LABOR AND WOMEN'S NUTRITION: A STUDY OF ENERGY EXPENDITURE, FERTILITY, AND NUTRITIONAL STATUS IN GHANA

Paul A. Higgins*
Harold Alderman

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* Paul Higgins is presently pursuing his Ph.D. at Tulane University, New Orleans, Louisiana, while Harold Alderman is currently working at the Agricultural Policies Division, Agricultural and Rural Development Department, World Bank.

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ABBREVIATIONS

BMI	—	body mass index
BMR	—	basal metabolic rate
GLSS	—	Ghana Living Standards Survey
LHS	—	left-hand side
OLS	—	ordinary least squares

ABSTRACT

Economic approaches to health and nutrition have focused largely on measures of child nutrition and related variables (e.g., birthweight) as indicators of household production of nutritional outcomes, and thus have been able to ignore two issues which have generated tremendous controversy in the clinical nutrition literature. The first is individual heterogeneity in energy expenditures. While preschoolers' energy expenditures also differ, the differences are deemed sufficiently small to be ignored. Not so for adults, whose waking hours are devoted mostly to labor activities the energy costs of which vary enormously. Variables measuring time allocation to various types of labor tasks were used to proxy differences in energy expenditure.

Parity, too, has been hypothesized to be an important determinant of female nutritional health in high fertility countries, with rapid reproductive cycling contributing to a cumulative nutritional decline. The "maternal depletion syndrome," however, remains controversial; much of the evidence heretofore has been impressionistic, or the result of studies based on small, nonrandom cohorts.

A two-step instrumental variables technique was employed to obtain consistent estimates of the structural parameters. Energy expenditure, as embodied in individual time allocations over the previous seven days, was found to be an important determinant of female nutritional status, with time devoted to agricultural tasks, in particular, having a strong negative effect. The results also appear to confirm the existence of a maternal depletion syndrome. Perhaps most importantly, evidence was found of a substantial downward bias of the calorie elasticity estimate when the energy expenditure proxies were excluded.

1. INTRODUCTION

The study of nutrition has been among the more fruitful applications of the economic theory of household production. In addition to using nutrition as an indicator of welfare, economists have incorporated nutritional variables into studies of labor productivity and wages, poverty, health, and fertility (Behrman and Deolalikar 1988). Yet there is a danger in such intellectual border crossings; while nutritional status reflects the state of health of an individual as influenced by the intake and use of food or nutrients (Gibson 1990), nutrient intake is only one in a complex of determinants of nutritional status. Diseases and parasites and the individual's genetic endowment have come to be recognized as important covariates conditioning the body's utilization of ingested food. But energy expenditure has been virtually ignored in economic approaches to the subject.

Nutritional status is largely the result of individual's net energy balance (Beaton 1983b). It is determined, in other words, by the person's energy *expenditure* as well as her calorie intake. Treating malnutrition solely as a problem of inadequate food or nutrient availability can lead to perverse results — for example, in the extreme, food-for-work programs may fail to improve the nutritional status of participants if the increased labor effort required offsets the effects of the additional food. At the least, it can paint too narrow a picture of the nutrition problem for planners, causing them to disregard the interactions of nonfood policies with nutrition, or to overlook possible avenues for improvement, such as the development of labor-saving devices. From a statistical standpoint, of course, neglecting energy expenditure differences in a population is likely to introduce statistical bias.

Many studies of nutritional status have reported strong positive income effects in reduced form or hybrid nutrition equations even when inputs, such as food or nutrients, morbidity, and health variables, are included. Since income per se is not an input into nutrition production, it is reasonable to ask whether the magnitude, perhaps even the significance, of these results may be the result of misspecification. If average energy expenditure per unit of time decreases with income in a population (or with assets that are correlated with expenditures), the effect of reduced energy expenditure could be incorrectly attributed to rising income;[1] if leisure is a normal good, then the income effect on leisure demand would simply reinforce the impact of this misspecification.

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[1] Bouis and Haddad (forthcoming) discuss this possibility with respect to the estimation of calorie demand.

Weak or insignificant impacts of calories on nutritional status have also been reported in the literature (e.g., Alderman and Garcia [1992] for nutritional status of children). While other plausible explanations, notably errors in the measurement of calorie intakes, have been put forward to explain similar puzzling results, it could equally well be the result of bias due to specification error. Calorie intakes and requirements are directly correlated with levels of individual energy expenditure (James and Schofield 1990), while the energy costs of activities are presumably negatively related to indicators of nutritional status such as body weight or adiposity, other things being equal. Thus, failing to account for differences in energy expenditure would tend to bias the coefficient on calories downward, quite apart from any measurement error effects.

The issue of energy expenditure is especially important in studies of adult nutrition, since adult energy use can be expected to vary systematically within a population depending on activity level.[2] An individual's energy expenditure is determined by her basal metabolic rate (BMR) and by the energy costs of her daily activities. The former is stochastic and generally unobserved, but correlated with age, gender, and body mass (James, Ferro-Luzzi, and Waterlow 1988). On the other hand, the nonstochastic component of energy expenditure is a function of the individual's time uses, and the intensity with which she pursues them (James and Schofield 1990).

