumers to quit foods that contain this nutrient, but also others that are harmful to health. Although the share of fish in the infant diet is low, following the household pattern (Table 8), the reduction in its price for those families that consumes it results in an extra resource to purchase Fruits, Chicken and Milk. It also appears that the subsidy given to the Milk category helps to reduce the consumption of Sweets. Probably, this relationship is due to the inclusion of yogurts in the first category, which may be a healthier snack option for children, than the items included in the Sweets category. However, giving a 20% discount on the price of Milk, purchased at home, also increases the purchase of Soft Drinks by 2.30%.

The last column of Table 7 shows the importance of jointly subsidizing these foods, showing a favorable scenario to promote a change in the pattern of children's caloric intake, contributing to a more diversified diet. I highlight how a joint reduction in the prices of these foods by 20%, besides generating a proportional increase in their own quantities, contributes significantly to the reduction of Pasta (-4.7%) and Sweet foods (-8.2%). Despite the magnitude of this impact, it is emphasized that these categories are part of child consumption and should be discouraged.

With the estimated coefficient for this BMI-calorie (Table 8), considering the average points of BMI distribution and infant food consumption, we can say that the 1% increase in calories acquired at home by 1% increases BMI in 0.12%. From the expression in (3), the sensitivity of the analyzed nutritional status indicator is calculated, given 1% price changes in each category. These elasticities are presented in Table 7, as well as the participation in each category in the total caloric intake and total calorie variation. I should be noted that these variations are calculated based on the participation, according to equation (4).

According Schroeter et al. (2008), we expect that, for foods that want to stimulate consumption, the price elasticity of BMI should be positive. Thus, thin subsidies could also contribute to maintaining that index within what is acceptable. In the case of Vegetables, even though it is a low-calorie food, the elasticity of BMI in relation to the price of that category was equivalent to -0.003, implying that a 20% discount on its price could increase the index by 0.06%. Similar impact is perceived in relation to Milk, whose subsidy would increase the average infant BMI by 0.1%. The reduction in the price of fruits and fish has proved effective in change the nutritional status. Given a 20% price reduction of these goods, the average BMI falls by 0.06% and 0.18%, respectively.

Once the effects cancel out, a combined discount given of the prices of Fruits and Vegetables and of a healthy food basket, in addition to not being able to change the standard food consumption of poor children, is also not interesting to avoid the growing cases of overweight in this age group, given that the elasticity in the mean is not statistically significant. The scenario that proposes 20% subsidies to foods essential to the children's diet, while promoting variability, does not modify the total caloric intake. So, this intervention does not reverse the process of growth of the average BMI of economically vulnerable children and, consequently, it does not reduce the incidence of childhood obesity. Thus, the policy generates a trade-off between variability in consumption and maintenance of nutritional status, on average. Table 8 also presents the BMI elasticities for unhealthy foods. For these foods, a subside policy would be effective in reducing the average BMI (because the negative signals), but it should be implemented with caution, so as not to discourage the consumption of foods that have a relation of complementarity with the taxed good.

Despite the low magnitude of the effects, which would signal the poor efficacy of changes in food prices on child nutritional status, the results corroborate with the analyzes in the literature (SCHROETER et al., 2008; FANTUZZI, 2010). In Fletcher et al. (2010), for example, showed that the effect of taxing soft drinks on the consumption and BMI of children and adolescents on calories is small and without significant influence on BMI (-0.01%), considering the effects of substitution between other beverages (milk, for example). For the public under analysis, the effects are still lower for most categories, due to the concentration of the food pattern in a few categories, which makes price changes ineffective to generate a significant change in the quantity acquired and, consequently, in the BMI. It is worth noting that the magnitudes of the cross-price elasticities are low, implying that changes in prices will not be enough to promote changes in the food pattern.

In fact, since food prices are the main determinants of consumer decision-making, thin subsidies may directly contribute to significant changes in the food consumption pattern, even if the combined changes in nutritional status are insignificant. This would be their advantage over income transfer policies, especially for the sample analyzed, which presents standards below the recommendations of the public health agencies due to insufficient income, which limits their choices. A price discount may be more effective by directly stimulating consumption of the subsidized basket. This corroborates with the results of Hidrobo et al. (2014) which, through a random distribution of coupons, found an improvement in the quantity and quality of the food purchased by the beneficiaries.

