# HOUSEHOLD FOOD CONSUMPTION AND DEMAND FOR NUTRIENTS IN SRI LANKA

Manori Nimanthika Lokuge Dona
Department of Agricultural and Applied Economics
Texas Tech University
Email: manori-nimanthika.lokuge@ttu.edu

Sanja Zivkovic
Department of Agricultural and Applied Economics
Texas Tech University
Email: sanja.zivkovic@ttu.edu

Kelly Lange
Department of Agricultural and Applied Economics
Texas Tech University
Email: kelly.lange@ttu.edu

Benaissa Chidmi
Department of Agricultural and Applied Economics
Texas Tech University
Email: benaissa.chidmi@ttu.edu

***Selected Paper prepared for presentation at the Southern Agricultural Economics Association's 2018 Annual Meeting, Jacksonville, Florida, February, 3-6 2018***

## Abstract

As people move away from nutritionally rich diets, the prevalence of non-communicable diseases (NCDs) has become one of the major challenges to the present world. However, the impact of NCDs on developing nations is more pronounced than that on developed nations. Sri Lanka, a lower-middle income developing country, is currently experiencing a rising incidence of NCDs. Close association between NCDs and unhealthy dietary habits infers the importance of studying household food and nutrient consumption in order to introduce sound policy implementations. Sri Lanka lacks national level studies related to food and nutrient consumption at household levels, thus the objective of this study is to analyze demographic and socio-economic determinants of consumption for major food commodities in Sri Lanka. Data are obtained from the latest household income and expenditure survey conducted by the Sri Lankan Department of Census and Statistics. Price and expenditure elasticities for food commodities are estimated using the Quadratic Almost Ideal Demand System (QUAIDS). The zero-expenditure problem that typically exists in survey data is circumvented by employing a Tobit model. Analysis is further extended to calculate nutrient elasticities. The results of this study demonstrate the impact of price and income changes on dietary intake of households.



**Keywords: Food demand, Nutrient elasticities, QUAIDS, Tobit**

## 1. Introduction

In the present world, both developed and developing countries are experiencing a nutritional transition that occurs as a result of a shift in dietary consumption and energy expenditure due to economic, demographic, and epidemiological changes. It steers people to move away from nutritionally rich diets, while leading the way towards unhealthy diets. Unhealthy diets often consist of a lot of processed or fast food that provide more calories from fat, saturated fat, trans fat, sodium and added sugars, therefore are less nutritious. According to the World Health Organization (WHO), unhealthy diets are one of the major risk factors which are responsible for non-communicable diseases (NCDs). Currently, in Sri Lanka, the prevalence of NCDs has become the largest contributor to disease burden in the country. Sri Lanka has turned out to be a victim of nutritional transition which leads to under-nutrition, overweight, and obesity. According to Jayawardena et al. (2014), NCDs have become more prominent during the last two decades. Furthermore, diet-related chronic diseases had been responsible for 18.3% of total mortality and 16.7% of hospital expenditure in Sri Lanka.

Sri Lanka is a developing country which falls into the lower-middle-income category in which the Gross National Income (GNI) per capita lies within $ 1,046 – $ 4,125 (World Bank 2016). Being a less developed country, Sri Lanka is severely affected by the repercussions of this growing burden of NCDs. The country is losing her productive individuals while simultaneously incurring high expenditures on medical facilities which could have been invested in more productive sectors such as agriculture, tourism, apparel, and textile. This results in a poor performance of the economic sector in Sri Lanka. Therefore, it is important to find solutions where food policy implementations play a crucial role at the nutritional improvement of people.

According to the past studies of Jayawardena et al. (2012, 2013) and Jayawardena (2013), a close association between NCDs and unhealthy dietary habits leads majority of Sri Lankans towards a failure of achieving recommended nutrient intakes. This infers the fact that respective authorities should concentrate more on nutritional factors when establishing policies. To introduce effective interventions, the knowledge of food consumption is crucial as Sri Lanka is a multi-cultural country with several religions and ethnic groups.

Food demand patterns and nutrient intakes are strongly correlated as any change in food prices and/or income affects the food consumption, thus affecting the individual's nutrient availability. Similar to price and income elasticities in food consumption studies, nutrient elasticities indicate the impact of changes in food prices and real income on the consumption of nutrients.

Although several studies had been published with respect to the nutrient intakes of Sri Lankan households, studies focused on nutrient elasticities are scarce in the literature. After Sahn's (1988) study on food energy intake in Sri Lanka, Nirmali and Edirisinghe (2015) had estimated price and income elasticities for the calorie availability of households in the Western province of Sri Lanka. However, a review of the literature indicates that there has been insufficient number of national level studies targeted on nutrient elasticities in Sri Lanka for more than two decades.

Given the circumstances, this study intends to examine household food consumption patterns in Sri Lanka, primarily focusing on nutrient intakes. The analysis aims to: 1) capture demographic impacts on the consumption of major food commodities in Sri Lanka, 2) estimate price and expenditure elasticities of major food commodities, and 3) compute nutrient elasticities with respect to food prices and expenditure.

The remainder of this paper is as follows: (1) section 2 reviews an extant literature on food and nutrient demand, (2) section 3 provides an overview of the empirical model, methodological issues, and data employed in this study, (3) section 4 discusses econometric results, and (4) section 5 presents conclusions and policy implications.

## 2. Literature Review

By addressing malnutrition and undernutrition issues in Tanzania, Abdulai and Aubert (2004) examined the demand for food and nutrients using the Quadratic Almost Ideal Demand System (QUAIDS) and a moment-based instrumental variable approach, respectively. Authors suggest that income improvements may have a considerable potential to enhance nutritional status in developing nations. Moreover, they recommend low-income countries such as Tanzania, to promote diversified diets with adequate levels of micronutrients at the community level in order to alleviate malnutrition. The study of Ecker and Qaim (2011) on food and nutrient consumption in Malawi is also based on the QUAIDS. In addition, authors had adopted the two-step estimation procedure proposed by Shonkwiler and Yen (1999) to avoid the zero-expenditure problem that results due to zero consumption during the recall period. According to Ecker and Qaim (2011), income-related policies are more likely to be favorable than price subsidies in improving nutrition.

Sahn (1988) insists that it is mandatory to be aware of food consumption patterns and parameters in predicting the effects of policy changes on households with different characteristics. This study provides a methodology for disaggregated food policy analysis in order to study the effects of food policies on consumers. Food consumption levels and food acquisition behavior among different population groups in Sri Lanka was considered to predict the impact of changes in food prices and income on food energy intake. The analysis was carried out using a set of price and income parameters, disaggregated by income groups and sector. Elasticity estimates of prices, expenditure, and calories suggest that moderation of food prices through technological changes will be in favor of uplifting food and calorie consumption among poor households. Further, Nirmali and Edirisinghe (2015) employed the Linear Approximation of the AIDS (LA/AIDS) and revealed that expected price increases in future will have a noticeable impact on the food and nutrition security of households in the Western province of Sri Lanka. Similarly, Ulubasoglu et al. (2016) also utilized the LA/AIDS to estimate food demand elasticities for Australia and found that price variations may heavily affect rice and meat consumption, whereas a little impact can be expected on consumption of milk and preserved fruit.