Note that this problem is related, though not identical, to the question of heterogeneous nutrient requirements across individuals (and over time) which currently bedevils the clinical nutrition literature (see Beaton 1983a,b and Dasgupta and Ray 1990). Whether individual requirements are fixed or adaptive, however, they are well-predicted by the energy costs of current activity levels, along with the aforementioned covariates of BMR (James, Ferro-Luzzi, and Waterlow 1988). Hence, including current energy expenditure — or some indicator of time use correlated with energy expenditure, along with age, height, and gender — seems a way of minimizing this source of bias in a nutrition regression, providing, of course, that the simultaneity of these choices can be appropriately modeled.

This study examines the determinants of the nutritional status of adult women using household survey data from Ghana. Its main contribution lies in exploiting time-use data to estimate the contribution of individual energy expenditure differentials in determining nutritional status.

The role of energy expenditures in contributing to female malnutrition is potentially more important in sub-Saharan Africa than anywhere else in the world. African women tend to spend a relatively higher proportion of their time performing physically demanding tasks, with relatively less leisure time, due mainly to their central role in agricultural production and distribution, and a lack of labor-saving devices (Lawrence et al. 1985; Singh et al. 1989; Lamba and Tucker 1990; and Mebrahtu 1991). Marked seasonal swings in energy expenditure,

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[2] This is not to say that energy expenditure can always be safely ignored in child studies (see Beaton 1983b).

as well as in body weight and composition and food availability, have also been documented among African women, especially in rural areas (Lawrence et al. 1989 and Reardon and Matlon 1989).

A secondary focus of the analysis is the role of fertility. In general, weight increases with parity. Among undernourished, high fertility populations, however, indicators of nutritional status based on weight may decline with increased parity (Adair 1991). Sub-Saharan Africa's average fertility rate (6.5 per woman, compared to 2.7 for East Asia and the Pacific, 2.0 for South Asia, 3.3 for Latin America and the Caribbean) (World Bank 1992) is the highest in the world. While acceptance of the notion of a maternal depletion syndrome is not universal (Winikoff and Castle [1987] express skepticism, for example), recent empirical evidence from a variety of settings suggests that rapid reproductive cycling indeed contributes to maternal nutritional depletion in high fertility countries (Merchant and Martorell 1983; Huffman, Wolff, and Lowell 1985; Adair et al. 1990; Merchant, Martorell, and Haas 1990a,b). Since none of these studies treated parity as an endogenous choice variable, however, the possibility of statistical biased results cannot be ruled out.

2. METHODOLOGY

THEORETICAL MODEL

The theoretical model used here is based on those employed by Rosenzweig and Schultz (1983) and Schultz (1984). Household members are assumed to behave as joint welfare maximizers with respect to individual health status, consumption, and time allocation.[3] Household utility is derived from both purchased and home-produced goods, including nutrition and health. A joint household preference function governing household decisions over this choice set takes the form:

$$U = U(H^{i}, C_n^{i}, C_f^{i}, L^{i}, I, \mu), \quad i = 1,\ldots,I \tag{1}$$

where H^i is the health status of household member i, C_n^i is member i's nonfood consumption vector, C_f^i is i's food consumption vector, L^i is i's leisure time, μ is an unobserved variable capturing tastes and norms, assumed to be exogenous to current consumption decisions, and I is household size.

The relationship between the nutritional status of each household member and nutrient and health inputs (as conditioned by the individual's health endowment and the household and community health environment and infrastructure) is governed by a production function of the form:

$$H^{i} = H\ (N^{i}, A^{i}, B^{i}, T^{i}, F^{i}; D^{i}, S, M, \eta^{i}), \; i = 1,\ldots,I \tag{2}$$

where N^i, A^i, B^i, and E^i are vectors of member i's recent nutrient intakes, morbidity episodes,[4] use of health care services, and energy expenditure, respectively; F^i is i's total parity; D^i is a vector of other fixed, observable individual characteristics of member i affecting her nutritional status; S and M are vectors of household and community fixed factors, respectively, that affect the nutritional status of household members; and η^i is i's (unobserved) health

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[3] This assumption has been criticized for ignoring bargaining between household members (e.g., Folbre 1986. For theoretical presentations of the bargaining approach, see Manser and Brown 1980 and McElroy and Horney 1981). The distinction between the two models is often nugatory in empirical applications, however (cf. exchange between Folbre 1984 and Rosenzweig and Schultz 1984), so Occam's Razor would seem to favor the former.

[4] Because diseases can reduce the absorption of nutrients consumed, as well as depressing the appetite, while fevers raise metabolic rates, the morbidity indicator may be thought of as conditioning the nutrient intake variable.

endowment. The household maximizes (1) subject to (2) and its full income budget constraint, generating input demands that enter the right-hand side of (2) and which take the general form:

$$Z = \Gamma\ (Y,\ P;\ D^i,\ S,\ M,\ \eta^i),\ i = 1,\ldots,I \tag{3}$$

where Z is a placeholder for $\{N^i, A^i, B^i, E^i, F^i\}$, Y is exogenous income, and P is the complete vector of prices, broadly defined to include time as well as money costs. Note that in this specification neither prices nor income enter directly into the production of health. Instead, they affect (2) indirectly via the demand for inputs.

INDIVIDUAL HETEROGENEITY

Empirical applications of the above model face several potential pitfalls. Perhaps best known is the problem of unknown individual heterogeneity — in terms of the current specification, the inability of researchers to observe η^i. To illustrate, consider the example of a household in which some members are inherently more robust than others, and thus better able to weather short-term shocks such as food shortages. Family members are likely to be aware of this, and in lean periods may choose to allocate relatively more food to those who most need it in order to survive. Typically, researchers cannot observe such differences in individual endowments; yet the observed levels of some health and nutrient inputs will undoubtedly vary according to this individual attribute η^i. The resulting correlation between the inputs and the error term in equation (2) will bias the coefficients if they are estimated using ordinary least squares (OLS).

