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The Consumption of Calories and Protein in Al-Hofuf Area, Saudi Arabia

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Abstract. A model is developed to estimate parameters describing consumption decisions with particular emphasis on calories and protein intakes. Findings from an empirical application to the data on 203 households of Al-Hofuf city, suggest that there is no deficiencies in calorie or protein intakes, even in the absence of expansions in overall food supply. Per capita consumption of calories and protein decreases as household size increases.

Income elasticities of consumption for calories and protein are below unity and as expected, the elasticities are much lower for highest income group. The analysis finds that, education levels of the household heads and type of housing unit had a significant impact on protein and calorie intakes. The analysis was limited to calories and protein. However, the methodological approach allows the incorporation of other nutrients, such as vitamins.

Introduction

Food policy analysis links nutrition objectives to economic policies and performance. In addition human nutrition interacts in many ways with the vast economic sector of agriculture and food. The major role of agricultural production is to provide populations with an adequate variety and quantity of edible products, while the objective of food distribution is to bring within reach of every consumer the foods that meet his choices and needs. Food policy uses household food consumption as the key variable to improve the nutritional status of individuals with the household. At the micro level consumption parameters are used to determine the implications of income changes on nutritional status.

Regression methods have been used to analyze the factors inlfuencing dietary status. This type of analysis is important in marketing, food assistance policy, understanding the structure of household demand and nutrition education. In the Kingdom of Saudi Arabia, studies on the relationship between socioeconomic factors and human nutrition are scarce, and additional work is required to adopt methodology and provide empirical estimates useful for policy making. The objectives of this study are to (a) develop a procedure for estimating the effects of various factors that influence the consumption of calories and protein, (b) provide empirical evidence of this relationship for the city of Al-Hofuf, Saudi Arabia, and (c) examine the implications of the findings of this study for food policy.

The Consumption Model

In some studies using cross sectional data, it has been established that there are economics of size in food use in large households [1-4]. The simplest procedure to account for variation in household size is to specify consumption and household income on a per capita basis. The per capita specification assigns equal weights to children and adults, thus ignoring variations in need with respect to age and sex. The per capita specification assumes that consumption is a linearly homogeneous function of household income and size. This precludes the existence of economics of scale in consumption. Economics of size in consumption can be controlled by considering the following equation:

$$Q/HS = f(I/HS, HS) \quad (1)$$

where Q, HS and I are food consumption, household size, and income, respectively. Equation (1) invalidates the cost of living comparison between the two households having different household composition, where a child, for example, is counted as some appropriate fraction of an adult.

Prais and Houthakker [1] developed techniques for incorporating household size and composition into an Engel function Their approach essentially involves measuring household size on a specific scale and an income scale. The specific scale is pertinent to each commodity and is used to determine the number of unit consumers of that item in the household. The specific scale essentially measures the relative requirements of different types of persons for various commodities. Household consumption or expenditure is then expressed in terms of unit consumers by dividing the former by the latter. With this approach, household income or expenditure is measured on an income scale. The latter is a weighted average of the specific scales with weights approximately proprotional to relative expenditures on the commodities consumed by the household. One of the reasons for the lack of use of Prais and Houthakker scales or more recent ones is the identification problem. This problem arises from the implicit assumption that the specific scales are a function of the income scale. Muellbauer [5] claimed that the identification problem cannot be solved unless prior restrictions are imposed on the scales or the budget identities are ignored. Over the years, studies on equivalence scale have been concerned about the establishment of a metric that would translate household size (HS) in equation (1) into equivalent persons.

Hymans and Shapiro [6] developed a more straight forward approach to incorporate household size and composition effects into Engel functions. They analyzed the allocation of household income to food consumption using cross sectional data. They constructed a food needs, variable for each household that takes specific account of variations in the consumption of households using the U.S. Department of Agriculture's minimum food requirements standards. We have modified this method to estimate the consumption functions of calorie and protein.