However, De Agostini (2014) states that very slow change can be expected in average daily individual calorie intake in the United Kingdom as a response to changes in food prices. Tian and Yu (2013) suggest income growth in poor families will increase consumption of plant food which is rich in carbohydrates and fiber. On the contrary, animal products which are rich in cholesterol will be highly demanded by people once they are free from poverty. Therefore, policies aiming at the nutritional improvement of people should not solely depend on income growth.

## 3. Empirical analysis

This study is centered on the consumer expenditure allocation which takes place in two stages. In the first stage, consumer primarily allocates total expenditure among various commodity groups such as food, clothing, housing, transport, and entertainment. Further, it is assumed that food groups (cereals, prepared food, pulses, vegetables, leafy vegetables, yams, meat, fish, dried fish, eggs, coconut, dairy products, and fruits) are weakly separable from all the other commodities demanded by the consumer. Since we are interested only in the demand for food commodities, our focus lies on the expenditures allocated in the second stage among different food groups.
To be consistent with the situations where budget shares are not linear in expenditure, Banks et al. (1997) proposed the QUAIDS that has the following indirect utility function:

$$\ln V = \left\{\left[\frac{\ln m - \ln a(P)}{b(P)}\right]^{-1} + \lambda(P)\right\}^{-1} \quad \textbf{(1)}$$

where $m$ is total expenditure, $P$ is a vector of prices, $a(P)$ is a differentiable, homogeneous function of degree one in prices, and $b(P)$ and $\lambda(P)$ are differentiable, homogeneous functions of degree zero in prices.

Consequently, household food consumption is analyzed using the QUAIDS **(equation 2)** proposed by Banks et al. (1997):

$$W_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln P_j + \beta_i \ln\left(\frac{m}{a(P)}\right) + \frac{\lambda_i}{b(P)}\left\{\ln\left[\frac{m}{a(P)}\right]\right\}^2 \quad \textbf{(2)}$$

where $W_i$ = budget share of $i^{th}$ food group; $P_j$ = price of the $j^{th}$ food group; $m$ = the total expenditure on all food items per household; $a(P)$ and $b(P)$ = functions of the vector of prices $P$. $\alpha_i$, $\gamma_{ij}$, $\beta_i$, and $\lambda_i$ are the parameters to be estimated.

The $ln\ a(P)$ has the translog form as follows:

$$ln\ a(P) = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln P_i + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \gamma_{ij}\ lnP_i\ lnP_j \quad \textbf{(3)}$$

$b(P)$ is the simple Cobb-Douglas price aggregator **(equation 4).**

$$b(P) = \prod_{i=1}^{n} P_i^{\beta_i} \quad \textbf{(4)}$$

In order to conform to the demand theory, following restrictions **(equations 5-7)** should be imposed on the parameters of the model (Chang and Serletis 2012).

Additivity $\sum_{i=1}^{n} \alpha_i = 1;\ \sum_{i=1}^{n} \beta_i = 0;\ \sum_{i=1}^{n} \lambda_i = 0;\ \sum_{i=1}^{n} \gamma_{ij} = 0$, for all $j$ **(5)**

Homogeneity $\sum_{j=1}^{n} \gamma_{ij} = 0$, for all $i$ **(6)**

Symmetry $\gamma_{ij} = \gamma_{ji,}$ for all $i, j$ **(7)**

Data for this study are obtained from the Household Income and Expenditure Survey (HIES) 2012/13, conducted by the Department of Census and Statistics (DCS), Sri Lanka. The HIES 2012/13 covers all 25 districts in the country and provides information on demographic characteristics, income, and expenditure of households in Sri Lanka. The sample consists of 20,536 households.

The HIES does not provide the actual market prices of commodities. Following the common practice undertaken in literature (Park et al. 1996; Weliwita et al. 2003), a proxy of unit values (expenditure/quantity) is used as prices of each food item ($P_{ki}$). Nevertheless, each food group consists of more than one food item. Hence, based on the price proxies, prices for each food group ($P^*$) are computed as the Stone's Price Index **(equation 8)**.

$$\ln(P^*) = \sum_{k=1}^{m} W_{ki} \ln(P_{ki}) \qquad \textbf{(8)}$$

where $W_{ki}$ and $P_{ki}$ represent the budget share and price proxies of $k^{th}$food item in the $i^{th}$food group, respectively.

Households may report zero expenditure on certain food commodities due to non-preference, responses to market price, or to sufficient household inventory during the survey period (Cheng and Capps 1988). Accordingly, for those households that reflect zero-expenditure, the $P^*$ is replaced by the average values of the non-zero $P^*$s within the ideal cluster (Weliwita et al. 2003).

Sample statistics with respect to food budget shares, price indexes, and expenditure are presented in Table 1. Cereals has the highest budget share amongst all food groups. Moreover, cereals, vegetables, pulses, and coconut report the least values for the proportions of zero consumption, indicating that these are the food groups that are mostly consumed by Sri Lankans.

However, if zero expenditure observations are excluded in the estimation, parameter estimates would be inconsistent because of the selectivity bias (Cheng and Capps 1988). Consequently, to circumvent the infrequent consumption observed in some households, the two-step procedure developed by Shonkwiler and Yen (1999) is employed.

We first utilize a probit model to model the market participation of households as follows:

$$y_{ih}^{*} = f(P^{*}, m; \theta) + \epsilon_{ih}, \qquad d_{ih}^{*} = Z_{ih}'\tau_i + v_{ih}, \tag{9}$$

$$d_{ih} = \begin{cases} 1 \; if \; d_{ih}^{*} > 0 \\ 0 \; if \; d_{ih}^{*} \leq 0 \end{cases} \qquad y_{ih} = d_{ih} y_{ih}^{*} \tag{10}$$

where:

$y_{ih}$ and $d_{ih}$ = observed dependent variables,

$y_{ih}^{*}$ and $d_{ih}^{*}$ = corresponding latent variables,

$\theta$ = vector of all parameters in the QUAIDS **(**specified in **equation 2)**

$Z_{ih}$ = vector of exogenous variables,

$\tau_i$ = conformable vector of parameters,

$\epsilon_{ih}$ and $v_{ih}$ = random errors, for the $i^{th}$food group and $h^{th}$household (Shonkwiler and Yen 1999; Yen et al. 2002).