Table 7 – Marshallian own-price elasticities of food demand and impacts of the 20% reduction in healthy food prices, for children (2 to 9 years old)

Categories	Own elasticities	Cereals, legumes and roots	Vegetables	Fruits and natural juice	Fish	Milk and yogurt	Fruits and vegetables	Health foods (except q1)
q1. Cereals, legumes and roots	-0.922***	18.44%***	0.88%*	-2.00%***	-2.84%***	-1.07%***	-1.11%	-5.02%***
q2. Vegetables	-0.718***	10.51%***	14.35***	7.21%***	-9.92%***	4.91%***	21.56%***	16.56%***
q3. Fruits and natural juices	-1.854***	5.701%***	-0.11%	37.07%***	4.96%***	5.19%***	36.96%***	47.11%***
q4. Beef and pork	-1.891***	4.39%***	0.079%	0.39%	-8.88%***	1.86%***	0.47%	-6.55%***
q5. Chicken and eggs	-1.219***	1.63%*	1.42%*	1.94%***	3.48%***	1.73%***	3.36%***	8.56%***
q6. Fish	-0.924***	7.95%***	1.48%	1.39%	18.47%***	2.33%***	2.87%**	23.68%***
q7. Processed meats	-1.872***	-0.56%	1.80%*	0.54%	-5.57%***	1.98%***	2.34%*	-1.26%
q8. Milk and yogurt	-0.953***	-3.72%***	-1.32%*	-0.30%	6.51%***	19.06%***	-1.62%	23.95%***
q9. Pasta and breads	-0.295***	-1.24%*	-0.02%	0.10%	-5.18%***	0.41%	0.08%	-4.69%***
q10. Others ultra-processed foods	-1.109***	3.26%	1.08%	-2.69%*	-1.77%	1.01%	-1.61%	-2.36%
q11. Sweet foods	-2.361***	3.67%***	-1.38%	-0.41%	-3.88%**	-2.57%***	-1.79%	-8.24%***
q12. Soft drinks	-2.592***	-2.38%	-1.06%	-1.80%	1.19%	2.30%***	-2.86%	0.63%
q13. Diet or light foods	-2.378***	9.34%***	-3.75%	10.82%***	-5.16%	-0.78%	7.07%**	1.14%
q14. Other foods (residual good)[a]	-0.500***	-17.63%***	2.74%	-16.61%***	17.37%***	-7.48%***	-13.87%***	-3.99%

Note: Significance level: * p<0.10. ** p<0.05. *** p<0.01, obtained by Delta Method and standard deviations estimate by bootstrap and clustered by psu

Source: Results of research

Table 8 - Total calories participation of each category and price elasticities of BMI, for children (2 to 9 years old)

Categories	Participation on total calories	Total calories variation	BMI variation
q1. Cereals, legumes and roots	34.48%	-0.273***	-0.032***
q2. Vegetables	0.63%	-0.022**	-0.003**
q3. Fruits and natural juices	2.12%	0.024***	0.003***
q4. Beef and pork	6.43%	-0.008	-0.001
q5. Chicken and eggs	7.70%	-0.085***	-0.010***
q6. Fish	2.05%	0.061***	0.007***
q7. Processed meats	4.43%	-0.148***	-0.017***
q8. Milk and yogurt	6.47%	-0.034***	-0.004***
q9. Pasta and breads	12.93%	-0.034**	-0.007**
q10. Others ultra-processed foods	0.18%	-0.057***	-0.007***
q11. Sweet foods	15.77%	-0.373***	-0.045***
q12. Soft drinks	0.76%	-0.069***	-0.008***
q13. Diet or light foods	0.20%	0.123***	0.015***
q14. Others foods	5.85%	-0.069***	-0.008***
Combined impact (20% prices reduction)			
Fruits and vegetables	2.75%	-0.052	-0.006
Health foods (except Cereals)	11.27%	-0.59	-0.07

Note: Significance level: * p <0.10, ** p <0.05, *** p <0.01, obtained by Delta Method and standard deviations estimate by bootstrap and clustered by psu.
Source: Results of research.

5. Conclusions

The pattern of food consumption in households is one of the main factors responsible for the early incidence of chronic noncommunicable diseases and the growth of cases of childhood obesity, making specific analyzes necessary to guide policy interventions to reverse this situation, as well as to encourage new habits food. In this sense, this paper analyzed how intervention in healthy food prices (thin subsidies) affects the amount of food in the household, allocated to children. I restricted the sample to households in poverty, since the participation of their children's healthy foods is more distant from the recommended levels.

Since it is not possible to observe data on the food intake of children under 10 years old in the database, I obtained the individualized estimates of calories from household aggregate. Thus, I can predict the total calorie consumption and by food categories among age groups. In addition, obtaining estimates of food consumption allowed the estimation of an individual demand system, specific for children aged between 2 and 9 years old, whose quantities allocated to these individuals are the result of a maximization process of the welfare of the person responsible by the child, who makes this decision, under the influence of several socioeconomic variables. That is, changes in these variables lead the responsible to change how much food will be allocated to the child, impacting on their nutritional status.