Our procedure for estimating the calorie and protein consumption functions is summarized in five steps. First, we calculate calorie and protein consumption of the household by age groups using detailed information from 203 households in Al-Hofuf city. The average quantity of the usable portion of various food items consumed by households in each age group is converted to calorie and protein levels using FAO food consumption tables. Second, the calorie and protein needs were calculated for each household taking specific account of variations in the age composition. Third, we estimate a measure of standard calorie consumed per person, by dividing the average calorie used per household by the average household size. Fourth, we estimate a measure of standard protein consumed per person, by dividing the average protein used per household by the average household size. Fifth, the number of standard persons in each household for calorie (SPC) and protein (SPP) are estimated by dividing the calculated calorie and protein needs for each household by standard calorie and protein consumed per person. The estimated number of standard persons in the particular household replaced the household size variable in equation (1) as follows:

$$QC/SPC = f(Y/SPC, HS) \quad (2)$$

$$QP/SPP = f(Y/SPP, HS) \quad (3)$$

where QC and QP are the average daily intake of calories and protein per household, respectively. Equations (2) and (3) relate quantity consumed per standard person to household income per standard person. In addition, these equations allow for differences in household composition and economics of size in calorie and protein consumption.

Cross-section analysis has been used to understand more clearly how socioeconomic factors influence dietary status. Adrian and Daniel [7], Scearce and Jensen [8] and Basiotis *et al.* [9] have shown money income to be positively related to the dietary status of low income households in the U.S.A. Household size has been reported as having a significantly negative effect on nutrient intake [10]. Akin [11] and Bunch and Hall [12] reported that the general education level of the female household head in the U.S.A. had a positive significant impact on nutritional status.

The studies discussed above led to the following relationship:

$$QC/SPC = f(Y/SPC, HS, EDU, HT) + U \quad (4)$$

$$QP/SPP = f(Y/SPP, HS, EDU, HT) + V \quad (5)$$

Th variables in equations (4) and (5) are defined as:

QC = the average daily intake of calories per household.

QP = the average daily intake of protein per household.

Y = monthly household income.

SPC = number of standard persons for protein consumpiton in the household.

HS = household size.

EDU = 1 if education of household head does not exceed elementary school, zero otherwise. The data used in this analysis were in the form of levels of education instead of number of years of education. Thus, the education of household head was treated as a discrete variable.

HT = 1 if a household lives in villa, zero otherwise.

U & V = stochastic error terms.

Data Sources and Mehtodology

The data used in this analysis are quantities consumed per week for each of thirteen groups of food, as well as household incomes, size, education, occupation and age distribution. A sample of 203 families (approximately 1,523 persons) was selected from the population of the city of Al-Hofuf, Saudi Arabia in 1988, using a random sampling procedure.

The detailed informations from the sample were used to calculate calorie and protein consumpiton of each household by age groups. Quantities of the usable portion of various food items consumed by households in each age group were converted to calorie and protein levels using FAO food nutrient tables [13].

Regression analysis was applied to estimate the parameters of the consumption functions for calories and protein (equations 4 and 5). The specific technique used in estimating the parameter was ordinary least-squares (OLS) [14]. In order to establish whether a particular variable has a significant net effect on the dependent variable, t-tests were performed. The statistical significance of the variables was at the 0.10 and 0.05 level in a two-sided t-test. The F-test was used to determine whether the set of all variables in the regression models have a significant net effect on the dependent variable. The statistical measure of goodness of fit used is the adjusted R-squared (R^{-2}), which is proportion of the total variance that is explained by the regression and adjusted for the degrees of freedom.

In order to test whether the education level of the household head and the type of housing units have a significant net effect on calorie and protein intakes, the null hypothesis is

$$RB = O \tag{6}$$

where R is a JXK matrix, $J \leq K$ being the number of independent restrictions to be tested (the education level of the household head and the type of housing units). The increase in residual sum of squares can be computed as follows. Let D_f be the residual sums of squares from the restricted regressions which contain the original expalanatory variables (household income per standard person and household size), while D_2 be the residual sum of squares from the unrestricted regression which contain all the explanatory variables including the education level of the household head and the type of housing units. For computational purposes, the appropriate test can be written as:

$$AVT = \frac{(D_1 - D_2) / K}{D_2 / (n-g)} \tag{7}$$

This test is known as the added variables test (AVT) [15]. The degrees of freedom are (g-k) and (n-g), where g=4 is the total number of the explanatory variables, K=2 is the number of the original explanatory variables and n=203 is the total number of observations. This provides a test of the null hypothesis (6), with rejection if the value of AVT exceeds the critical vlaue. If (6) is rejected, the education level of the household head and type of housing units are a significant addition and they have a significant net effect on calorie and protein intakes. If (6) cannot be rejected, then the educational level of the household head and type of housing units are not statistically significant factors in influencing calories and protein consumption.