Demographic variables ($Z_{ih}$) (Table 2) are incorporated into the probit model to capture how purchasing decisions for each and every food group vary based on demographic characteristics. Sri Lanka has several ethnic groups: Sinhalese, Tamils, and other ethnicities (Moors, Malays, Burghers, and other). Sector is classified under three different categories: urban, estate, and rural[1]. Therefore, ethnicity and sector are considered in the form of dummy variables, where other ethnicities and rural sector are regarded as the reference categories for ethnicity and sector, respectively. When household size is of significance, it is more realistic to take household size as proportional to the gender and age of household members. With compared to a household with kids, a household of same size with adults may consume more food and nutrients. Hence, by utilizing the information provided in Nanayakkara (1994), adult equivalent is constructed for each household based on its gender and age composition, thereby, more accurate estimate can be expected for food and nutrient consumption than the household size.

Unlike in linear regression models, probit coefficients cannot be directly used for interpretations. Following Greene (2012), the interpretations of demographic variables considered in the probit model are based on the marginal effects computed in Stata. Based on Shonkwiler and Yen (1999), after obtaining probit estimates $(\widehat{\tau_i})$ in the first step, the normal probability density $\left(\phi(Z'_{ih}\widehat{\tau_i})\right)$ and the cumulative distribution $\left(\Phi(Z'_{ih}\widehat{\tau_i})\right)$ are calculated in the second step. Subsequently, $\phi(Z'_{ih}\widehat{\tau_i})$ and $\Phi(Z'_{ih}\widehat{\tau_i})$ are incorporated into the QUAIDS (specified in **equation 2),** therefore, the estimating model is:

$$W_i^* = \Phi(Z'_{ih}\widehat{\tau_i})\left(\alpha_i + \sum_j \gamma_{ij} \ln\left(P_j^*\right) + \beta_i \ln\left(\frac{m}{a(P^*)}\right) + \frac{\lambda_i}{b(P^*)}\left\{\ln\left[\frac{m}{a(P^*)}\right]\right\}^2\right) + \delta_i \phi(Z'_{ih}\widehat{\tau_i}) + \varepsilon_i \tag{11}$$

However, as in conventional systems, the adding-up restriction **(equation 5)** does not hold in censored demand systems. Consequently, the QUAIDS is estimated by considering all $n$ equations (Yen et al. 2002; Ecker and Qaim 2011). The Generalized Method of Moments (GMM) is used for the estimation to avoid possible heteroscedasticity and endogeneity of budget share equations (Abdulai and Aubert 2004).

[1] Urban sector covers all residential areas governed by a municipal council or an urban council. Plantation areas that are more than 20 acres of extent and having not less than ten residential laborers come under the estate sector. Areas that cannot be grouped under urban or rural sectors are considered rural sector.

Next, expenditure and uncompensated price elasticities are calculated according to **equations 12** and **13**, by differentiating **equation 11** with respect to $\ln m$ and $\ln P_j^*$, respectively (Ecker and Qaim 2011).

$$\eta_m = \left(\frac{\mu_i}{W_i^*}\right) + 1 \tag{12}$$

where $\mu_i = \frac{\partial W_i^*}{\partial \ln m} = \Phi(Z_{ih}'\hat{\tau}_i)\left(\beta_i + \frac{2\lambda_i}{b(P^*)}\left\{\ln\left[\frac{m}{a(P^*)}\right]\right\}\right)$.

$$\eta_p = \left(\frac{\mu_{ij}}{W_i^*}\right) - \delta_{ij};\ \delta_{ij} = 1 \text{ for } i = j,\ \delta_{ij} = 0 \text{ for } i \neq j \tag{13}$$

where $\mu_{ij} = \frac{\partial W_i^*}{\partial \ln P_j^*} = \Phi(Z_{ih}'\hat{\tau}_i)\left(\gamma_{ij} - \mu_i\left(\alpha_j + \sum_k \gamma_{jk} \ln P_k^*\right) - \frac{\beta_j\lambda_i}{b(P^*)}\left\{\ln\left[\frac{m}{a(P^*)}\right]\right\}^2\right)$.

According to Lancaster (1966), consumers maximize their utility not from the good per se, but from the characteristics it possesses. In this regard, consumers maximize utility from various attributes of the food such as nutrient content, taste, texture, and color. This creates a demand for nutrients, where the consumption of nutrients depends on food prices, income, and demographic variables. Given the rising incidents of NCDs and unhealthy dietary habits, as done in past studies (Behrman and Wolfe 1984; Weinberger 2001; Variyam et al. 2002; Abdulai and Aubert 2004), the demand for nutrients is estimated as a function of food prices, total food expenditure, and demographic characteristics.

To facilitate direct estimation of elasticities, Behrman and Wolfe (1984) and Tian and Yu (2013) suggest transforming nutrient intakes and other explanatory variables into log values. Therefore, demand for calories, proteins, fats, and carbohydrates is estimated according to the following model **(equation 14)** as a system of equations using the Iterated Seemingly Unrelated Regression (ITSUR). Due to the presence of heteroscedasticity in the model, standard errors are obtained through heteroscedasticity-consistent covariance matrix. Further, nutrient consumption may vary with households' purchasing power. Consequently, we compute nutrient elasticities for the population, poorest, and richest quintiles with respect to food prices and expenditure.

$$\ln N_{hp} = \alpha + \beta \ln P_i^* + \gamma \ln m_h + \delta Z_h + \mu_h \quad \textbf{(14)}$$

where $N_{hp}$ = $p^{th}$ nutrient intake in the $h^{th}$ household, $P_i$ = a vector of price indexes of food groups, $m_h$ = total food expenditure in the $h^{th}$ household, $Z_h$ = a vector of demographic variables.

The vector $Z_h$ contains the same demographic variables that we considered for the food consumption (Table 2), where $Z_{hd}$ represents dummy variables (sector and ethnicity). Therefore, interpretations of nutrient intakes with respect to sector and ethnicity are based on the percentage effects calculated as follows (Greene 2012):

$$\%\left(\Delta E\left[N_{hp}|Z_{hd}\right]/\Delta Z_{hd}\right) = 100\% \left\{\frac{E\left[N_{hp}|Z_{hd}=1\right]-E\left[N_{hp}|Z_{hd}=0\right]}{E\left[N_{hp}|Z_{hd}=0\right]}\right\} = 100\%\left[exp\left(\delta_{Z_{hd}}\right)-1\right] \quad \textbf{(15)}$$

Since the HIES does not provide data on nutrient intakes of households, dietary intakes of calorie, protein, fats, and carbohydrates should be derived from the food consumption data provided by the HIES. Consequently, nutrient intakes are calculated using nutrient databases available in the Biodiversity for Food and Nutrition, Sri Lanka (n.d.) and the U.S. Department of Agriculture (2016). Following Nanayakkara (1994), weekly intake of nutrients is estimated as stated below.

$$N_{ihp} = \sum_{k=1}^{m}\left[Q_k . g_k \left(\frac{P_k}{100}\right) f_{N_{kp}}\right] \quad \textbf{(16)}$$

where $N_{ihp}$ = $h^{th}$ household's total intake of the $p^{th}$ nutrient gained through the consumption of $i^{th}$ food group, $Q_k$ = weekly consumption of the $k^{th}$ food item, $g_k$ = gram equivalent of the $k^{th}$ food item, $P_k$ = percentage of edible portion of the $k^{th}$ food item, $f_{N_{kp}}$ = conversion factor for the respective nutrient. Thus, $N_{hp} = \sum_{i=1}^{n} N_{ihp}$.