There are essentially three possible responses to this difficulty. The first is simply to estimate equation (2) by OLS, and live with the possibility of bias. A case can be made for doing so, since the bias may be small and the remaining options, while consistent, are often relatively inefficient (see Buse 1988).[5] Another option is to use full information methods to estimate the production function and input demands as a simultaneous system. This was the approach chosen by Rosenzweig and Schultz (1983), for example, in their analysis of birth weight production with endogenous inputs in the United States. Guilkey et al. (1989) also used this method in their study of birth outcomes in the Philippines. Explicitly modeling the full structural system is appealing, but this requires the researcher to specify the complete structure of the model, possibly increasing the likelihood of specification error. Perhaps more to the point in many applications, they can make insupportable demands upon the data set.

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[5] For this reason it is interesting to compare the estimates of the preferred model, presented below, with the OLS estimates, which appear in an appendix table.

The remaining option — which is related to the second — is to use an instrumental variables (IV) estimator. This method also may impose heavy demands on the data set. It is often difficult in practice to find identifying restrictions for more than one or two endogenous health or nutrient inputs, when many more are usually required. Even when sufficient plausible restrictions are available to identify the model, the instruments may perform poorly, leading to estimates of the structural coefficients that are imprecise.

Ideally, the vector *M* in equations (3) should contain a complete set of prices and wages, as well as other community variables affecting the demand for nutrient and health inputs — examples include roads, distance to nearest clinic, quality of available health care services, climate, prevalence of disease vectors in the local water supply and environs, local dietary and other customary practices, and the like. Often these are not observed; with the exception of local market prices and some locational indicators, this is unfortunately true of the data set we use here.

As is true of many integrated household data sets, however, ours was generated using cluster sampling techniques. Each cluster represents a single market and a relatively homogeneous group of households, and interviews within each cluster were conducted over a short period of time. As such, there is likely to be virtually no intra-cluster price variation, while all of the other variables in *M* are by definition constant within a cluster. This fact suggests the possibility of taking into account the *effects* of these missing variables in the instrumenting equations using cluster-fixed effects or similar techniques. This is discussed in the next section.

IDENTIFYING THE EFFECTS OF MISSING COMMUNITY FACTORS

Consider the following estimating equations, which may be viewed as linear approximations to equations (2) and (3):

$$H_{vi} = Z_{vi}\alpha^{H} + D^{H}_{vi}\beta^{H} + S^{H}_{v}\gamma^{H} + M^{H}_{v}\delta^{H} + \eta^{H}_{vi} + \omega^{H}_{v} \tag{4}$$

$$Z_{vi} = D^{Z}_{vi}\beta^{Z} + S^{Z}_{v}\gamma^{Z} + M^{Z}_{v}\delta^{Z} + \eta^{Z}_{vi} + \omega^{Z}_{v} \tag{5}$$

where the v subscript indexes villages (clusters) and i indexes individuals. As before, Z represents the vector of inputs into the production of nutrition; D, S, and M denote observable individual, household, and village factors, respectively, which affect nutrition production or input demands; the η and ω terms are unobserved personal and village characteristics.

If most elements of the vector M^{Z} in equation (5) are unavailable, then the unobserved component ω^{Z} may contain the bulk of the information explaining the use of some inputs, meaning that any predicted values derived from the estimated coefficients of equation (5) are likely to be inefficient instruments. If any of the included predetermined variables are correlated with ω^z, then the parameter estimates from (5) would also be biased. A possible solution to this problem would be to use a community-fixed effects model to estimate (5), whereby the data are deviated from their cluster means:[6]

$$Z_{vi} - \bar{Z}_v = (D^z_{vi} - \bar{D}^z_v)\beta^z + (S^z_v - \bar{S}^z_v)\gamma^z + \eta^z_{vi} \tag{6}$$

Equivalently, this equation can be expressed in terms of dummy variables:

$$Z_{vi} = D^z_{vi}\beta^z + S^z_v\gamma^z + X_v\lambda + \eta^z_{vi} \tag{7}$$

where X_v is a vector of cluster dummy variables, such that the jth element is defined to be unity if individual i lives in cluster j, and zero otherwise. As long as all observations within a given cluster are collected in the same time period, then equation (7) is nearly equivalent to the more richly parameterized equation (5).

Thus, the total variance in equation (5) may be partitioned into the within-cluster sum of squares about the cluster means, and the sum of squares of the cluster means about the grand mean, and their respective effects treated separately. Because M^z and ω^z are constant across households in a given cluster, they are differenced out when the data are deviated from their means and thus need not be considered in the estimation of (6). For this reason, there is no possibility of bias due to the correlation between M^z and ω^z in these regressions. Thus, β^z and γ^z may be consistently estimated. If consistent estimates of these parameters were the primary goal of this exercise, then cluster-fixed effects would be fully appropriate.