Empirical Results

Summary statistics concerning the household size, income, daily intake of calories per capita and daily intake of protein per capita by various categories are presented in Table 1. The average daily per capita intake of calories and protein for the sample as a whole were estimated to be 3611 and 94.6 respectively. These estimates are more than the requirements for any age group. Thus, no additional food would be needed to fulfill calorie and protein requirements if available food were distributed according to needs.

Table 1. Estimated calorie and protein intakes, household size and income by various categories

Characteristics	Number of households	Average household size (Number)	Average household income (SR/month)	Daily intake of calories per capita	Daily intake of protein per capita (g)
All households	203	7.5	9310	3611	94.60
Household income < 8000 SR	96	6.6	4764	3555	88.97
Household income ≥ 8000 SR	107	8.3	13412	3654	98.80
Education of household head < 6-years	101	8.6	9632	3165	84.40
Education of household head ≥ 6-years	103	6.4	9015	4211	108.50

Source: Calculated from questionnaire.

In general, the higher the income level of the household, the more calories and protein consumed, households with incomes of 8000 SR or more consumed 103% of calories and 111% of protein consumed by the households with less incomes. The households whose head had a six-year education or more consumed more calories and protein than households whose head had a less education (Table 1). These results were attributed to efficiency in food procurement on one hand and the selection and preparation of more nutritious meals on the other hand. In addition, these results were due partially to the positive correlation between education and income.

Table 2 presents the basic statistical results from calorie and protein regressions. The coefficient associated with the household income per standard person for calories was found to be not significantly different than zero. Thus, household income is not a statistically significant factor in influencing calories consumption. Calorie intakes decreased significantly with increased household size. The general education levels of the household heads had a significant impact on calorie consumption. The households whose head had not completed elementary school education consumed less calories than the households whose head had a higher eduction. The coefficient associated with the binary variable that indicates the type of the housing units was found to be significantly different from zero. The household who lives in a villa consumed more calories than those who live in lower types of housing.

Markedly high $\bar{R}^2$ were not expected from the results, partly because the data refers to individual households and partly because for some commodities, the data

Table 2. Regression coefficients of the consumption function (t-ratios in parentheses)

Item	Calories	Protein
Independent variables:		
Intercept	7272.50	25.01
	(6.32)	(6.76)
Income per standard person	0.14	0.01
	(0.60)	(2.11)
Household size	– 212.93	– 8.47
	(–2.06)	(–2.56)
Education level of the household head	– 1306.20	–44.78
	(–1.93)	(–2.05)
Type of housing units	2550.60	53.40
	(3.80)	(2.48)
Summary statistics		
R^{-2}	0.13	0.16
F	8.30	10.40
Added variables test (AVT)	9.24	5.58

on purchases does not adequately reflect consumption. If we compoare the consumption functions on the basis of $\bar{R}^2$ we observe that the consumption function of protein have a higher proportion of explained variation than the consumption function of calories. However, a low $\bar{R}^2$ does not necessarily imply that there is no relationship between the dependent and independent variables. This realtionship was tested by computing F-statistic and it was found that all variables in the regression models have a significant net effect on the dependent variable (Table 2). The added variables test (AVT) suggests that education levels of household head and type of housing units have an important influence on the consumption of both calories and protein.

Significant and positive income coefficient was found for protein. Thus, as household income increases, quantity of protein consumed per standard person would increase. The coefficient associated with household size was found to be negative and significant. As household size increases, quantity of protein consumed per standard person would decrease. The households whose head had less than elementary school education consumed less protein than those whose head had a more education. It seems that the higher the education level of household head the better selection and preparation of more nutritious meals.