Considering the socioeconomic variables that influence this process, the most important are the prices and income, which constitute the budget constraint and limit the consumption possibilities. Especially for poor children, it is perceived that the insufficiency of income reduces these possibilities to a food basket with low variability. From the relationship between BMI and calories and the price elasticity demand for food, I simulate the effects of a discount to the healthy food prices on the pattern of children consumption and nutritional status. The low magnitude of the price impact indicates that changes in food prices have a small influence on the food quantity allocated to children analyzed. This may be due to income restriction, which does not allow changes in the consumption structure, even with the gain in purchasing power given by a reduction in food prices. Even so, the thin subsidies in a healthy food basket are more effective to promote a significant variability of consumption, in addition to reducing the consumption of processed meats and sweet foods. This is due to substitution relations between these and healthy foods, indicating that healthy dietary habits are not practiced because they are relatively more costly to these consumers. Nevertheless, the BMI effects is not significative.

The purpose of the study was to investigate the influence of these policies in terms of outcomes. However, it is also in the interest of a policy maker to compare these interventions in terms of cost. That is, it would be interesting to investigate whether government expenditures with the distribution of discount coupons for economically vulnerable families and the transfer to the retail would be relatively cheaper and viable than the income transfer policy. It is worth mentioning that the present analysis is static, reflecting the impact of what is consumed in the period, on average, on the stock of body mass, which is the result of the habits practiced over time. A dynamic analysis would contribute to verify the role of the analyzed policies on the formation of new habits and their influence on this stock. It is also suggested, as future research, the disaggregation of household food consumption, according to nutritional composition and to verify how these interventions also influence the acquisition of nutrients by the children.

References

BANKS, J.; BLUNDELL, R.; LEWBEL, A. Quadratic Engel curves and consumer demand. **The review of Economics and Statistics**, v. 79, n. 4, p. 527-539, nov., 1997.

BEHRMAN, J.R.; DEOLALIKAR, A.B. Health and Nutrition. In: CHENERY, H.; SRINIVASAN, T.N**. Handbook of Development Economics**, v.1. North Holland, Nova York, 1988.

BIRCH, L. L.; VENTURA, A. K. Preventing childhood obesity: what works? **International journal of obesity,** v. 33, Ps74-Ps81, 2009.

BLUNDELL, R.; ROBIN, J. M. Estimation in large and disaggregated demand systems: an estimator for conditionally linear systems, **Journal of Applied Econometrics**, n. 14, p.209-232, 1999

BONNET, C.; DUBOIS, P.; OROZCO, V. Food Consumption and Obesity in France, **Mimeo Toulouse School of Economics,** Dec, 2008.

______. Household food consumption, individual calorie intake and obesity in France. **Empirical Economic**, n. 46, p. 1143-1166, 2014.

CASH, S. B.; SUNDING, D. L.; ZILBERMAN, D. Fat taxes and thin subsidies: Prices, diet, and health outcomes, **Food Economics - Acta Agriculturae Scandinavica,** Section C, v. 2, p. 167-174, 2005.

CAWLEY, J.; An economic framework for understanding physical activity and eating behaviors. **American journal of preventive medicine**, v. 27, n. 3, p. 117-125, 2004

CHESHER, A. Diet reveled?: Semiparametric estimation of nutrient intake. **Journal of Royal Statistical Society**, v. 160, n.3, p.389-428, 1997.

______. Individual demands from household aggregates: time and age variation in the composition of diet, **Journal of Applied Econometrics,** n. 13, p. 505-524, 1998.

COX, T.; WOHLGENANT, M. Prices and quality effects in cross-section demand analysis. **The American Journal of Agricultural Economics,** v. 68, n.4, p. 908 – 919, 1986.

DEATON, A. Quality, quantity and spatial variation of prices. **The American Economic Review**, v. 78, n. 3, p. 418-430, jun., 1988.

______. **The analysis of household surveys:** A microeconometric approach to development policy. The Johns Hopkins University Press, Baltimore, 479 p., 1997.