As a means of obtaining the IV estimator of the nutrition production function, on the other hand, using cluster-fixed effects to construct instruments may not be the best choice. Note that the vector M^z is dropped when estimating (6); yet M^z is apt to contain many exogenous variables useful for identifying instruments, even though it may be relatively sparse for the reasons given above. Furthermore, the fixed-effects estimator of equation (6) can use only the information contained in the intra-cluster variation; inter-cluster variation is ignored. For these reasons, the fixed-effects estimator of (6) is likely to be imprecise. The cluster means of the observed Z_{vi}, which implicitly contain much of the information on the effects of the unobserved community variables in explaining inter-cluster variations in input use, may be included as instruments in the estimation of equation (4) along with the predicted deviations.

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[6] Strauss (1990) uses a similar method to deal with the problem of missing *household* variables in a study of child nutrition in Côte d'Ivoire.

The approach taken in the present study is slightly different. Rather than estimating equation (6) in fixed effects, the cluster mean of the LHS variables in equations (5) is included as an instrument in equations (5); in effect, $S_v^z\gamma^z + M_v^z\delta^z + \omega_v^z$ is substituted for Z_v.[7] As discussed above, the community means implicitly contain information on the missing cluster characteristics useful for identifying the instruments. While the pathways by which the missing community variables affect input levels cannot be identified using this method, the impact of these missing variables on the production of nutrition, as they operate through the demand for inputs, can be consistently estimated.[8]

MODEL SPECIFICATION

In this study, women's nutritional status is measured by Quetlet's body mass index (BMI), defined as (weight/height^2), the most commonly used indicator of nutritional status for nonpregnant, nonlactating adults.[9] BMI has a very low correlation with height, but is highly correlated with adiposity (Gibson 1990 and Fogel 1991). It is also highly correlated with many health-related indicators, including mortality risk (Waaler 1989).

Nonetheless, there is as yet little agreement on BMI's distribution in healthy populations, and hence of appropriate cutoff values for evaluating health and mortality risk. One classification provided by James, Ferro-Luzzi, and Waterlow (1988) suggests that BMI levels between 18.5 and 23 be considered normal, with values above 23 being overweight.[10] Individuals falling below 18.5 are assigned one of three categories, ranging from grade I, or mild to moderate energy deficiency for BMI between 18.5 and 17, to grade III, or severe wasting, for BMI below 16.

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7 A similar technique is used by Alderman and Garcia (1992).

8 It might be argued that while this technique accounts for the problem of *individual* heterogeneity, the related problem of unobserved *cluster* heterogeneity is not addressed. That is, ω_v^H and ω_v^Z may not be independent, so that inclusion of the cluster means in the first stage estimation of the Z_{vi} may not result in instruments that are fully independent of the error term in equation (4). Most of the observed inter-cluster variation in nutritional status, however, is likely the result of fluctuations in levels of input use. These, of course, would be captured in the first-stage predictions of the instruments. Moreover, indicators are included in the structural nutritional status equation for agroecological zones, urban and semiurban areas, and the capital and other relatively privileged cities. These should account for most of the remaining unexplained cluster heterogeneity.

9 On the relative merits of different indices for adult nutritional status, see Gibson (1990) and the references therein and Smalley et al. (1990).

10 Other cutoff values have been suggested by Royal College of Physicians (1983); Dugdale (1985); Payne (1986); and Health and Welfare Canada (1988).

An obvious input to nutrition is the individual's intake of calories in the previous period. In the present study this is not directly observed and is proxied by per capita household calorie availability as well as by covariates such as age and height.[11] Calorie availability derives from the household's food demand and thus flows from the interaction of household tastes and preferences with the budget constraint. The latter is determined by the household's assets and human capital, relative prices, and the opportunities and limitations imposed by locale and season.

Morbidity is the result of exposure to pathogens and parasites, as modified by individual choices and characteristics, and by the availability and quality of health care services. Nutrition affects susceptibility to illness through its influence on the immune system, as well as being affected by it. Exposure, on the other hand, is largely a function of the level of community sanitation and the type of water supply, as well as by local prevalence of disease organisms and local customs and practices.

Demand for health care services is also a function of exogenous income and prices, as well as individual and household characteristics. However, availability of, and distance to, health care facilities are often more important determinants in developing countries, particularly in rural areas (see Gertler and van der Gaag 1990). Quality of services and the extent and diffusion of knowledge about health care practices within the community may also play important roles but are generally not observed.

Energy expenditure, as previously mentioned, is determined by the individual's basal metabolic rate and by the energy costs of her daily activities. The former may be proxied by age and height (James, Ferro-Luzzi, and Waterlow 1988); the latter is determined by the individual's time uses and intensities. These are functions, in turn, of individual tastes, relative prices (including the value of time), other individual and household characteristics, and all of the local factors affecting the individual's choice set, including community norms, infrastructure, cropping patterns, climate, and season.

Parity, too, is influenced by individual preferences, as well as prices. It is also a function of community standards and expectations and of the woman's access to, and knowledge of, birth control methods. These latter factors are covariates of village infrastructure and locational variables, as well as numerous unobserved community characteristics affecting the state and diffusion of knowledge within the community (Bollinger 1992).

Thus a number of variables that enter the nutrition production function are significantly influenced by the community's environment and infrastructure,

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[11] Adult height is generally considered predetermined since it is largely a product of early childhood nutrition, in interaction with the genetic potential of the individual (Martorell 1991). Height may also be influenced by nutrition during adolescence, especially if pregnancy occurs before growth is completed (see Kennedy and Bentley [forthcoming] and the references therein).

knowledge base, and norms and practices, all of which are unobserved. These include recent days of illness, consumption of health care services, hours devoted to tasks demanding various levels of energy expenditure, and parity. Each of these variables was instrumented using cluster average values in addition to other exogenous variables.[12] Calorie availability, by contrast, was identified in the usual fashion.

