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AN ESTIMATION OF HOUSEHOLD NUTRIENT ELASTICITIES IN URBAN, RURAL AND ESTATE SECTORS OF SRI LANKA

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Abstract

Nutrient elasticities are important indicators for human resource development. The objective of the paper is to estimate nutrient expenditure and nutrient demand elasticities in urban, rural and estate sectors. Micro data were collected from HIES in 2006/07, 2009/10, 2012/13 and 2016. For that Badulla, Kandy, Nuwara-Eliya and Ratnapura districts were selected and samples were gathered from urban 2010, rural 8508, estate 3363 and totally 13881 households. Ten types of main food groups consisting of 112 food items were used to estimate nutrient demand elasticities as well as energy, protein, carbohydrate and fat nutrient expenditure elasticities were estimated. Modified Linear Approximation of Almost Ideal Demand System (MLA AIDS) and Demand Model for Nutrient Availability (DMNA) models were used to estimate results. Iterative Seemingly Unrelated Regression (ISUR) is applied to ensure consistent and efficient estimates. Nutrient expenditure elasticities for energy, protein and carbohydrate are relatively higher in the estate sector. Fewer nutrient elasticities are found in rural sectors. Among the nutrients, protein contains relatively more (0.895) nutrient elasticity in all sectors. Nutrient demand elasticities are price inelastic. Rice, vegetable, meat, fish, egg, coconut and milk food groups are price in-elastic for all types of nutrients in all three sectors. So, for the price inelastic food groups in these sectors, decreasing prices are associated with increases in the consumption of nutrients.

keywords: Carbohydrate, DMNA, Energy, Fat, Protein

INTRODUCTION

Sri Lanka has been categorized as a Low-Income Food-Deficit Country by the Food and Agriculture Organization recently, and food is the most important item in a household's consumption basket. According to Sri Lanka Socio-Economic Data 2016, the consumption expenditure account had the largest share of national expenditure. For example, over 75% of the Gross Domestic Product (GDP) in 2016 was spent on consumption expenditure. However, food contributes nearly 40% of the total expenditure shares of an average household (Consumer Finances and Socio-Economic Survey, 2003/04). Food demand patterns and nutrient intakes are strongly associated with changes in food prices and household income that affect food consumption and nutrient availability. People living in residential areas are categorized as urban, rural and estate sectors in Sri Lanka. Sri Lanka is experiencing a nutritional transition that occurs in a shift in nutritional consumption and nutrient expenditure due to social, economic, geographic, demographic, seasonal, technical, cultural, personal, nutritional etc. factors. So, in these backgrounds, it is necessary to find out how the demand for nutrients and nutrient consumption patterns changed sector-wise annually in Sri Lanka. Though several nutrient studies published in Sri Lanka, a review of the literature indicates that there have been insufficient national level studies on nutrient elasticities. Some remarkable examples are, Sahn’s (1988) analysed of food energy elasticities using a Binary choice model, and Nirmali and Edirisinghe (2015) estimated price and income elasticities for calorie availability of households using a Linear Approximation of Almost Ideal Demand System (LA AIDS) model. Then Dona *et al.* (2018) studied food and nutrient consumption at household levels using the Quadratic Almost Ideal Demand System (QUAIDS) model and the results revealed that nutrient elasticities concerning price changes in most food groups were significantly negative. As quantity demanded, all food groups were found to be inversely related to corresponding price changes. Jayasinghe *et al.* (2018) estimated household expenditure, per-capita expenditure and expenditure per equivalent adult using a complete system of Box-Cox Engel curves. An inter-temporal analysis of expenditure elasticities showed that although the magnitude of expenditure elasticities changed, the necessity or luxury classification of household commodities has mostly remained unchanged. Given the circumstances, the purpose of this study is to examine household nutrient elasticities for food prices and expenditure in urban, rural and estate sectors.

LITERATURE REVIEW

A considerable number of nutritional studies were conducted in the African region since malnutrition was a huge issue there. Akinleye & Rahji (2007) investigated the nutritional effects of changes in income and prices in Nigerian households using an AIDS model. Ecker & Qaim (2009) estimated micronutrient elasticities in Malawi using a demand system. Further, energy and income elasticities were estimated in Tanzania (Abdulai & Aubert, 2004a), Kenya (Bouis *et al*., 1992), Rwanda (Von Braun *et al*., 1991), and Sierra Leone (Strauss, 1984) using different methodologies and techniques. They concluded that when food is insecure, household energy-food price elasticities were even less suitable for inference about nutrient consumption. Similarly, Abdulai & Aubert (2004b) studied income and price elasticities for several micronutrients in Tanzania. The result showed that higher expenditure elasticities for meat, fish, eggs, milk and milk products, fruits, and vegetables, relative to cereals and pulses, were impacted by very high nutrient demand. Tey *et al.* (2007) examined meat consumption in Malaysia in terms of income, price and nutrient elasticities using a LA AIDS model. The study revealed that major meat products such as beef, pork, poultry and mutton were normal goods and own price elastic. Torresy (2015) investigated the impacts of food price shocks on the purchase of nutrients in urban Mexican households. Perez & Minor (2012) demonstrated that the upward tendency of food prices in international markets had significant implications for food consumption and nutrition in Mexican households. Liaskos & Lazaridis (2003) estimated nutrient elasticities using Multiple Linear Regression Analysis in Greece. Results indicated that nutrient consumption increases at a decreasing rate when moving to higher income levels. Pereda *et al.* (2015) examined the Brazilian diet by estimating consumer demand for nutrients using a QUAIDS model. The results suggested that protein, lipids and fibers were luxury goods for poorer households and necessary goods for high-income households while carbohydrates and fat were normal goods. Further, Widarjono (2012) studied nutrient demand in Indonesian households and the study showed that all expenditure nutrient elasticities were positive and urban households were more elastic than rural households. In addition, Gibson & Rozelle (2002) detected that unconditional calorie demand elasticity was about 0.6 for the poorest half of the population in urban Papua New Guinea using the non-parametric and semi-parametric estimations technique. Ye & Taylor (1995) used a structural model and identified that income elasticities of energy and protein intake were high in low-income rural households in China but it declined rapidly as income increased. Meng *et al.* (2009) also found that the income elasticity of calorie consumption was more than 0.5 for low-income group in urban China and declined as income increased.