______.; MUELLBAUER, J. **Economics and consumer behavior.** New York: Cambridge, 1980a, 450p.
______. An Almost Ideal Demand System. **The American Economic Review.** v. 70, n. 3., p. 312-326, jun., 1980b.
DE AGOSTINI, P. The relationship between food consumption and socioeconomic status: Evidence among British youths. ISER Working Paper 21, 2005.
DREWNOWSKI, A.; DARMON, N.; BRIEND, A. Replacing fats and sweets with vegetables and fruits: a question of cost. **American journal of public health**, v. 94, n. 9, p. 1555-1559, set., 2004.
FLETCHER, Jason M.; FRISVOLD, David E.; TEFFT, Nathan. The effects of soft drink taxes on child and adolescent consumption and weight outcomes. **Journal of Public Economics**, v. 94, n. 11, p. 967-974, 2010.
FLORES, M.; RIVAS, J. **Cash incentives and unhealthy food consumption.** Bulletin of Economic Research, v. 69, n.1, p. 42-56, 2017.
FOOD AND AGRICULTURAL ORGANIZATION OF THE UNITED NATIONS – FAO. **Implications of economic policy for food security:** a training material. Roma: FAO, 1997.
FRANKS, P.W.; HANSON, R. L.; KNOWLER, W. C.; SIEVERS, M.L.; BENNETT, P. H.; LOOKER, H. C. Childhood obesity, other cardiovascular risk factors, and premature death. **The New England Journal of Medicine,** v. 362, Feb., 2010.
INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA - IBGE. **Antropometria e estado nutricional de crianças, adolescentes e adultos no Brasil.** Rio de Janeiro: 2010a.
______. **Avaliação nutricional da disponibilidade de alimentos no Brasil.** Rio de Janeiro: 2010b.
______. **Análise do consumo alimentar pessoal no Brasil.** Rio de Janeiro: 2010c.
_____. **Percepção do estado e saúde, estilo de vida e doenças crônicas:** Brasil, Grandes Regiões e Unidades de Federação, 2013. Rio de Janeiro: 2014.
LIN, B. H., SMITH, T. A., LEE, J. Y., Hall, K. D. Measuring weight outcomes for obesity intervention strategies: the case of a sugar-sweetened beverage tax. **Economics & Human Biology**, v. 9 4, 329-341, 2011.
LOPEZ, R. A.; FANTUZZI, K. L. Demand for carbonated soft drinks: implications for obesity policy. **Applied Economics**, n. 44, p. 2859-2865, 2012.
MIQUEL, L.; LAISNEY, F. Consumption and nutrition: age-intake profile for Czechoslovakia 1989-1992. **Economics of Transition**, v. 9, n.1, p. 115-151, 2001.
REICHMAN, N. E., CORMAN, H., NOONAN, K., DAVE, D. Infant health production functions: What a difference the data make. **Health Economics**, 2009, v.18, n.7, p. 761-782.
PAN, S.; JENSEN, H. H. Does the Food Stamp Program Affect Food Security Status and the Composition of Food Expenditures? **Journal of Agricultural and Applied Economics**, v. 40, n. 01, p. 21-35, 2008.
SCHROETER, C.; LUSK, J.; TYNER, W. Determining the impact of food price and income changes on body weight. **Journal of Health Economics,** n. 27, p. 45-68, 2008.
SHONKWILER, J.; YEN, S. Two-step estimation of a censored system of equations. **American Journal of Agricultural Economics**, v. 81, n. 4, p. 972-982, Nov. 1999.
SMED, S., JENSEN, J. D., DENVER, S. Socio-economic characteristics and the effect of taxation as a health policy instrument. **Food Policy**, n. 32, p. 624-639, 2007.
VERLEY JR, E. et al. Adesão ao guia alimentar para população brasileira. **Revista de Saúde Pública**, v. 47, n. 6, p. 1021-1027, 2013.
WHITAKER, R. C.; WRIGHT, J. A.; PEPE, M. S.; SEIDEL, K. D.; DIETZ, W. H. Predicting obesity in young adult from childhood and parental obesity. **The New England Journal of Medicine,** v. 337, n. 13, Sep., 1997.
World Health ORGANIZATION – WHO. **Reducing risks, promoting healthy life.** Paris: WHO, 2002. Disponível em: http://whqlibdoc.who.int/publications/2002/9241562072.pdf. Acesso em: 12 de dezembro de 2014.
______. **Global health risks:** mortality and burden of disease attributable to selected major risks. Geneva: WHO, 2009. Disponível em:

http://www.who.int/healthinfo/global_burden_disease/GlobalHealthRisks_report_full.pdf. Acesso em: 21 de Agosto de 2015.
______. **Assessing and managing children at primary health-care facilities to prevent overweight and obesity in the context of the double burden of malnutrition.** Geneva: WHO, 2017. Disponível em: who.int/nutrition/publications/guidelines/children-primaryhealthcare-obesity-dbm/en. Acesso em: 24 de outubro de 2017.