Additional individual characteristics included in the nutrition production function include age, which is intended to pick up developmental processes; height,[13] which may proxy unobservable genetic endowments that contribute to overall physical robustness (Martorell 1991); and education dummies which, for any given level of inputs, influence the knowledge and efficiency with which they are used in producing nutrition.

For the most part household attributes, including the age-gender composition, information about the household head, household assets, and the educational stock of its members, enter the nutrition equation via the instruments rather than directly in the structural production equation. This is in keeping with household production theory, which views nutritional status as the outcome of the levels of the proximate inputs chosen by the individual household members. The same holds for many of the observable community factors. Nevertheless, household size was included directly in order to capture potential scale economies; and dummy variables for the Savannah and Forest agroecological zones, and for Accra and Kumasi, the major urban centers, were also included in order to account for any additional regional disparities not measured elsewhere.

Finally, quarterly dummies were included to account for possible seasonal effects. Seasonal swings in nutritional status are certainly expected in Africa, particularly in rural areas (Lawrence et al. 1985). However, while the prices of most of the major staples exhibit marked seasonality, the impact of this on nutrition should be fully accounted for by the calorie availability pathway. Seasonal differences in disease prevalence, too, ought to affect nutrition indirectly, via the illness instrument. However, quarterly dummies were included in order to allow for the possibility of additional unobserved seasonal factors.

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[12] To avoid reintroducing individual heterogeneity in these regressions, non-self cluster mean was used, calculated over all households in the cluster *other than* that of the individual in question.

[13] Both age and height may also capture the residual effects of previous deprivation, e.g., the calamitous drought and famine that hit Ghana in 1983-84.

3. DATA

The model is estimated with data from the 1987-88 Ghana Living Standards Survey (GLSS), a nationally representative, self-weighing random sample of nearly 3200 households, or roughly 15,000 people.[14] Community (cluster-level) prices were gathered for most of the calorie-dense foods and some nonfood items in a complementary market survey that was undertaken at the same time as the household interviews. Field staff made three purchases of each commodity and recorded the prices paid. Subsequently the purchases were weighed, giving a unit price. Missing prices were handled where possible by using the price from the closest available cluster. Rice prices, which were not recorded on the questionnaire, were obtained from regional agricultural market data.

The definitions of all variables used in the subsequent analysis are given in Table 1. Descriptive statistics on these variables are presented in Table 2.

A major aim of this paper is to construct a useful proxy for individual energy expenditure. The time-use module of the GLSS, administered to all household members seven years of age and older, reports hours devoted to "main" and "secondary" jobs during the seven days prior to interview, as well as the time spent in the home performing nonmarket-oriented tasks (e.g., preparing meals, fetching water and wood, etc.) during the same period.

Seventy-two percent of the women worked outside the home, and of these, 21 percent reported working at least two jobs in the previous seven days. This, of course, is in addition to a weekly average of more than 20 hours of labor in the home, a category which more than 95 percent of the sample reported performing. Agriculture dominates the activities of Ghanaian women. Forty-three percent reported that agricultural tasks constituted their main job in the previous week; of those reporting a secondary job, 40 percent said that this, too, was in agriculture. The predominance of agricultural employment is, however, not apparent in the mean hours in agriculture reported in Table 2; those who did perform nonagricultural work reported more time in that activity and thus the average time spent in nonagricultural activities exceeds that in agriculture.

It should be noted that the distinction between market time ("labor supply") and nonmarket time, often made in time allocation studies, is not germane to this discussion. Instead, what is required is that the average energy intensity of an hour's labor in any activity be more homogeneous within the given job class than across classes. Obviously, the more similar with respect to energy intensity the activities are within classes, and the more dissimilar they are

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[14] For a discussion of the GLSS survey design and sampling methodology, see Scott and Amenuvegbe (1989).

Table 1 — Definitions of Major Variables

Variable	Definition
BMI[a]	Body mass index: Wt (kg)/Ht^2 (m)
Age	Reported age in years
Height	Measured height in centimeters
Education dummies	
Primary	Equals one if highest grade respondent reports completing is in primary school, and zero otherwise.
Secondary	Equals one if highest grade respondent reports completing is in secondary school, and zero otherwise.
Postsecondary	Equals one if highest grade respondent reports completing is beyond secondary school, and zero otherwise.
Household size	Number of members of respondent's household.
Female-headed	Equals one if respondent resides in a household headed by a woman, and zero otherwise.
Forest zone	Equals one if respondent's household is located in the Forest agroecological zone, and zero otherwise.
Savannah zone	Equals one if respondent's household is located in the Savannah agroecological zone, and zero otherwise.
2nd quarter	Equals one if respondent was interviewed during the second quarter of the year (April-June) and zero otherwise.
3rd quarter	Equals one if respondent was interviewed during the third quarter of the year (July-September), and zero otherwise.
4th quarter	Equals one if respondent was interviewed during the fourth quarter of the year (October-December), and zero otherwise.
Urban	Equals one if respondent's household is located in an urban area, and zero otherwise.
Semiurban	Equals one if respondent's household is located in a semiurban area (population 2,000 or more), and zero otherwise.