METHODOLOGY

The research design approaches of Household Income and Expenditure Surveys (HIES) were fully adopted in this study. The sample design of the survey was a two-stage stratified random sampling of Neymann allocation from Urban, Rural and Estate sectors. Micro data were collected at the field in twelve consecutive monthly rounds to capture seasonal variations in income, expenditure and consumption of household's weekly records. The data collection of the survey was done through direct interviews using a standard structured questionnaire. A household was used as the sample unit and the district was selected as the study area.

Table 1: Nos of Survey Sampled Households by Sectors

HIES Survey Year	Nos of households surveyed			
	Urban	Rural	Estate	Total
2016	323	2883	726	3932
2012/13	615	1830	885	3330
2009/10	509	1849	881	3239
2006/07	563	1946	871	3380
Total Households	2010	8508	3363	13881

Source: HIES Reports in 2006/07, 2009/10, 2012/13 and 2016

The study area was chosen by two conditions. First, it consists of all three sectors in each district; second, each district comprises a minimum of 5% of the population in each sector. Accordingly Badulla, Kandy, Nuwara-Eliya and Ratnapura districts only were selected as the study area. The sample size was estimated by HIES carried out by the Department of Census and Statistics, Sri Lanka in 2006/07, 2009/10, 2012/13 and 2016 periods. Table 1 illustrates the distribution of the sample by district. Totally 13881 households were selected as samples for this study.

Micro data was collected from the HIES mentioned in Table 1. The listed 112 food items in the food category of household expenditure were aggregated to provide ten food groups' monthly food expenditures separately. The main types of food groups were used in this study as rice, wheat flour, bread, pulses, vegetables, meat, fish, egg, coconut and milk & milk products. Each food group consists of its food items listed in the HIES given below used in this study;

(1) Rice: White Kekulu Normal, White Kekulu Samba, Red Kekulu Normal, Red Kekulu Samba, Samba, Nadu Red, Nadu White, Basmathi and Other Rice
(2) Wheat flour (WF): Wheat Flour
(3) Bread: Normal Bread
(4) Pulses: Gram Dhal, Masoor Dhal, Watana Dhal, Green Gram, Gram, Red Cowpea, White Cowpea, Soya, Soya Meet, Other Pulses
(5) Vegetables: Ash Plantain, Brinjal, Ladies Fingers, Bitter Gourd, Thuba Karivila, Long Beans, Snake Gourd, Ridge Gourd, Pumpkin, Beans, Carrot, Beetroot, Cabbage, Cauliflower, Tomatoes, Leeks, Knol Khol, Capsicum, Winged Bean, Radish, Drumstick, Cucumber, Cooking Melon, Ash Pumpkin, Wild Eggplant, Plate Brush, Kohila Yams, Lotus Stem, Plantain Flower, Ambarella, Raw Mango, Raw Cashew Nuts, Mushroom, Immature Jack, Other Vegetables, Mukunuwanna, Gotukola, Kankun, Kathurumurunga, Spinach, Thampala, Sarana, Kohila Leaves, Onion Leaves, Cabbage Leaves, Other Leaves, Jack & Jack Seed, Bread Fruit, Potatoes, Sweet Potato, Mannioc, Kiriala, Innala, Other Yams
(6) Meat: Chicken, Beef, Mutton, Pork
(7) Fish: Balaya, Seer, Shark, Paraw, Thalapath, Tuna (Kelawalla), Mullet, Other Large Fish, Sprats, Hurulla, Karalla / Katuwalla, Kumbala / Angila, Salaya / Sudaya, Other Small Fish, Lula, Theppli / Telapiya / Korali, Catla / Rohu, Other Fresh Water Fish
(8) Egg: Hen Eggs
(9) Coconut: Coconut Nuts

(10) Milk & Milk Products: Cow Milk, Goat Milk, Sterilized Milk, Curd, Yoghurt, Condensed Milk, Milk Powder, Infant Milk Powder, Butter, Margarine, Cheese, Milk Packets, Other Liquid Milk.

A model of household demand for the different food items which compete for the household budget allocation requires a complete demand system framework. Arising from its theoretical consistency which postulates that households maximize utility in their consumption decision-making process, and its flexibility to encompass broad ranges of behaviour, the MLA AIDS was selected for modelling household behaviour in Equation (1). From this Equation expenditure elasticity (Equation 2) and uncompensated own price elasticity (Equation 3) were derived.

$$W_i = \alpha_i + \sum_j \gamma_{ij} \ln(p_j) + \beta_i \ln\left(\frac{x}{P^L}\right) \quad (1)$$

Where i = food group i, j = food group j, w_i = budget share of food group i, p_j = price of food group j, x = household's monthly total food expenditure, P^L = Laspeyres Price Index (LPI), α_i, β_i and γ_i are estimated parameters

Here LPI is used to overcome the units of measurement error and it renders parameter estimates insensitive to units of measurement. Thus, LPI satisfies the fundamental property of index numbers because it is a variant of changes in the units of measurement for prices. Hence, the LPI becomes a geometrically weighted average of prices (Moschini, 1995). Therefore, the above-mentioned model is used in this study. And the model was selected as the basic model for the aggregated complete demand system estimation in the study due to its flexible functional form and nimbleness in estimation (Green & Alston, 1990). To be theoretically consistent, the estimated model satisfies adding up, homogeneity and symmetry conditions of standard demand theory restrictions.

The expenditure and price elasticity derived from Equation (1) are as follows:

$$\eta_i = 1 + \left(\frac{\beta_i}{w_i}\right) \quad \text{Expenditure Elasticity} \quad (2)$$

$$\varepsilon_{ij} = -\delta_{ij} + \left(\frac{\gamma_{ij} - \beta_i \overline{w}_j}{\overline{w_i}}\right) \quad \text{Marshallian (Uncompensated) Price Elasticity} \quad (3)$$

Where δ_{ij} is the Kronecker delta that is equal to one if $i = j$ (own price), and zero for $i \neq j$ (cross price). In this study, the sample mean was used for the point of normalization.

A system of shared equations based on Equation (1) and subject to the restrictions of adding-up, homogeneity, and symmetry are estimated using the Iterative Seemingly Unrelated Regression (ISUR) method of Zellner. It assumes that budget shares of various commodities are linearly related to logarithms of real food expenditure and relative food prices. This method is equivalent to Full Information Maximum Likelihood (FIML) estimation. ISUR ensures consistent and asymptotically efficient estimates. Therefore, it is used to estimate the MLA AIDS models with correlated random errors when the share equations are not simultaneous. The adding-up property of demand causes the error covariance matrix of the system to be singular, so one of the expenditure share equations is dropped from the system to avoid singularity problems. The estimates are invariant of which equation is deleted from the system. Homogeneity is maintained by normalizing all of the prices (proxied by the aggregate cost figures) by the price of other food items. The coefficients about the expenditure share equation of other food items' aggregate, which is dropped from the system in the estimation stage, are obtained by using the adding-up property. Symmetry is imposed during the estimation of the system of equations. So, both MLA AIDS and DMNA models are employed in ISUR. Statistical analysis was applied by STATA 15.