## 4. Results and Discussion

### 4.1. Demographic, price, and expenditure effects on food consumption

Demographic determinants of the market participation of households for each food group are interpreted based on the significant marginal effects of probit estimates. Therefore, only the marginal effects of 1$^{st}$ stage probit estimates are shown here (Table 3).

Urban households, compared to rural households, show less tendency to consume cereals, pulses, vegetables, yams, dried fish, and coconut, while moving towards prepared food, leafy vegetables, meat, fish, eggs, dairy products, and fruits. Marginal effects with respect to the estate sector reveal that estate households are more likely to consume pulses, dried fish, and dairy products than rural households. Amidst the food groups that are less likely to be consumed by estate sector households, consumption of fish is the least (Table 3).

However, when comparing two major ethnicities with other ethnicities in Sri Lanka, no significant marginal effects are recorded for cereals and coconut. Even though the marginal effects of vegetables are significant, the probability difference shared with other ethnicities is minute. Cereals, coconut, and vegetables are essential components in Sri Lankan meals, and it is evident that these food groups are demanded by each household regardless of their ethnicity. Regarding two major ethnicities, both Sinhalese and Tamil households express similar effects for most of the food groups. These two ethnicities demand pulses, vegetables and yams more than other ethnicities. However, they are less likely to consume prepared food, meat, fish and eggs. Majority of Sinhalese and Tamils is Buddhists and Hindus in religion, respectively. Hence, reported low tendencies of Sinhalese and Tamil households to purchase animal source foods may have been affected by religious impacts because most Buddhists and Hindus are vegetarians.

Marginal effects of adult equivalent report significant values for all food groups. As expected, with an increase in household size or adult equivalent, households are more likely to buy all food commodities, except prepared food. Prepared food may be needed in bulk quantities in order to maximize the utility of all household members. As prepared food is ready-to-eat food, it is not economical to purchase it in large quantities. Therefore, lower tendency to purchase prepared food when adult equivalent increases is quite acceptable (Table 3).

More than 90% of estimated parameters of the second-step QUAIDS are statistically significant at 1% level. In favor of the QUAIDS, all food groups except dairy products report significant coefficients ($\lambda_i$) for the quadratic term of the expenditure. However, even though QUAIDS parameter estimates are highly significant, they are not presented here for brevity because they do not facilitate economic interpretations (Abdulai and Aubert 2004). Instead, we examine household food consumption in terms of price and expenditure elasticities.

Table 4 presents uncompensated own-price and cross-price elasticities for the 13 food groups. Own-price elasticities of all food groups are statistically significant at 1% level, and negative as expected, therefore, consistent with the demand theory. Estimates which absolute values are above unity, meat (-1.24) and eggs (-1.04) are found to be price-elastic, while all other food groups are price-inelastic. Price elasticities of the most popular food groups among Sri Lankans such as cereals, pulses, vegetables, and coconut lie within -0.5 and -0.7. Nonetheless, price elasticities of prepared food, leafy vegetables, yams, fish, dairy products, and fruits vary between -0.8 and -1.0, hence, they are on the verge of being price elastic.

These results infer that whenever market prices rise, Sri Lankans are more likely to give up consumption of meat, eggs, prepared food, leafy vegetables, yams, fish, dairy products, and fruits. The main meal of Sri Lankans, is rice with several side dishes of pulses (mostly red lentils) and vegetables, where a curry of animal proteins (meat, fish, or eggs) is added for non-vegetarian meals. Coconut serves as one of the essential ingredients in making these curries. Accordingly, reported lower values for the price elasticities of cereals, pulses, vegetables, and coconut are evident because they are the food groups that are highly demanded by Sri Lankans regardless of their market prices. Besides, all sources of animal proteins are price elastic, thus, people may approach dried fish as a substitute for costly animal source food in order to obtain animal proteins. Therefore, it is not surprising to observe the price elasticity of dried fish within the range of -0.5 and -0.7 (Table 4).

According to the cross-price elasticities presented in Table 4, cereals and yams can be identified as substitutes. The marginal effects of probit estimates also suggest that rural households are more likely to consume yams. Consequently, it is noteworthy to recognize the rural community of the country to validate this substitutability between cereals and yams. Due to usual dietary patterns of Sri Lankans, pulses, coconut, vegetables, fish, and dried fish are indeed complements to cereals and yams. Yet, the significant complementary behavior shared between cereals and prepared food is contrary to the expectation. With compared to the substitutability of animal source foods considered in this study, it is of significance to notice that both meat and eggs are substitutable with dried fish.

Sri Lankans normally take fruits as dessert, and dairy products for morning and evening tea. Therefore, neither fruits nor dairy products are accompanied by other food groups. Further, none of the other food groups can serve fruits and dairy products as substitutes. Given that, it is not realistic to discuss cross-price elasticities of fruits and dairy products with other food groups.

All food groups report statistically significant expenditure elasticities at 1% level. Food groups considered in this study are well-liked components of Sri Lankan cuisine and hence, no household can be expected to move away from these food groups as living standards enhance. Thus, it is understandable why none of the food groups appears to be inferior. Expenditure elasticities are positive for all groups and vary within 0.7 and 1.8, while recording the lowest values for pulses and the highest for eggs. Meat (1.25), fish (1.39), eggs (1.82), dairy products (1.26), and fruits (1.57) report expenditure elasticities above unity. Even though prepared food (0.92) has its expenditure elasticity below one as other necessary food groups do, the difference is only slightly small (Table 4).

These estimates of expenditure elasticities infer that Sri Lankans are less likely to access meat, fish, eggs, dairy products, fruits, and also, prepared food, unless they achieve higher living standards as a result of real income or economic growth. Conforming to the dietary patterns of Sri Lankans, cereals (0.79), vegetables (0.78), and pulses (0.71) indicate lowest expenditure elasticities amongst 13 food groups. As discussed above with respect to price elasticities, expenditure elasticities also highlight the dominant role played by cereals, vegetables, and pulses in Sri Lankan diets. This signifies that households tend to purchase these food groups, despite living standards and market prices, hence, cereals, vegetables, and pulses have become necessities to Sri Lankans.

### 4.2. Demographic, price, and expenditure effects on nutrient consumption

Nutrient elasticities with respect to demographic variables are presented in Table 5. Because sector and ethnicity enter the model as dummy variables, percentage effects are calculated as mentioned in the methodology **(equation 15)**, and interpretations are based on significant estimates. Urban households are more likely to consume low nutrient levels compared to nutrient consumption of rural households. Percentage effects for intakes of fats (12.8%) and carbohydrates (9.1%) report highest most differences between urban and rural residents. Households in the estate sector, however, record higher intake of carbohydrates (9.1%) and lower intake of fats (12.6%) than their counterparts in the rural sector.