(continued)

Table 1 (continued)

Variable	**Definition**
Accra	Equals one if respondent's household is located in Accra (the national capital), and zero otherwise.
Kumasi	Equals one if respondent's household is located in Kumasi (capital of Ashanti Region), and zero otherwise.
Log per capita calories available[a]	The average total calories available to the household during the two weeks prior to interview, divided by household size, in natural logarithms.
Log per capita household expenditures[a]	The total expenditures (cedis) reported on all goods and services in the two weeks prior to interview by all household members, including imputed value of home-produced foods, divided by household size, in natural logarithms.
Number of days ill in past four weeks[a]	The number of days respondent reported being ill in the four weeks prior to interview.
Number of days incapacitated, past four weeks[a]	The number of days respondent reported being sufficiently ill or injured as to prevent the performance of her normal activities.
Log health care expenditures, past four weeks[a]	The amount (cedis) spent by household for curative and preventative health care goods and services for the respondent during the four weeks prior to interview, in natural logarithms.
Parity[a]	The number of pregnancies carried to term by the respondent, including stillbirths.
Agricultural hours, last seven days[a]	The number of hours reported spent by respondent in the seven days prior to interview on agricultural and forestry activities.
Nonagricultural hours, last seven days[a]	The number of hours reported spent by respondent in the seven days prior to interview on all nonagricultural activities other than nonmarket-oriented labor at home.
Home labor hours, last seven days[a]	The number of hours reported spent by respondent in the seven days prior to interview on nonmarket-oriented labor at home.

[a] Endogenous variables.

Table 2 — Means and Standard Deviations of Major Variables

Variable	**Rural (n=1,977)**	**Urban (n=1,153)**	**Pooled (n=3,130)**
BMI	20.888 (3.204)	23.026 (4.951)	21.673
Age	38.861 (15.989)	36.607 (14.885)	38.033 (15.628)
Height	156.998 (6.267)	158.306 (6.357)	157.481 (6.330)
Education			
Primary	0.097	0.101	0.099
Secondary	0.217	0.401	0.284
Postsecondary	0.009	0.061	0.028
Household size	6.591 (3.837)	5.904 (3.381)	6.338 (3.690)
Female-headed	0.328	0.410	0.358
Forest zone	0.461	0.328	0.412
Savannah zone	0.305	0.134	0.242
2nd quarter	0.212	0.263	0.231
3rd quarter	0.257	0.201	0.237
4th quarter	0.258	0.159	0.222
Urban	—	—	0.368
Semiurban	0.316	—	0.120
Accra	—	0.256	0.094

(continued)

Table 2 (continued)

Variable	**Rural (n=1,977)**	**Urban (n=1,153)**	**Pooled (n=3,130)**
Kumasi	—	0.094	0.035
Log per capita calories available	7.656 (0.675)	7.555 (0.675)	7.619 (0.677)
Log per capita household expenditures	10.647 (0.596)	11.102 (0.623)	10.815 (0.644)
Number of days ill in past four weeks	3.388 (6.127)	3.560 (6.218)	3.451 (6.158)
Number of days incapacitated, past four weeks	1.893 (4.252)	1.479 (3.560)	1.740 (4.014)
Health care expenditures, past four weeks	586.584 (1,928.430)	1,010.460 (2,830.070)	742.329 (2,309.960)
Parity	4.836 (3.475)	3.824 (3.253)	4.461 (3.430)
Agricultural hours last seven days	16.172 (15.896)	3.345 (8.962)	11.447 (15.081)
Nonagricultural hours, last seven days	7.676 (16.483)	19.607 (24.658)	12.071 (20.702)
Home labor hours, last seven days	20.686 (11.867)	21.111 (13.462)	20.843 (12.479)

[a] Standard deviations appear in parentheses below means.

between classes, the better job the time allocation variables will do at representing variations in energy expenditure within the sample, and thus the population.

It was decided to aggregate hours into just three categories for use in the regression analysis: agricultural, nonagricultural, and home labor. The low level of technology that prevails in Ghanaian agriculture and the virtual lack of animal traction assures that most, if not all, agricultural activities are labor-intensive and relatively demanding. On the other hand, the available GLSS time-use data are insufficient to distinguish among gradations of the physical exertion required in the other occupations — e.g., between sales and service jobs. Thus the agriculture/nonagriculture distinction was a natural one in this case. Home labor was included because it is such a significant component of women's time allocation in Ghana.

Table 3 illustrates the sample distribution of nutritional status for female respondents 18 years of age and above, using the categories suggested by James, Ferro-Luzzi, and Waterlow (1988). By this standard, 17 percent of women in Ghana during the sample period could be classified as undernourished (BMI less than 18.5); roughly 2 percent suffered from severe (Grade III) caloric deficiency; while the remainder fell into less acutely dangerous brackets.

Table 3 also makes clear that rural inhabitants are generally thinner than their urban counterparts: rural women are observed in the lowest categories at rates twice that of urban dwellers. While a significant share of Ghanaian women are undernourished, a surprisingly high proportion appears to be overweight, particularly in urban areas.[15] This may simply reflect genetic differences between the Ghanaian population and those used to derive the cutoff values. It may also reflect dietary habits that have lagged behind behavioral changes as the society becomes more sedentary. While less of a concern than undernutrition, this apparent high prevalence of obesity nevertheless may pose a potentially serious health problem.