Demand Model for Nutrient Availability (DMNA)

Expenditure and uncompensated own price elasticities are estimated in the first stage, while we explore the use of a demand model for nutrient availability in the second stage as developed by Huang (1996). To do this, information about the nutrient values of each food that we considered here is needed. Let a_{ki} be the amount of the k^{th} nutrient obtained from a unit of the i^{th} food. The total amount of that nutrient obtained from various foods, say Φ_k may be expressed as below;

$$\Phi_k = \sum_i a_{ki} q_i \quad (4)$$

This is referred to by Huang (1996) as the values of a_{ki}'s for non-foods will be assigned zero, thus the terms associated with non-foods will disappear. This equation, including all foods consumed, plays a central role in the transformation of food demands into nutrient availability. By substituting a demand equation for the quantity variable of Equation (4), changes in consumer nutrient availability become as below:

$$d\Phi_k = \sum_i a_{ki} \left[\sum_j \left(\frac{\delta q_i}{\delta p_i} \right) dp_i + \left(\frac{\delta q_i}{\delta m} \right) dm \right] \quad (5)$$

Furthermore, the relative changes in consumer nutrient availability can be expressed as a function of the relative changes in food prices and per capita expenditure as follows:

$$\frac{d\Phi_k}{d\Phi} = \sum_j \left(\frac{\Sigma_i e_{ij} a_{ki} q_i}{\Phi k}\right)\frac{dp_j}{p_j} + \left(\frac{\Sigma_i \eta_i a_{ki} q_i}{\Phi k}\right)\frac{dm}{m} = \frac{\sum_j \Pi_{kj} dp_j}{p_j} + \frac{p_k dm}{m} \quad (6)$$

Where $\Pi_{kj} = \frac{\sum_i e_{ij} a_{ki} q_i}{\Phi_k}$ is a price elasticity measure relating the effect of the j^{th} food price on the availability of the k^{th} nutrient, and p_k represents the effect of expenditure on the availability of that nutrient.

Obviously, the measurement represents the weighted average of all own and cross price elasticities (e_{ij}'s) in response to the j^{th} price with each weight expressed as the share of each food's contribution to the k^{th} nutrient $\left(\frac{a_{ki} q_i}{\Phi k}\right)$. Similarly, the measurement of ρ_k represents the weighted average of all expenditure elasticities (η_i's) with each weight again expressed as the share of each food's contribution to the k^{th} nutrient. Thus, the general calculation of nutrient elasticity matrix, say N, for the case of ℓ nutrients and n foods can be obtained as a product of multiplying matrix S by matrix D as follows:

$$N = S \times D \quad (7)$$

where N is the $\ell \times (n+1)$ matrix of nutrient elasticities in response to changes in food prices and expenditure, S is the $\ell \times n$ matrix with entries of each row indicating a food's share of a particular nutrient, and D is the $n \times (n + 1)$ matrix of demand elasticities. From these nutrient elasticity measurements, a change in a particular food price or per capita expenditure will affect all food quantities demanded through the interdependent demand relationships and thus cause the levels of consumer nutrient availability to change simultaneously.

RESULTS AND DISCUSSIONS

Food share of nutrients such as energy, protein, carbohydrate and fat are estimated separately for all three sectors and all ten types of food groups based on monthly household food consumption. OLS is used to estimate the model. The results of energy share based on monthly household food consumption are given below in Table 2.

Table 2: Results of Estimated Energy Share based on Food Consumption

	Year	Rice	WF	Bread	Pulse	Veg	Meat	Fish	Egg	Coco	Milk
Urban	2006/7	0.493	0.060	0.126	0.060	0.051	0.010	0.009	0.009	0.108	0.073
	2009/10	0.519	0.066	0.102	0.059	0.062	0.012	0.010	0.007	0.100	0.065
	2012/13	0.569	0.048	0.058	0.061	0.067	0.010	0.010	0.008	0.109	0.060
	2016	0.563	0.037	0.070	0.065	0.061	0.012	0.010	0.011	0.116	0.056
Rural	2006/7	0.621	0.042	0.059	0.053	0.060	0.004	0.005	0.005	0.114	0.038
	2009/10	0.624	0.039	0.051	0.049	0.067	0.004	0.038	0.116	0.005	0.006
	2012/13	0.642	0.030	0.035	0.057	0.070	0.005	0.006	0.006	0.112	0.039
	2016	0.624	0.028	0.041	0.058	0.068	0.006	0.007	0.006	0.119	0.043
Esta	2006/7	0.530	0.213	0.047	0.051	0.039	0.003	0.002	0.004	0.078	0.034
	2009/10	0.554	0.197	0.034	0.050	0.046	0.003	0.003	0.004	0.080	0.030
	2012/13	0.565	0.168	0.031	0.057	0.049	0.005	0.003	0.005	0.084	0.034

	2016	0.555	0.155	0.032	0.064	0.058	0.005	0.003	0.008	0.082	0.039

Source: Developed by author

Results in Table 2 disclose that rice is the most important element in the diet among the major foods, which provides total energy intake of an average of 54% in the urban, 63% in the rural and 55% in the estate sector. The second energy source is coconut for urban and rural sectors, while wheat flour is for the estate sector. Likewise, the third energy source is bread in the urban, vegetables in the rural and coconut in the estate sectors. The meat food group provides an average of 1%, 0.5% and 0.4% of the total food energy intake in urban, rural and estate sectors, respectively. Likewise, the fish food group contributes 1%, 1.4% and 0.3% of the total energy intake in urban, rural and estate sectors, respectively. Pulses and vegetable food groups shared nearly 6% of the total food energy in all three sectors. On average, egg, meat and fish food groups provide the least energy source for urban, rural and estate sectors respectively.