Both Sinhalese and Tamil households indicate relatively higher consumption for all nutrients than those of other minor ethnicities. Corroborating the phenomenal role played by rice and coconut in Sri Lankan diets, Sinhalese households denote highest nutrient intakes of fats (22.4%) and carbohydrates (21.6%). For Tamil households, the highest are the intakes of carbohydrates (15.6%) and proteins (10%), where cereal-based diets of Tamils are usually accompanied by curries made from pulses in which proteins are the major nutrient. Consequently, nutrient consumption is expected to be influenced by ethnic differences coupled with religious impacts.

All nutrient elasticities with respect to the adult equivalent are positive and statistically significant. For a 10% increase in the adult equivalent, intakes of carbohydrates, fats, and proteins are likely to increase by 4.1%, 3.5%, and 3.1%, respectively. It is true that households increase their food consumption as adult equivalent increases, yet, the highest value is reported for carbohydrates coming from cereals due to the staple food in Sri Lanka. Conversely, proteins denote the lowest increment, emphasizing the relative low accessibility to high-priced rich protein sources.

Table 6 show nutrient elasticities with respect to food prices and expenditure, categorized under the whole population, poorest, and richest households. Nutrient elasticities with respect to price changes of most of the food groups are significantly negative. As quantity demanded for all food groups is found to be inversely related with corresponding price changes, it is true that price upturns may diminish nutrient intakes of households. However, consumption of all nutrients appears to be very less responsive to the price changes in most of the food groups. It is evident that household food consumption heavily depends on substitutes, and consequently, they alter food choices as prices vary. Because of the ability to endure these price changes through substitution, it is clear that households are more likely to gain necessary nutrients by any means. Therefore, nutrient intakes are not sensitive to the food price changes as food consumption exhibits.

Conversely, nutrient intakes tend to be affected by the price changes in cereals and meat relatively in higher magnitudes. Significant reduction in consumption of carbohydrates and calories can be expected as a result of a price increase in cereals. Secondly, protein intake will be discouraged as meat prices increase. Rice, the staple food in Sri Lanka, represents the majority of cereals group and is the main source of carbohydrates. Similarly, meat is a rich source of proteins. Cereals (rice) and meat are responsible for notable shares of carbohydrates and proteins, respectively; therefore, substitution is more challenging. Moreover, price of cereals remains the most powerful category for the carbohydrates intake in both poor and rich households, while price variations in fish and dried fish may influence protein intakes in poor households.

Expenditure elasticities for all nutrients are statistically significant at 1% level. Proteins (0.75) record the highest expenditure elasticity in the population, while calories (0.61) indicate the lowest value. These results imply that people may shift towards other affordable food choices such as cereals and vegetables, in order to obtain adequate energy. This is apparent from the expenditure elasticity recorded by carbohydrates (0.63), which is the lowest value amongst three macro-nutrients. This again represents the usual dietary pattern of Sri Lankans, where the majority of households are devoted to have rice at least for one meal. Rice, being the staple food in Sri Lanka and a rich carbohydrate source, compensates the calorie intake when costly protein sources are not affordable. While being closer to the carbohydrate's expenditure elasticity, calorie intake seems to be affected by the fat intake as well. Since rice is consumed together with several curries in which coconut milk serves as one of the major ingredients, coconut becomes the major source of fat in Sri Lanka (Table 6).

Cross-price elasticities presented in Table 4 unveil the substitutability of price and expenditure elastic animal source foods (meat, fish, eggs, and dairy) with low-cost food groups like cereals, vegetables, yams, coconut etc., which again are rich sources of carbohydrates and fats. This highlights that when people confront an income shock, they may, however, find a way to obtain calories that the body needs, but not consuming essential nutrients in sufficient levels. Hence, even though calories show the least sensitivity to the changes in expenditure, it does not mean that carbohydrates, fats, and proteins are being equally responsible for the calorie intake. Nevertheless, in an event of facing unfavorable economic situations, people may shift towards price and expenditure inelastic protein sources such as pulses and dried fish in order to obtain proteins. However, cross-price elasticities show that people are more biased to select carbohydrate and fat sources as substitutes for animal source foods, thus, it is also noteworthy to consider the trend to move away from animal proteins.

This highest sensitivity to the nutrient protein is evident not only in the population as a whole but also in the extremes of expenditure levels, the poorest and the richest. If living standards weaken by 10%, poorest households will drop their protein consumption by 7.8%, while 6.3% decline can be expected in richest households (Table 6). Therefore, although the poorest and richest may respond in different magnitudes as expenditure varies, proteins remain as the least accessible nutrient for both groups. Interestingly, fats appear to be the least responsive macro-nutrient in both poorest and richest households. This may be due to the higher consumption of coconuts in Sri Lanka. Given that, it corroborates the fact that Sri Lankans intake of calories is consistent with imbalanced nutrient intakes.

Furthermore, consumption of all macro-nutrients in deprived communities will relatively be affected in higher proportions than the well-off. Even though the percent change in the consumption of each nutrient (proteins, fats, and carbohydrates) is less than the percent change in expenditure, the poorest can be expected to worse off as a result of a hostile economy. Besides, as expenditure increases, richest households vary more in consumption of proteins, fats, and carbohydrates (0.41 - 0.63) than those of poorest households (0.71 – 0.78) (Table 6). This finding infers that, when civilians meet enhanced living standards in a favorable economy, more imbalanced nutrient intakes are expected in wealthy households. As a result, households are likely to continue imbalanced nutrient intakes, regardless of the status of livelihoods.

## 5. Conclusions and Policy Implications

As an attempt to fill the gap perceived in the extant literature, this study provides an insight of food and nutrient consumption in Sri Lanka. The QUAIDS with GMM, and ITSUR are employed to examine the impacts of food prices and socio-economic characteristics on food and nutrient intakes, respectively.

Lower sensitivity to the price changes of cereals, pulses, vegetables, dried fish, and coconut indicates that these food groups are considered the most important in Sri Lankan dietary patterns. Conversely, price variations in meat and eggs will have a huge impact on the consumption of meat and eggs, while the demand for prepared food, leafy vegetables, yams, fish, dairy products, and fruits are also likely to exhibit a higher sway as prices fluctuate. Fruits and all animal source foods except dried fish are found to be the most sensitive food groups to the changes in expenditure. However, except for leafy vegetables and yams, the magnitudes of price elasticities of all food groups are less than their counterparts of expenditure elasticities. Hence, enhanced standards of living may have a greater influence on the consumption of most of the food groups than that of price reductions. This implies that income-related policies play a crucial role in food consumption patterns, rather than price policies. Nevertheless, a rise in wealth may not encourage the consumption of leafy vegetables and yams as a price drop does.