Table 4 shows the joint distribution of rural and urban BMIs, heights and weights by predicted household per capita expenditure decile (a proxy for permanent income).[16] Height, weight, and BMI all fail to display a consistent relationship with per capita expenditures at the means. These observations, however, must be tempered by the knowledge that there is a substantial spatial component to the social disparities observed in Ghana: income, wealth, infrastructure and services, educational opportunities, and agronomic potential

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[15] Using GLSS data, Alderman (1990) reported that males in Ghana are leaner overall, but that proportionately more women appear to be suffering from the more severe grades of undernutrition as well as from obesity.

[16] The log of per capita household expenditures was predicted as a function of fixed household assets and human capital variables, as well as the cluster mean of the dependent variable (Alderman and Higgins 1992). In the text below, this variable will be termed "income" to avoid confusion with energy expenditures.

Table 3 — Distribution of Nutritional Status (Chronic Energy Deficiency), Nonpregnant, Nonlactating Ghanaian Women 18 Years and Older

BMI Range	**Classification**	**Rural (n=1,977)**	**Urban (n=1,153)**
		(Percent)	
BMI > 23.0	Overweight	19.1	38.1
18.5 ≤ BMI ≤ 23.0	Normal energy reserves	61.2	50.5
17.0 ≤ BMI < 18.5	Normal-to-mild CED	12.9	7.8
16.0 ≤ BMI < 17.0	Mild-to-moderate CED	4.7	2.2
BMI < 16.0	Severe CED	2.1	1.5

Note: Classifications are somewhat imprecise for the mild and moderate CED levels because of normal variations observed in healthy populations (see James, Ferro-Luzzi, and Waterlow 1988).

Table 4 — Distribution of BMI, Weight, and Height, by Income Decile, Nonpregnant, Nonlactating Ghanaian Women 18 Years and Older

Decile	Rural				Urban			
	Weight	Height	BMI	N	Weight	Height	BMI	N
1	51.9	157.6	20.9	255	59.3	159.4	23.3	58
2	51.0	157.1	20.7	263	54.6	158.5	21.6	50
3	51.3	157.0	20.8	268	55.4	158.1	22.2	45
4	50.7	156.9	20.6	244	54.1	157.8	21.8	70
5	50.7	156.1	20.7	228	57.6	157.7	23.2	85
6	51.5	156.9	20.9	207	57.7	157.1	23.3	106
7	53.1	157.2	21.4	196	56.6	158.4	22.5	118
8	51.3	156.8	20.8	155	55.8	157.9	22.4	159
9	52.5	157.0	21.3	109	59.8	158.0	23.9	204
10	56.1	158.5	22.3	54	59.9	159.5	23.5	258

Note: Weights and heights are expressed in kilograms and centimeters, respectively. Rank ordering of individuals wwas performed over the entire sample, rather than within rural and urban subsamples separately. Ranking was on the basis of predicted per capita household expenditures, an exogenous income instrument, where log of per capita expenditure was regressed on household assets, demographic, community and regional characteristics, and quarterly indicators.

all tend to follow the same south–to-north gradient exhibited by the prevailing rainfall pattern. There are also ethnic differences, which, while far more complex, correspond in a rough way to the simple coast-forest-savannah division.

4. RESULTS

Results from several alternative specifications of the nutritional status regression are presented in Table 5. Overall, the pattern displayed by the coefficients on the time-use variables tends to support the hypothesis that individual time allocation plays an important role in determining female nutritional status. They also are consistent with the interpretation that time-use variables, appropriately disaggregated, are useful for proxying the individual energy costs of routine daily activities. These coefficients indicate, for example, that an additional 10-hour day per week devoted to agricultural labor would result, ceteris paribus, in an expected reduction in BMI of 0.64 (nearly 15 percent of the range between obesity and the cutoff for mild chronic energy deficiency). By contrast, the nonagricultural time allocation variable has a positive coefficient, which is consistent with the more sedentary nature of nonagricultural labor in Ghana.

The positive net effect of home labor, while smaller in absolute value than the other time-use coefficients, was not expected. Some of the tasks elicited in this category (e.g., hauling water, gathering fuelwood) would seem to be as demanding as most farm tasks; others, such as childcare, cooking, and clothes mending, are far less energy intensive. The comparatively small positive coefficient may reflect the net impact of disparate activities with widely varying energy demands which were inappropriately aggregated into a single category. Unfortunately, the data allow no way of treating these categories apart.

The results also imply that the elasticities of other explanatory variables may be substantially biased if the variation in individual energy expenditure is not taken into account. The coefficient for calorie availability, in particular, is small, unstable, and uniformly insignificant in *all* specifications, which exclude the time-use variables. When the latter are included, by contrast, the magnitude of the parameter estimate for calories jumps dramatically and becomes statistically significant ($p = 0.039$).[17] The direction of bias when time allocation is excluded is consistent with the discussion of the joint interaction of individual calorie consumption, requirements, and energy expenditures in the introduction.

Similar patterns are observed for several other variables. For instance, coefficients for the forest and savannah zones, and urban and semi-urban areas, which "explain" a very large proportion of the variance of the dependent variable

[17] Moreover, this result is also robust across several other permutations (not reported here because of space limitations), so long as the time-use variables are included.