The results of protein share based on monthly household food consumption are given in Table 3. Results illustrate that rice is the primary food providing an average of 48%, 59% and 51% of the total protein among the ten food groups for urban, rural and estate sectors, respectively. Pulses in urban and rural sectors, and wheat flour in the estate sector provide more protein shares followed by rice. The next major protein sources are vegetables, milk and bread in the urban and rural sectors; pulses, vegetables and milk in the estate sector. Meat and fish contribute separately 4% in the urban sector; 2% in the rural sector; 2% and 1% in the estate sector. Egg contributes the least protein source for all three sectors on average.

Table 3: Results of Estimated Protein Share based on Food Consumption

	Year	Rice	WF	Bread	Pulse	Veg	Meat	Fish	Egg	Coco	Milk
Urban	2006/7	0.448	0.057	0.104	0.116	0.073	0.036	0.035	0.017	0.028	0.086
	2009/10	0.467	0.062	0.083	0.111	0.088	0.035	0.036	0.013	0.026	0.079
	2012/13	0.506	0.044	0.047	0.114	0.095	0.038	0.039	0.015	0.028	0.073
	2016	0.503	0.034	0.057	0.122	0.083	0.047	0.039	0.018	0.030	0.069
Rural	2006/7	0.590	0.042	0.050	0.110	0.086	0.014	0.019	0.010	0.032	0.048
	2009/10	0.591	0.038	0.044	0.102	0.096	0.015	0.025	0.009	0.032	0.049
	2012/13	0.596	0.029	0.029	0.114	0.099	0.020	0.022	0.011	0.031	0.049
	2016	0.573	0.027	0.035	0.116	0.099	0.025	0.026	0.012	0.032	0.055
Estate	2006/7	0.500	0.207	0.041	0.106	0.052	0.013	0.008	0.008	0.021	0.044
	2009/10	0.521	0.191	0.029	0.103	0.061	0.014	0.012	0.008	0.022	0.039
	2012/13	0.522	0.160	0.026	0.116	0.065	0.024	0.011	0.010	0.023	0.044
	2016	0.502	0.145	0.026	0.125	0.079	0.027	0.011	0.015	0.021	0.049

Source: Developed by author

The results of carbohydrate share based on monthly household food consumption are given in Table 4. Results depict that among the ten types of foods, rice is the primary source providing an average of 64%, 73% and 62% of the total carbohydrate in urban, rural and estate sectors respectively. The next major source of carbohydrate share is bread for the urban sector, vegetables for the rural sector and wheat flour for the estate sector. Third sources of carbohydrates are vegetables, wheat flour and pulses in the urban sector; pulses, bread and wheat flour in the rural sector; and vegetables, pulses and bread in the estate sector. On average, coconut provides the least energy source for the urban sector, while milk contributes to rural and estate sectors.

Table 4: Results of Estimated Carbohydrate Share based on Food Consumption

	Year	Rice	WF	Bread	Pulse	Veg	Meat	Fish	Egg	Coco	Milk
Urban	2006/7	0.597	0.072	0.141	0.056	0.068	-	-	-	0.029	0.036
	2009/10	0.617	0.079	0.112	0.055	0.078	-	-	-	0.026	0.033
	2012/13	0.678	0.056	0.065	0.055	0.087	-	-	-	0.029	0.030
	2016	0.680	0.046	0.078	0.061	0.080	-	-	-	0.030	0.025
Rural	2006/7	0.719	0.048	0.064	0.046	0.076	-	-	-	0.029	0.017
	2009/10	0.723	0.045	0.056	0.043	0.087	-	-	-	0.029	0.018
	2012/13	0.741	0.035	0.038	0.049	0.089	-	-	-	0.029	0.018
	2016	0.730	0.033	0.046	0.053	0.086	-	-	-	0.031	0.021
Estate	2006/7	0.589	0.232	0.050	0.043	0.050	-	-	-	0.019	0.017
	2009/10	0.615	0.216	0.035	0.042	0.060	-	-	-	0.019	0.014
	2012/13	0.636	0.186	0.032	0.048	0.061	-	-	-	0.021	0.016
	2016	0.632	0.174	0.033	0.055	0.068	-	-	-	0.020	0.018

Source: Developed by author

Table 5: Results of Estimated Fat Share based on Food Consumption

	Year	Rice	WF	Bread	Pulse	Veg	Meat	Fish	Egg	Coco	Milk
Urban	2006/7	0.115	0.017	0.082	0.012	0.033	0.013	0.054	0.031	0.457	0.186
	2009/10	0.134	0.019	0.068	0.014	0.046	0.019	0.062	0.027	0.443	0.169
	2012/13	0.149	0.014	0.039	0.017	0.044	0.011	0.062	0.033	0.473	0.158
	2016	0.137	0.010	0.045	0.016	0.032	0.011	0.059	0.033	0.503	0.154
Rural	2006/7	0.175	0.014	0.042	0.013	0.041	0.006	0.028	0.020	0.553	0.109
	2009/10	0.173	0.012	0.037	0.013	0.044	0.007	0.037	0.019	0.549	0.109
	2012/13	0.184	0.009	0.025	0.015	0.048	0.006	0.036	0.024	0.539	0.112
	2016	0.167	0.008	0.028	0.015	0.046	0.005	0.044	0.025	0.546	0.116
Estate	2006/7	0.183	0.088	0.040	0.014	0.033	0.003	0.016	0.022	0.485	0.117
	2009/10	0.191	0.079	0.029	0.016	0.037	0.002	0.024	0.023	0.488	0.111
	2012/13	0.189	0.066	0.026	0.017	0.042	0.004	0.021	0.027	0.487	0.120
	2016	0.176	0.059	0.027	0.019	0.053	0.003	0.022	0.039	0.470	0.132

Source: Developed by author

The results of fat share based on monthly household food consumption are in Table 5. The results illustrate that among ten types of foods, coconut is the primary source of fat that contributes an average of 47%, 55% and 48% of total fat in urban, rural and estate sectors respectively. The second source of fat is milk and milk products for the urban sector; rice for the rural and estate sectors. The third fat source is rice for the urban sector; milk and milk products for rural and estate sectors. Meat contributes the least protein source for all three sectors on average.

Next nutrient expenditure elasticities are estimated separately for all three sectors and OLS was used to estimate the model. The results of energy expenditure elasticities for all three sectors are given below in Table 6.