Table 3 reports household size and income elasticities for calories and protein. The income elasticity of calorie and protein intake was estimated for three groups (all households, low income and high income households). The households within each income group were faced with essentially the same price for any given food product.

In addition, little variation in tastes and preferences was expected among households within a given income group. Thus, the income elasticities were estimated by regressing quantity consumed on household income per standard person within each group. The education of household head and type of housing units have not been included because the number of households whose head does not exceed elementary school and the number of households living in villas were limited. The estimated income elasticities were consistent with expectations. Low income households appeared to have a higher income elasticities than high income households. This is due to the fact that low income households usually spend a very large proportion of their total income which is frequently insufficient to cover nutritional requirements.

Table 3. Household size and income elasticities of calorie and protein

Commodity	Household	Income		
		All households	Low-income households	High-income households
Calories	−0.277**	0.123	0.380***	0.221*
Protein	−0.322***	0.219***	0.583***	0.321***

*, **, *** indicate that the elasticities were statistically significant at the 0.10, 0.05 and 0.01 levels, respectively.

The range of income elasticities was between 0 and 1.0, implying that the percentage change in quantity consumed of calorie or protein is less than the corresponding percentage change in household income. A ten percent increase in household income results in a 3.8 and 2.21 percent increase in consumption of calories for low income and high income households, respectively. A ten percent increase in household income results in a 5.83 and 3.21 percent increase in quantity of protein consumed by low income and high income households, respectively. The income elasticity of calorie intake is smaller than the income elasticity of protein intake for both low income and high income households. This is partly because the high protein foods tend to have higher income elasticity than low protein foods. In addition, this could be a result of the households already exceeding calorie needs more than protein needs.

Significant and negative household size elasticities were found for calories and protein. A one percent increase in household size results in a 0.28 and 0.32 percent decrease in calories and protein consumption respectively. This is partially due to lower waste and higher efficiency in meal preparation in large households.

Conclusions

This study has focused on the determinants of calorie and protein intakes using household survey data on consumption. The estimated impact of changes in household income on calorie and protein intakes was presented. In addition, the impacts of household size, education levels of household heads and type of housing units on a calorie and protein intakes were analyzed.

The information generated by this study can be used to determine the implicaitons of changes in income on nutritional status, especially among the low income hoseholds. This type of information is essential to improve the nutritional status of the population of both rich and poor countries. The empirical analysis was limited to calories and protein. However, the methodological procedure allows the incorporation of other essential nutrients, such as vitamins. The statistical analysis presented in this study does not consider intrafamily distribution of nutrients. Thus, additional work is needed to relate changes in household incomes to change in nutrient intakes by the most vulnerable members of the household.

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استهلاك السعرات الحرارية والبروتين بمدينة الهفوف بالمملكة العربية السعودية

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ملخص البحث. تستهدف هذه الدراسة تقدير معالم دوال استهلاك السعرات الحرارية والبروتين لبعض الأسر بمدينة الهفوف بالمملكة العربية السعودية، ولقد تم تطوير نموذج لتقدير معالم تلك الدوال وطبق على عينة مكونة من ٢٠٣ أسر. ودلت النتائج المتحصل عليها بأن كميات الغذاء المتوافرة لتلك الأسر تعد كافية لاستيفاء متطلباتهم من كل من السعرات الحرارية والبروتين، كما تبين أن معدل استهلاك الفرد من كل منهما يتناقص تدريجيًا بزيادة حجم الأسرة. كذلك فإنه قد تم تقدير مرونات الدخل، ووجد أنها أقل من الواحد الصحيح، وكما هو متوقع فإن مرونات الدخل للأسر ذات الدخل المنخفض أكبر بكثير من نظيرتها للأسر ذات الدخل المرتفع. ولقد أوضحت النتائج أيضًا أن مستوى تعليم رب الأسرة ونوع سكن الأسرة لهما تأثيرات معنوية على الكمية المستهلكة من كل من السعرات الحرارية والمواد البروتينية.

هذا ويمكن الاستفادة من النموذج المستخدم في هذا المجال في تقدير استهلاك عناصر غذائية أخرى مثل الفيتامينات على سبيل المثال.