Dried fish seems to be a manageable food for all households, where only wealthier people are able to purchase other animal source foods such as meat, fish, eggs, and dairy products. A shortage of dried fish in the market will have a dire impact on the consumption of animal source foods and animal proteins. Therefore, the fisheries sector of Sri Lanka needs to introduce strategies that are favorable to dried fish producers to uplift the dried fish industry.

Since no substitutions are available for dairy products and fruits, their high sensitivity to prices and expenditure may motivate consumers to discontinue consumptions whenever the market and economic situations are unfavorable. Cheap price policies may encourage purchasing dairy products and fruits, yet, domestic producers will worse off as a result of low returns. Thus, policies that will improve household income may be useful to achieve a sustainable change. However, both fruits and dairy products consist of local production and imports. As a result, not only the policies related to domestic production but also trade policies should be carefully investigated.

Sectoral impacts are evident in both food and nutrient consumption. Urbanites are the potential group to access most of price and expenditure elastic foods, yet, exposed to low nutrient intakes. Ethnic disparities do not influence consumption of cereals, coconut, and vegetables, whereas consumption of meat complements can be affected. However, gain of nutrients is higher for both Sinhalese and Tamils than that of minor ethnicities.

Conversely, amongst all macro-nutrients that provide energy, proteins are the least accessible nutrient to Sri Lankans. High consumption of rice and coconut induces intakes of carbohydrates and fats, respectively. Therefore, imbalanced nutrient intakes with more carbohydrates and fats, but fewer proteins can be expected. However, seasonal or short-term price variations may not adversely affect the nutrient consumption of households. Yet, relatively a higher impact can be observed in the calorie intake as a result of fluctuations in cereals and meat prices that affect carbohydrate and protein intakes, respectively. Nutrient consumption of poor households appears to be more responsive to the food price changes than nutrient consumption in rich households.

Nevertheless, expenditure effects greatly influence households' consumption of nutrients. Hence, policies should be targeted on improving income and living standards rather than controlling prices of food commodities. However, income growths and price moderations may not ensure balanced nutrient consumption of individuals. Because of the devoted dietary patterns of Sri

Lankans, such policies that are favorable for consumers may put individuals more nutritionally risk in some instances. Consequently, all income and price regulations should be carried out concurrently with campaigns that educate people about nutritional dietary patterns.

**Future Research**

Demand for food and nutrients may exhibit diverse impacts under different income groups. Future research should consider estimating demand under disaggregated income levels. Further, consumption choices vary amidst intra-group food commodities. In this regard, this study can be further extended to calculate elasticities in terms of disaggregated food commodities under each group, while incorporating demographic variables to the QUAIDS. In addition, not only the macro-nutrients but also the micro-nutrients play a significant role in individuals' health and nutritional status. Hence, given the current status of unhealthy dietary habits, malnutrition, and under-nutrition, it is valuable to estimate elasticities for micro-nutrients as well.

## References


Abdulai, A., and D. Aubert. 2004. "A Cross-Section Analysis of Household Demand for Food and Nutrients in Tanzania." *Agricultural Economics* 31(1):67-79.

Banks, J., R. Blundell, and A. Lewbel. 1997. "Quadratic Engel Curves and Consumer Demand." *Review of Economics and statistics* 79(4):527-539.

Behrman, J.R., and B.L. Wolfe. 1984. "More Evidence on Nutrition Demand: Income Seems Overrated and Women's Schooling Underemphasized." *Journal of development economics* 14(1):105-128.

Biodiversity for Food and Nutrition, Sri Lanka. n.d. *Food Composition Table - Literature Review*. Retrieved from http://bfnsrilanka.org/index.php/food-composition-tables

Chang, D., and Serletis, A. 2012. "Imposing Local Curvature in the QUAIDS." *Economics Letters* 115(1):41-43.

Cheng, H.T., and O. Capps. 1988. "Demand Analysis of Fresh and Frozen Finfish and Shellfish in the United States." *American Journal of Agricultural Economics 70*(3):533-542.

De Agostini, P. 2014. "The Effect of Food Prices and Household Income on the British Diet." Working Paper, ISER (No. 2014-10).

Ecker, O., and M. Qaim. 2011. "Analyzing Nutritional Impacts of Policies: An Empirical Study for Malawi." *World Development* 39(3):412-428.

Greene, W.H. 1951. *Econometric Analysis*, 7th. ed. New Jersey: Prentice Hall.

Jayawardena, R. 2013. "Validity of Dietary Questionnaires in Sri Lankan Adults and the Association of Dietary Intake with Obesity". PhD dissertation, Queensland University of Technology.

Jayawardena, R., N.M. Byrne, M.J. Soares, P. Katulanda, and A.P. Hills. 2012. "Food Consumption of Sri Lankan Adults: An Appraisal of Serving Characteristics". *Public Health Nutrition* 16(4):653-658.

Jayawardena, R., N.M. Byrne, M.J. Soares, P. Katulanda, B. Yadav, and A.P. Hills. 2013. "High Dietary Diversity is associated with Obesity in Sri Lankan Adults: An Evaluation of Three Dietary Scores". *BMC Public Health* 13:314-322.

Jayawardena, R., S. Thennakoon, N. Byrne, M. Soares, P. Katulanda, and A. Hills. 2014. "Energy and Nutrient Intakes among Sri Lankan Adults". *International Archives of Medicine* 7:34-45.

Lancaster, K.J. 1966. “A New Approach to Consumer Theory.” *Journal of political economy* 74(2):132-157.

Nanayakkara, A.G.W. 1994. “An Analysis of Poverty in Sri Lanka.” *Sri Lanka Journal of Social Sciences* 17:49-78.

Nirmali, S.A.N., and J.C. Edirisinghe. 2015. “Food Demand Elasticities, Price Changes and Calorie Availability of Households in the Western Province of Sri Lanka.” *Sri Lankan Journal of Agricultural Economics* 12.

Park, J.L., R.B. Holcomb, K.C. Raper, and O. Capps. 1996. “A demand systems analysis of food commodities by U.S. households segmented by income.” *American Journal of Agricultural Economics* 78(2):290-300.

Sahn, D.E. 1988. “The Effect of Price and Income Changes on Food-Energy Intake in Sri Lanka.” *Economic Development and Cultural Change* 36(2):315-340.

Shonkwiler, J.S., and S.T. Yen. 1999. “Two-Step Estimation of a Censored System of Equations.” *American Journal of Agricultural Economics* 81(4):972-982.

Tian, X., and X. Yu. 2013. “The Demand for Nutrients in China.” *Frontiers of Economics in China* 8(2):186-206.

Ulubasoglu, M., D. Mallick, M. Wadud, P. Hone, and H. Haszler. 2016. “Food Demand Elasticities for Australia.” *Australian Journal of Agricultural and Resource Economics* 60(2):177-195.