Table 6: Results of Estimated Energy Expenditure Elasticity

Time Period	Urban	Rural	Estate
2006/7	0.833**	0.717**	0.865***
2009/10	0.847***	0.794*	0.857***
2012/13	0.839*	0.776***	0.868**
2016	0.878***	0.789***	0.889***

*Note: ***, **, * indicates that variables are significant at 1%, 5% and 10% level of significance respectively; Source: Author's calculations*
Source: Developed by author

Results in Table 6 reveal that energy expenditure elasticities are relatively higher than the nutrient expenditure elasticities in all three sectors. For example, a 10 percent expenditure growth will have aggregated energy intake increase of 8.78 percent in the urban sector in 2016. Energy expenditure elasticities in urban, rural and estate sectors show a marginally fluctuating pattern over time. It may be the reason for changing the general prices of energy food items. Further, some of the existing studies also identified similarities to our findings. For example, Dona et al., 2018, estimated energy expenditure elasticity for the poorest group was 0.624 and for the richest group 0.506 in 2012/13. Relatively more energy expenditure elasticities of demand were observed in the estate sector. Therefore, changes in expenditure affect the energy consumption of the estate sector more than other sectors. So, estate sector households spent relatively more money to get energy from food. In contrast, relatively less energy expenditure elasticities are found in the rural sector. As a result, rural sector households spent relatively less money to get energy from food.

Table 7: Results of Estimated Protein Expenditure Elasticity

Time Period	Urban	Rural	Estate
2006/7	0.855**	0.743**	0.895*
2009/10	0.851***	0.798*	0.867***
2012/13	0.872*	0.835**	0.882**
2016	0.847***	0.840***	0.865***

*Note: ***, **, * indicates that variables are significant at 1%, 5% and 10% level of significance respectively*
Source: Developed by author

The results of protein expenditure elasticities for all three sectors are given in Table 7. Results show that its value is relatively high among the protein expenditure elasticities in all sectors. For example, a rise in 10 percent expenditure growth will increase aggregated protein intake by 8.65 percent in the estate sector in 2016. Moreover, it is clear that protein expenditure elasticities in urban and estate sectors tend to fluctuate merely over time, but the rural sector depicts a marginally increasing pattern over time, increasing of protein food prices may be the reason for it. In addition, protein expenditure elasticities of demand in the estate sector are relatively higher than urban sector, while less in the rural sector. This implies that a change in income will affect more in estate sector protein expenditure while less in rural sector protein expenditure. Thus, estate sector households spent relatively more money to get protein from food whereas rural households spent less money to get protein. Further, some of the existing studies also identified similar to our findings. For example, Dona et al., 2018, found protein expenditure elasticity for the poorest group at 0.776 and the richest group at 0.629 in 2012/13.

The results of carbohydrate expenditure elasticities for all three sectors are given below in Table 8. Results disclose that its value is relatively high among the carbohydrate expenditure elasticities in all sectors. For example, a rise in 10 percent expenditure growth will increase aggregated carbohydrate intake by 8.71 percent in the urban sector in 2016. Further, some of the existing studies also identified similar to our findings.

Table 8: Results of Estimated Carbohydrate Expenditure Elasticity

Time Period	Urban	Rural	Estate
2006/7	0.825**	0.735**	0.883**
2009/10	0.811**	0.828*	0.855**
2012/13	0.850*	0.833**	0.866***
2016	0.871***	0.838***	0.859**

*Note: ***, **, * indicates that variables are significant at 1%, 5% and 10% level of significance respectively*
Source: Developed by author

For example, Dona et al., 2018, mentioned that the expenditure elasticity of carbohydrates for the poorest group was 0.731 and for the richest group 0.509 in 2012/13 in Sri Lanka. Moreover, it is clear that carbohydrate expenditure elasticities in urban and estate sectors tend to fluctuate merely over time, but the rural sector depicts a marginally increasing pattern over time. In addition, carbohydrate expenditure elasticities of demand in the estate sector were relatively higher except for 2016 than the urban sector, while less in the rural sector. This implies that change in income will affect more on estate sector carbohydrate expenditure while less in the rural sector. Thus, estate sector households spent relatively more money to get carbohydrates from food, whereas rural households spent less money to get carbohydrates.

Table 9: Results of Estimated Fat Expenditure Elasticity

Time Period	Urban	Rural	Estate
2006/7	0.849**	0.605***	0.785**
2009/10	0.832*	0.631**	0.767***
2012/13	0.769**	0.640*	0.756**
2016	0.824***	0.657***	0.769***

*Note: ***, **, * indicates that variables are significant at 1%, 5% and 10% level of significance respectively*
Source: Developed by author

Table 9 shows the results of fat expenditure elasticities for all three sectors. It reveals that its value is relatively low among the fat expenditure elasticities in all sectors. For example, a 10 percent expenditure growth rise will have an aggregated fat intake increases by 6.57 percent in the rural sector in 2016. Moreover, it is clear that fat expenditure elasticities in urban and estate sectors tend to fluctuate merely over time, but the rural sector depicts a marginally increasing pattern over time. In addition, fat expenditure elasticities of demand in the urban sector are relatively higher than the other two sectors. This implies that change in income will affect more on urban sector fat expenditure while less in the rural sector. Thus, urban sector households relatively spent more money to get fat from food, whereas rural households spent less money to get fat. Further, some of the existing studies also identified similar to our findings. For example, Dona et al., 2018, estimated fat expenditure elasticity for the poorest group at 0.709 and the richest group at 0.414 in 2012/13 in Sri Lanka.

Nutrient demand elasticities for each food group are estimated separately for all three sectors and the results are given below. The results were obtained using the OLS method. The results of energy demand elasticities for ten types of food groups with three sectors are given below in Table 10. It reveals that energy demand elasticities are relatively less than unity for all food groups, which indicates that energy consumption is price inelastic in general. For example, rice food group shows a negative price impact on energy demand in all sectors during the study period. That is, if a 10 percent increase in the price of rice would tend to reduce the energy by 5.28 percent availability to the rural households in 2016. In addition, vegetables, meat, fish, egg, coconut, and milk also have a negative price impact on energy in all three sectors during the study period. Further, wheat flour in the estate sector; bread in the urban sector also show a negative price impact on energy demand. However, pulses in all sectors; wheat flour in urban and rural sectors, and bread in rural and estate sectors show a positive price impact on energy demand. Among the food groups, rice is relatively more energy responsive to price changes in all three sectors.

Table 10: Results of Estimated Energy Demand Elasticities

	Year	Rice	WF	Bread	Pulse	Veg	Meat	Fish	Egg	Coco	Milk
Urban	2006/7	-0.478*	0.073**	-0.104*	0.066**	-0.138*	-0.142**	-0.082	-0.180*	-0.085	-0.085**
	2009/10	-0.491*	0.061*	-0.068***	0.066*	-0.166	-0.156*	-0.240**	-0.206	-0.106*	-0.088***
	2012/13	-0.535*	0.072*	-0.013**	0.041**	-0.183*	-0.172*	-0.053	-0.238*	-0.131**	-0.089*
	2016	-0.519***	0.067*	-0.025*	0.091*	-0.180*	-0.213*	-0.225*	-0.248	-0.150*	-0.092***
Rural	2006/7	-0.574*	0.072*	0.018*	0.173*	-0.155*	-0.202*	-0.197*	-0.125*	-0.070*	-0.061
	2009/10	-0.549*	0.050*	0.012*	0.174*	-0.167**	-0.177*	-0.219	-0.182*	-0.046	-0.063*
	2012/13	-0.547***	0.086**	0.018***	0.165**	-0.199*	-0.234*	-0.231***	-0.136	-0.103	-0.077*
	2016	-0.528***	0.081*	0.022	0.162	-0.219*	-0.245**	-0.253**	-0.148*	-0.123***	-0.081*
Estate	2006/7	-0.403*	-0.159	0.049*	0.043*	-0.116*	-0.111*	-0.146	-0.139**	-0.096*	-0.075**
	2009/10	-0.420***	-0.117*	0.069**	0.044*	-0.142	-0.149***	-0.171***	-0.154***	-0.118***	-0.078***
	2012/13	-0.425**	-0.134	0.084*	0.012*	-0.166*	-0.164*	-0.174*	-0.162	-0.132**	-0.086*
	2016	-0.384***	-0.112***	0.103***	0.022	-0.197	-0.182***	-0.119***	-0.165**	-0.146***	-0.096

*Note: ***, **, * indicates that variables are significant at 1%, 5% and 10% level of significance respectively*
Source: Developed by author

Moreover, egg, fish, meat, vegetable and coconut in the urban sector; fish, meat, vegetable, pulses, egg, and coconut in the rural sector; wheat flour, bread, vegetable, meat, fish, egg, and coconut in the estate sector are relatively more energy responsive to price changes. However, relatively less energy responsive food groups to price changes are wheat flour, bread, pulses, and milk in the urban sector; wheat flour, bread and milk in the rural sector; pulses and milk in the estate sector. It is noted that patterns of energy demand marginally increased in vegetable, meat, egg, coconut and milk food groups in all sectors. The rest of other food groups show a marginally fluctuating energy demand patterns. Dona et al., 2018, estimated negative price impact on energy in the food groups of cereals (-0.313), vegetables (-0.134), meat (-0.129), fish (-0.148), coconut (-0.091) and dairy products (-0.034) while positive price impact on pulses (0.015) and eggs (0.035) for the poorest group in 2012/13. Further for the richest group cereals (-0.180), pulses (-0.011), vegetables (-0.045), meat (-0.117), fish (-0.087), eggs (-0.016) and dairy products (-0.065) were negative price impact on energy but coconut (0.012) had positive price impact on energy food in 2012/13.

Table 11: Results of Estimated Protein Demand Elasticities

	Year	Rice	WF	Bread	Pulse	Veg	Meat	Fish	Egg	Coco	Milk
Urban	2006/7	-0.437*	0.066**	-0.086*	0.019**	-0.135*	-0.139**	-0.079	-0.139*	-0.051	-0.089**
	2009/10	-0.443*	0.063*	-0.060***	0.036*	-0.163	-0.144*	-0.095**	-0.158	-0.067*	-0.081**
	2012/13	-0.472*	0.063*	-0.034**	0.042**	-0.180*	-0.159*	-0.169	-0.178*	-0.087**	-0.079*
	2016	-0.488**	0.064*	-0.020*	0.052*	-0.197*	-0.205*	-0.225*	-0.182*	-0.101*	-0.078**
Rural	2006/7	-0.541*	0.069*	0.039*	0.160*	-0.158*	-0.187*	-0.262*	-0.099*	-0.041*	-0.058
	2009/10	-0.517*	0.055*	0.026*	0.144*	-0.172**	-0.196*	-0.337*	-0.105*	-0.053	-0.068*
	2012/13	-0.508**	0.087**	0.025***	0.139*	-0.197*	-0.213*	-0.364**	-0.101	-0.071*	-0.070*
	2016	-0.486***	0.086*	0.014	0.129	-0.218*	-0.223**	-0.372*	-0.105*	-0.089**	-0.072**
Estate	2006/7	-0.379*	-0.147	0.061*	-0.011*	-0.110*	-0.111*	-0.162	-0.117**	-0.071*	-0.072**
	2009/10	-0.391**	-0.106*	0.082**	-0.017*	-0.135	-0.147**	-0.174**	-0.126**	-0.084**	-0.074***
	2012/13	-0.392**	-0.120	0.092*	-0.061*	-0.157*	-0.174*	-0.195***	-0.127	-0.095**	-0.081*
	2016	-0.412***	-0.104**	0.107***	-0.054*	-0.187*	-0.196**	-0.217	-0.132**	-0.107***	-0.087*

*Note: ***, **, * indicates that variables are significant at 1%, 5% and 10% level of significance respectively*
Source: Developed by author

The results of protein demand elasticities for ten types of food groups with three sectors are given below. Results disclose that protein demand elasticities are relatively less than unity for all food groups, which indicates that protein consumption is price inelastic in general. For example, the meat food group shows a negative price impact on protein demand in all sectors during the study period. That is, if a 10 percent increase in the price of meat would tend to reduce the protein by 2.23 percent availability to the rural households in 2016. In addition, vegetables, meat, fish, egg, coconut, and milk also have a negative price impact on protein in all three sectors during the study period. Further, bread in the urban sector; wheat flour and pulses in the estate sector also show a negative price impact on protein demand.