U.S. Department of Agriculture. 2016. *USDA Food Composition Databases, Release 28.* Retrieved from *https://ndb.nal.usda.gov/ndb/*

Variyam, J.N., Blaylock, J., and Smallwood, D. 2002. “Characterizing the Distribution of Macronutrient Intake among US Adults: A Quantile Regression Approach.” *American Journal of Agricultural Economics* 84(2):454-466.

Weinberger, K. 2001. “What Determines Micronutrient Demand of the Poor? A Case Study from Rural India.” *Quarterly Journal of International Agriculture* 40(4):343-360.

Weliwita, A., D. Nyange, and H. Tsujii. 2003. “Food demand patterns in Tanzania: a censored regression analysis of microdata.” *Sri Lankan Journal of Agricultural Economics* 5(1):9-34.

World Bank. 2016. 2016|World Development Indicators. Retrieved from https://openknowledge.worldbank.org/bitstream/handle/10986/23969/9781464806834.pdf

Yen, S.T., K. Kan, and S.J. Su. 2002. “Household Demand for Fats and Oils: Two-Step Estimation of a Censored Demand System.” *Applied Economics* 34(14):1799-1806.

**Table1: Sample statistics of budget shares, prices, and expenditure**

| | Mean | Std. Dev. | Proportion of zero consumption (%) | | Mean | Std. Dev. |
|---|---|---|---|---|---|---|
| **Budget shares $W_i$** | | | | **Price Indexes $P^*$** | | |
| **Cereals** | 0.237 | 0.116 | 2.371 | **Cereals** | 4.279 | 0.285 |
| **Prepared food** | 0.130 | 0.183 | 24.518 | **Prepared food** | 0.638 | 2.029 |
| **Pulses** | 0.049 | 0.039 | 9.296 | **Pulses** | 5.253 | 0.266 |
| **Vegetables** | 0.086 | 0.053 | 3.935 | **Vegetables** | 4.668 | 0.288 |
| **Leafy vegetables** | 0.019 | 0.018 | 21.825 | **Leafy vegetables** | 2.507 | 1.105 |
| **Yams** | 0.025 | 0.023 | 17.004 | **Yams** | -1.976 | 1.119 |
| **Meat** | 0.047 | 0.073 | 61.399 | **Meat** | 6.035 | 0.161 |
| **Fish** | 0.116 | 0.100 | 23.870 | **Fish** | 5.964 | 0.393 |
| **Dried fish** | 0.053 | 0.055 | 25.263 | **Dried fish** | 6.284 | 0.322 |
| **Eggs** | 0.014 | 0.019 | 52.035 | **Eggs** | 2.648 | 0.133 |
| **Coconut** | 0.090 | 0.057 | 5.980 | **Coconut** | 3.523 | 0.307 |
| **Dairy products** | 0.101 | 0.092 | 26.227 | **Dairy products** | 6.675 | 0.425 |
| **Fruits** | 0.032 | 0.043 | 38.308 | **Fruits** | 2.232 | 0.857 |
| **Total food expenditure (LKR)** | 2786.49 | 1358.91 | | | | |

*1 USD = 153.12 LKR*

**Table 2: Sample statistics of demographic variables**

| | Mean | Std. Dev. |
|---|---|---|
| ***Sector**** | | |
| **Urban** | 0.252 | - |
| **Estate** | 0.090 | - |
| **Rural** | 0.658 | - |
| ***Ethnicity**** | | |
| **Sinhalese** | 0.678 | - |
| **Tamils** | 0.226 | - |
| **Other ethnicities** | 0.097 | - |
| **Adult equivalent** | 3.039 | 1.351 |

**Reference categories for sector and ethnicity are rural sector and other ethnicities, respectively.*

**Table 3: Marginal effects of first-step probit estimates**

| Food group | Sector | | Ethnicity | | Adult equivalent |
|---|---|---|---|---|---|
| | Urban | Estate | Sinhalese | Tamils | |
| **Cereals** | -0.009** | -0.010 | -0.006 | 0.004 | 0.037** |
| **Prepared food** | 0.149** | -0.116** | -0.158** | -0.140** | -0.008** |
| **Pulses** | -0.015** | 0.046** | 0.205** | 0.080** | 0.049** |
| **Vegetables** | -0.011** | -0.004 | 0.010* | 0.010* | 0.047** |
| **Leafy vegetables** | 0.030** | -0.075** | 0.188** | 0.030 | 0.045** |
| **Yams** | -0.038** | -0.016 | 0.131** | 0.105** | 0.053** |
| **Meat** | 0.116** | -0.044** | -0.367** | -0.049* | 0.052** |
| **Fish** | 0.073** | -0.299** | -0.107** | -0.031** | 0.064** |
| **Dried fish** | -0.021** | 0.094** | 0.147** | -0.592** | 0.033** |
| **Eggs** | 0.053** | -0.020 | -0.024** | -0.020* | 0.048** |
| **Coconut** | -0.015** | -0.006 | -0.007 | -0.003 | 0.037** |
| **Dairy products** | 0.165** | 0.049** | -0.001 | -0.024* | 0.054** |
| **Fruits** | 0.070** | -0.127** | 0.023* | -0.075** | 0.026** |

*Note: ** and * indicate significance at the 1% and 5% levels, respectively.*

**Table 4: Price and expenditure elasticities of food groups**

| Price elasticity | Cereals | Prepared food | Pulses | Vegetables | Leafy vegetables | Yams | Meat | Fish | Dried fish | Eggs | Coconut | Dairy products | Fruits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Cereals** | **-0.729**** | -0.029** | -0.009* | -0.094** | -0.002 | 0.005** | 0.163** | -0.017** | -0.119** | 0.095** | -0.038** | 0.009* | -0.015** |
| **Prepared food** | -0.018** | **-0.876**** | -0.004** | 0.003** | -0.001** | -0.002** | 0.014** | -0.011** | -0.003** | 0.004** | -0.026** | -0.017** | 0.003** |
| **Pulses** | -0.004 | -0.017** | **-0.678**** | -0.040** | 0.007* | -0.010** | -0.025* | 0.078** | -0.098** | 0.048** | -0.011 | -0.018* | -0.001 |
| **Vegetables** | -0.214** | -0.002 | -0.036** | **-0.726**** | 0.000 | -0.005 | 0.194** | 0.052** | -0.058** | 0.049** | -0.096** | 0.037** | -0.020** |
| **Leafy vegetables** | -0.011 | -0.017** | 0.012 | -0.001 | **-0.974**** | 0.005 | -0.036** | 0.126** | -0.011 | -0.078** | 0.092** | 0.018* | 0.015** |
| **Yams** | 0.042** | -0.020** | -0.023** | -0.011 | 0.005 | **-0.903**** | 0.128** | -0.026* | 0.011 | 0.013 | -0.083** | 0.006 | 0.001 |
| **Meat** | 0.234** | 0.000 | -0.054** | 0.126** | -0.021** | 0.028** | **-1.244**** | -0.022 | 0.023* | -0.298** | 0.092** | -0.049** | -0.010 |
| **Fish** | -0.142** | -0.047** | -0.005 | -0.018** | 0.012** | -0.018** | -0.040** | **-0.952**** | -0.039** | 0.001 | -0.085** | 0.018** | 0.001 |
| **Dried fish** | -0.283** | -0.012* | -0.080** | -0.060** | -0.004 | 0.004 | 0.058** | -0.015 | **-0.548**** | 0.046** | -0.069** | 0.054** | 0.019** |
| **Eggs** | 0.431** | 0.002 | 0.056* | 0.070* | -0.079** | -0.001 | -0.996** | -0.132** | 0.080** | **-1.040**** | 0.201** | -0.183** | -0.062** |
| **Coconut** | -0.038** | 0.009** | -0.015 | -0.070** | 0.024** | -0.022** | 0.115** | -0.058** | -0.050** | 0.072** | **-0.747**** | -0.057 | -0.006 |
| **Dairy products** | -0.077** | -0.063** | -0.046** | -0.010 | -0.006* | -0.008** | -0.054** | 0.047** | 0.019** | -0.027** | -0.042** | **-0.933**** | -0.010* |
| **Fruits** | -0.202** | -0.018** | -0.044** | -0.096** | -0.005 | -0.013** | -0.077** | -0.039** | 0.000 | -0.021** | -0.057** | -0.066** | **-0.810**** |
| **Expenditure elasticity** | 0.797** | 0.918** | 0.706** | 0.778** | 0.821** | 0.824** | 1.246** | 1.399** | 0.862** | 1.824** | 0.831** | 1.264** | 1.570** |