However, wheat flour and pulses in urban and rural sectors; bread in rural and estate sectors show a positive price impact on protein demand. Among the food groups, rice is relatively more protein responsive to price changes in all three sectors. Moreover, fish, meat, vegetable, egg and coconut in the urban sector; fish, meat, vegetable, pulses and egg in the rural sector; fish, meat, vegetable, egg, coconut, bread and wheat flour in the estate sector are relatively more protein responsive to price changes. However, relatively less protein responsive food groups to price changes are wheat flour, bread, pulses and milk in the urban sector; wheat flour, bread, coconut and milk in the rural sector; pulses and milk in the estate sector. It is noted that patterns of protein demand marginally increased in vegetable, meat, fish, egg and coconut food groups in all sectors. Further rice and pulses in urban and estate sectors; milk in rural and estate sectors; and bread in the estate sector also showed a marginally increased protein demand. However, the protein demand pattern marginally decreased in rice and pulses in the rural sector; bread in the urban and rural sectors; milk in the urban sector. The demand pattern of protein for wheat flour is almost similar in the urban sector but it shows a marginally fluctuating pattern in rural and estate sectors. The rest of other food groups show marginally fluctuating protein demand patterns. Some studies also evaluated protein demand elasticities in Sri Lanka by Dona et al., 2018 under the poorest and richest categories in 2012/13 respectively, cereals (-0.276, -0.149), pulses (0.025, -0.009), vegetables (-0.122, -0.031), meat (-0.123, -0.144), fish (-0.187, -0.074), eggs (-0.001, -0.028), coconut (-0.079, -0.018) and dairy products (-0.033, -0.079). Here pulses under the poorest group had only a positive price impact on protein demand, while others had a negative price impact on protein demand.

Table 12: Results of Estimated Carbohydrate Demand Elasticities

	Year	Rice	WF	Bread	Pulse	Veg	Meat	Fish	Egg	Coco	Milk
Urban	2006/7	-0.567*	0.071**	-0.098*	0.086**	-0.162*	-0.150*	-0.128	-0.189*	-0.054	-0.072**
	2009/10	-0.570*	0.074*	-0.055***	0.094*	-0.186*	-0.162*	-0.143**	-0.219	-0.072*	-0.078**
	2012/13	-0.627*	0.092*	-0.016**	0.110**	-0.210*	-0.181	-0.173	-0.254*	-0.093**	-0.079*
	2016	-0.634**	0.095*	-0.003*	0.131*	-0.212	-0.231*	-0.266*	-0.265	-0.105*	-0.080**
Rural	2006/7	-0.651*	0.084**	0.050*	0.219*	-0.183	-0.215	-0.329*	-0.128*	-0.043*	-0.062
	2009/10	-0.633*	0.099**	0.034*	0.211*	-0.198*	-0.228**	-0.360	-0.137*	-0.056	-0.072*
	2012/13	-0.626**	0.104*	0.024**	0.209**	-0.228*	-0.245*	-0.385**	-0.139	-0.074*	-0.074**
	2016	-0.608***	0.110*	0.013*	0.206*	-0.254	-0.257	-0.398*	-0.150*	-0.093*	-0.077*
Estate	2006/7	-0.440*	-0.111*	0.065*	0.064*	-0.125	-0.107	-0.125	-0.136*	-0.073	-0.062**
	2009/10	-0.459**	-0.122**	0.088**	0.066*	-0.154*	-0.149**	-0.185*	-0.151**	-0.086***	-0.065***
	2012/13	-0.469**	-0.136*	0.111*	0.063*	-0.182*	-0.162*	-0.206*	-0.160*	-0.096*	-0.073*
	2016	-0.478*	-0.145***	0.131**	0.065	-0.214	-0.185*	-0.232**	-0.161**	-0.107**	-0.081*

*Note: ***, **, * indicates that variables are significant at 1%, 5% and 10% level of significance respectively*
Source: Developed by author

The results of carbohydrate demand elasticities for ten types of food groups with three sectors are in Table 12. It reveals that carbohydrate demand elasticities are relatively less than unity for all food groups, which indicates that carbohydrate consumption is price inelastic in general. For example, the rice food group shows a negative price impact on carbohydrate demand in all sectors during the study period. That is, if a 10 percent increase in the price of rice would tend to reduce the carbohydrate by 6.08 percent availability to the rural households in 2016. In addition, vegetables, meat, fish, egg, coconut and milk also have a negative price impact on carbohydrate in all three sectors during the study period. Further, wheat flour in the estate sector; bread in the urban sector also show a negative price impact on carbohydrate demand. However, pulses in all three sectors; wheat flour in the urban and rural sectors and bread in rural and estate sectors show a positive price impact on carbohydrate demand. Among the food groups, rice is relatively more carbohydrate responsive to price changes in all three sectors. Moreover, egg, fish, meat, vegetable, pulses and coconut in the urban sector; fish, meat, vegetable, pulses, egg and wheat flour in the rural sector; wheat flour, bread, vegetable, meat, fish and egg in the estate sector are relatively more carbohydrate responsive to price changes. However, relatively less carbohydrate responsive food groups to price changes are wheat flour, bread, and milk in the urban sector; coconut, bread and milk in the rural sector; pulses and milk in the estate sector. It is noted that patterns of carbohydrate demand marginally increased in wheat flour, vegetable, meat, fish, egg, coconut and milk food groups in all three sectors. Further rice in the urban and estate sectors; bread in the estate sector; pulses in the urban sector also showed a marginally increased carbohydrate demand. However, the carbohydrate demand patterns marginally decreased for rice, bread and pulses in the rural sector; and bread in the urban sector. Moreover, pulses in the estate sector show almost equal carbohydrate demand patterns. The rest of other food groups show marginally fluctuating carbohydrate demand patterns. Dona et al., 2018 find out carbohydrate demand elasticities for poorest group cereals -0.391, pulses -0.006, vegetables -0.178, meat -0.094, fish -0.141, eggs 0.139, coconut -0.059 and dairy products -0.007 while for richest group cereals -0.256, pulses -0.016, vegetables -0.069, meat -0.120, fish -0.101, eggs 0.021, coconut 0.013 and dairy products -0.063 in 20212/13 period.

Table 13: Results of Estimated Fat Demand Elasticities

	Year	Rice	WF	Bread	Pulse	Veg	Meat	Fish	Egg	Coco	Milk
Urban	2006/7	-0.164*	-0.032*	-0.151*	-0.044*	-0.193*	-0.100*	-0.109*	-0.164*	-0.221	-0.124*
	2009/10	-0.171*	-0.042*	-0.134*	-0.015	-0.149*	-0.121*	-0.119*	-0.173**	-0.268**	-0.129*
	2012/13	-0.187**	-0.053*	-0.128*	-0.013**	-0.142*	-0.132*	-0.126	-0.194**	-0.304***	-0.136***
	2016	-0.199*	-0.062**	-0.124***	-0.009**	-0.129*	-0.139**	-0.317**	-0.203*	-0.355***	-0.139*
Rural	2006/7	-0.139*	-0.015*	-0.154	0.011**	-0.060*	-0.150**	-0.076*	-0.118*	-0.209***	-0.056*
	2009/10	-0.172	-0.024*	-0.148**	0.036***	-0.094*	-0.164*	-0.082*	-0.126*	-0.223**	-0.069*
	2012/13	-0.190*	-0.034*	-0.135*	0.048*	-0.116*	-0.192*	-0.091*	-0.133**	-0.250	-0.084*
	2016	-0.198*	-0.056	-0.126**	0.060**	-0.128*	-0.203*	-0.115*	-0.142**	-0.270***	-0.094*
Estate	2006/7	-0.197*	-0.160**	-0.085***	0.004*	-0.110**	-0.178**	-0.175*	-0.165**	-0.254**	-0.143**
	2009/10	-0.195**	-0.152*	-0.069**	0.006*	-0.129**	-0.203***	-0.198*	-0.177*	-0.331***	-0.148***
	2012/13	-0.196**	-0.142*	-0.067*	0.011	-0.142*	-0.233*	-0.237*	-0.183*	-0.360**	-0.156
	2016	-0.197**	-0.060*	-0.060**	0.032***	-0.165***	-0.255**	-0.272*	-0.204**	-0.387***	-0.176**

*Note: ***, **, * indicates that variables are significant at 1%, 5% and 10% level of significance respectively*
Source: Developed by author

The results of fat demand elasticities for ten types of food groups with three sectors are in Table 13. It shows that fat demand elasticities are relatively less than unity for all food groups, which indicates that fat consumption is price inelastic in general. For example, the coconut food group shows a negative price impact on fat demand in all sectors during the study period. That is, if 10 percent increase in the price of coconut would tend to reduce the fat by 3.87 percent availability to the estate households in 2016. In addition, rice, wheat flour, bread, vegetables, meat, fish, egg and milk also have a negative price impact on fat in all three sectors during the study period. Further, pulses in the urban sector also show a negative price impact on fat demand. However, pulses in the rural and estate sectors show a positive price impact on fat demand. Among the food groups, coconut is relatively more fat responsive with respect to price changes in all three sectors. Moreover, fish, egg, meat, vegetable, milk, rice and bread in the urban sector; fish, meat, vegetable, pulses, egg, rice and bread in the rural sector; fish, vegetable, meat, egg, coconut, milk and rice in the estate sector are relatively more fat responsive with respect to price changes. However, relatively less fat responsive food groups to price changes are pulses in all sectors; wheat flour in the urban and rural sectors; bread in the estate sector. It is noted that pattern of fat demand marginally increased in vegetable, meat, fish, egg, coconut and milk food groups in all three sectors; and rice and wheat flour in the urban and rural sectors; pulses in the rural and estate sectors. However, the fat demand pattern marginally decreased in bread in all three sectors; and wheat flour in the estate sector; pulses in the urban sector. More over rice in the estate sector shows almost similar fat demand pattern. The rest of other food group show a fluctuating fat demand pattern. Dona et al., 2018, estimated a negative price impact on fat in the food groups of cereals (-0.363), vegetables (-0.110), meat (-0.188), fish (-0.201), eggs (-0.068), coconut (-0.163) and dairy products (-0.087) while positive price impact on pulses (0.106) for the poorest group in 2012/13. Further for the richest group cereals (-0.098), vegetables (-0.008), meat (-0.102), fish (-0.064), eggs (-0.079) and dairy products (-0.072) were negative price impact on energy while pulses (0.001), coconut (0.057) had positive price impact on fat food items in 2012/13.

CONCLUSIONS

Once nutrient results disclose that rice is the main stable food among ten foods in the urban, rural and estate sectors since it includes relatively more energy, protein and carbohydrate. Similarly, coconut is a crucial food in all three sectors to contribute fat consumption. It is observed that the major sources of energy, protein, carbohydrates and fat in Sri Lanka are derived from plant products with very less portions from animal products. Among the three sectors, the rural sector has more food share value in the above nutrients. So, rural households consume more nutrients relative to other sectors for healthy life and labour productivity.

In sum, nutrient (energy, protein, carbohydrate and fat) consumption are positive and relatively high responsive to household total expenditure changes. Total expenditure growth will have aggregated an increase in consumption of all nutrients in all three sectors during the study periods, which is as expected by theory and some of the existing empirical studies (eg. Abdulai et al., 2004b; Ecker et al., 2009; Dona et al., 2018). Nutrient expenditure elasticities for energy, protein and carbohydrate are relatively more in the estate sector, which is consistent with those for food demand. So, estate sector households spent relatively more money to get nutrients (energy, protein and carbohydrate) from food groups. However, more fat expenditure elasticity was found in the urban sector as a result, they relatively spent more money on fat consumption. At the same time, relatively less nutrient elasticities are found in the rural sector, which depicts that rural households spend less on getting these nutrients. Moreover, among the nutrients, protein contains relatively more (0.895) nutrient elasticity in all sectors. That is, the protein type of food is highly responsive to total expenditure changes. As a result, proteinous types of food items are relatively high prices in markets. Likewise, fat has relatively less (0.605) nutrient elasticity among all three sectors and is relatively less responsive to household expenditure changes.

Nutrient demand elasticities such as energy, protein, carbohydrate and fat are relatively less than unity for all food groups, which indicates that nutrient consumption is price inelastic in general. Hence, households are mostly able to adjust their consumption patterns through a substitution of high-priced foods, so that the effects of moderate short-term food price variations on nutritional status are relatively less. Rice, vegetable, meat, fish, egg, coconut and milk food groups in all three sectors are price in-elastic for all types of nutrients. So, for the price inelastic food groups in these sectors, decreasing prices are associated with increases in the consumption of nutrients. This shows empirical evidence by Dona et al., 2018 estimated in 2012/13 in Sri Lanka.

And also, this study introduced a new research model namely DMNA developed by Huang (1999), to measure how economic factors influence nutrient availability. The advantage of this model was that it incorporates information on a food demand system including own and cross-price elasticities, and expenditure elasticities into the measurement of nutrient responses. This allowed seeing how changes in the availability of all nutrients vary depending on how food price and income changes manifest themselves through the food demand relationships. These results were an attempt to evaluating the possible effects of changes in prices and income on dietary quality in all food products. The nutrient response estimate could offer a piece of important information for the knowledge of food demand structure which was a necessary step in the formulation of strategies and intervention policies in the food sector. This might be undertaken by studying food policy scenarios and examining the effects of possible changes and nutrients that were available for consumption.

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