*Note: ** and * indicate significance at the 1% and 5% levels, respectively. Diagonal price elasticities are own-price elasticities. Off diagonal elasticities are cross-price elasticities.*

**Table 5: Effects of demographic factors on nutrient consumption**

| Demo-graphic variables | Calories | | Proteins | | Fats | | Carbohydrates | |
|---|---|---|---|---|---|---|---|---|
| | Parameter estimate | % effect | Parameter estimate | % effect | Parameter estimate | % effect | Parameter estimate | % effect |
| **Urban** | -0.099** | -9.42 | -0.048** | -4.72 | -0.137** | -12.81 | -0.096** | -9.13 |
| **Estate** | 0.006 | 0.60 | 0.014 | 1.39 | -0.134** | -12.55 | 0.087** | 9.06 |
| **Sinhalese** | 0.188** | 20.72 | 0.173** | 18.91 | 0.202** | 22.35 | 0.195** | 21.55 |
| **Tamils** | 0.122** | 13.02 | 0.096** | 10.02 | 0.081** | 8.43 | 0.145** | 15.58 |
| **Adult equivalent** | 0.373** | - | 0.313** | - | 0.346** | - | 0.411** | - |

*Note: ** indicates significance at the 1% level.*
*Coefficients of adult equivalent present elasticities.*

**Table 6: Price and expenditure elasticities of nutrients**

| | Calories | | | Proteins | | |
|---|---|---|---|---|---|---|
| | **Population** | **Poorest** | **Richest** | **Population** | **Poorest** | **Richest** |
| **Constant** | 9.774** | 10.859** | 9.978** | 5.261** | 6.419** | 5.612** |
| ***Prices*** | | | | | | |
| **Cereals** | -0.259** | -0.313** | -0.180** | -0.218** | -0.276** | -0.149** |
| **Prepared food** | -0.070** | -0.131** | -0.062** | -0.079** | -0.142** | -0.071** |
| **Pulses** | -0.010 | 0.015 | -0.011 | -0.004 | 0.025 | -0.009 |
| **Vegetables** | -0.075** | -0.134** | -0.045* | -0.048** | -0.122** | -0.031 |
| **Leafy vegetables** | -0.049** | -0.065** | -0.045** | -0.101** | -0.129** | -0.090** |
| **Yams** | 0.005* | 0.003 | 0.005 | 0.002 | 0.006 | 0.000 |
| **Meat** | -0.120** | -0.129 | -0.117** | -0.143** | -0.123 | -0.144** |
| **Fish** | -0.090** | -0.148** | -0.087** | -0.099** | -0.187** | -0.074** |
| **Dried fish** | -0.067** | -0.143** | -0.044** | -0.083** | -0.176** | -0.039* |
| **Eggs** | -0.002 | 0.035 | -0.016 | -0.019 | -0.001 | -0.028 |
| **Coconut** | -0.071** | -0.091* | 0.012 | -0.066** | -0.079** | -0.018 |
| **Dairy products** | -0.043** | -0.034 | -0.065** | -0.052** | -0.033 | -0.079** |
| **Fruits** | -0.006 | -0.004 | -0.008 | 0.002 | 0.005 | -0.004 |
| **Food expenditure** | 0.609** | 0.624** | 0.506** | 0.745** | 0.776** | 0.629** |

| | Fats | | | Carbohydrates | | |
|---|---|---|---|---|---|---|
| | **Population** | **Poorest** | **Richest** | **Population** | **Poorest** | **Richest** |
| **Constant** | 6.387** | 8.191** | 6.915** | 7.830** | 8.008** | 8.193** |
| ***Prices*** | | | | | | |
| **Cereals** | -0.217** | -0.363** | -0.098** | -0.354** | -0.391** | -0.256** |
| **Prepared food** | -0.075** | -0.175** | -0.054** | -0.076** | -0.128** | -0.072** |
| **Pulses** | 0.007 | 0.106* | 0.001 | -0.011 | -0.006 | -0.016 |
| **Vegetables** | -0.040* | -0.110 | -0.008 | -0.102** | -0.178** | -0.069** |
| **Leafy vegetables** | -0.030** | -0.051** | -0.025** | -0.049** | -0.066** | -0.042** |
| **Yams** | -0.008 | -0.029* | -0.005 | 0.007** | 0.011* | 0.007 |
| **Meat** | -0.132** | -0.188 | -0.102** | -0.122** | -0.094 | -0.120** |
| **Fish** | -0.089** | -0.201** | -0.064** | -0.100** | -0.141** | -0.101** |
| **Dried fish** | -0.090** | -0.161** | -0.071** | -0.060** | -0.163** | -0.027 |
| **Eggs** | -0.102** | -0.068 | -0.079 | 0.060** | 0.139* | 0.021 |
| **Coconut** | -0.099** | -0.163** | 0.057 | -0.041** | -0.059* | 0.013 |
| **Dairy products** | -0.062** | -0.087* | -0.072** | -0.035** | -0.007 | -0.063** |
| **Fruits** | 0.007 | 0.019 | 0.005 | -0.014** | -0.020 | -0.015* |
| **Food expenditure** | 0.656** | 0.709** | 0.414** | 0.625** | 0.731** | 0.509** |

*Note: ** and * indicate significance at the 1% and 5% levels, respectively.*
*Coefficients of prices and food expenditure present elasticities.*