Table 5 — Nutritional Status Regressions, Women 18 Years and Older

Variable	(1)	(2)	(3)	(4)
Intercept	13.132 (2.798)	15.336 (3.478)	16.005 (3.663)	10.426 (3.666)
Age (years)	0.223 (0.022)	0.192 (0.027)	0.372 (0.061)	0.298 (0.058)
Age squared	-0.002 (0.0002)	-0.002 (0.0003)	-0.004 (0.0006)	-0.003 (0.0005)
Height (cm.)	0.005 (0.011)	-0.013 (0.014)	-0.018 (0.015)	-0.019 (0.014)
Education				
Primary	0.860 (0.247)	0.466 (0.325)	0.269 (0.347)	0.449 (0.324)
Secondary	0.643 (0.185)	0.536 (0.227)	0.202 (0.259)	-0.015 (0.243)
Postsecondary	1.528 (0.432)	1.199 (0.530)	0.491 (0.596)	0.514 (0.549)
Household size	0.104 (0.024)	0.125 (0.030)	0.156 (0.033)	0.190 (0.032)
Female-headed	0.221 (0.156)	0.271 (0.214)	0.174 (0.227)	0.361 (0.232)
Forest zone	-1.050 (0.164)	-0.715 (0.218)	-0.575 (0.233)	-0.030 (0.239)
Savannah zone	-1.327 (0.201)	-0.591 (0.291)	-0.598 (0.306)	-0.230 (0.305)
2nd quarter	-0.246 (0.188)	-0.427 (0.232)	-0.443 (0.244)	-0.171 (0.242)
3rd quarter	0.398 (0.188)	0.147 (0.236)	0.103 (0.248)	0.314 (0.241)
4th quarter	0.002 (0.192)	-0.037 (0.234)	-0.106 (0.247)	0.231 (0.251)

(continued)

Table 5 (continued)

Variable	(1)	(2)	(3)	(4)
Urban	1.854 (0.174)	1.559 (0.221)	1.302 (0.244)	0.250 (0.284)
Semiurban	0.532 (0.191)	0.488 (0.236)	0.411 (0.249)	0.084 (0.240)
Log per capita calories available[a]	0.306 (0.276)	0.322 (0.348)	-0.002 (0.379)	0.830 (0.402)
Number of days ill in past four weeks[a]	—	-0.020 (0.085)	0.044 (0.090)	-0.078 (0.088)
Log health care expenditure, past four weeks[a]	— (0.028)	0.120[d] (0.030)	0.129[b] (0.028)	0.102[b]
Parity[a]	—	—	-0.398 (0.119)	-0.247 (0.116)
Agricultural hours, last seven days[a]	—	—	—	-0.064 (0.020)
Nonagricultural hours, last seven days[a]	—	—	—	0.058 (0.018)
Home labor hours, last seven days[a]	—	—	—	0.027 (0.019)
R^2	0.129	0.097	0.092	0.119
N	3,130	3,130	3,130	3,130

<u>Notes:</u> Standard errors are in parentheses below estimates. They, and the R^2 statistics, are corrected to account for the disturbances in the first-stage regressions. The asymptotic standard errors of the estimates in the probit regressions are <u>not</u> corrected, however. Dependent variable is BMI. Sample mean of dependent variable is 21.67. Pregnant and lactating women were excluded from sample.

[a] Endogenous RHS variables.

[b] times 10^{-2}.

[c] Maximum likelihood probit estimation. Dependent variable equals one when BMI < 18.5, and zero otherwise. 522 cases equal one, and 2,608 equal zero.

in the parsimonious models (columns [1] through [3]), drop by an average of 80 percent in absolute value in model 4, which includes the time-use variables. Moreover, none of coefficients of the regional and sector dummy variables remain significant by the usually accepted criteria when time allocation is included. This indicates that most, if not all, of the regional pattern observed in female nutritional status that is not explained by calories, parity, morbidity, and the availability of health care services, works through regional differences in the pattern of women's daily activities, and the energy costs that they imply.

Parity is associated with a negative net effect on nutritional status. The coefficient suggests that, on average, each additional pregnancy carried to term by a woman in Ghana implies an expected drop in her BMI of between 0.25 and 0.40, or roughly half of the impact of an additional day of work in agricultural labor each week, holding other factors constant. The coefficients on the dummy variables for secondary and postsecondary educational attainment shrink approximately 60 percent in absolute magnitude upon the introduction of parity into the regression, in the process becoming smaller than their estimated standard errors. This suggests that much of the apparent ameliorative effect of education on women's nutrition operates through its impact on fertility, rather than by directly influencing the health technology practiced in the home.

A set of analogous regressions, which include an exogenous income instrument in place of calories, are presented in Table 6. As previously noted, income is not a proximate input in the production of nutritional outcomes. In effect, then, these equations are hybrids of structural and reduced forms; while formally inconsistent with household production theory, they may be usefully interpreted as conditional production functions (Strauss 1990). They are of interest primarily to shed further light upon the nature of the specification error discussed above. These regression results are generally quite similar to those reported in the previous table. The notable exception is that, in distinction to the calorie variable in Table 5, the coefficient on incomes falls from 1.45 to 0.62 — i.e., by nearly 60 percent of its value — as variables measuring morbidity, health care, parity, and time uses enter the model sequentially. When predicted calories is added,[18] the income variable shrinks to 0.2 and is no longer distinguishable from zero by the usual criteria.

This result illustrates an important difference in the impact of excluding time allocation variables in the two sets of equations. As discussed above, the relationship between calories and BMI is unambiguously positive; likewise, the partial correlation between energy expenditure and BMI is unambiguously negative. Since calorie intake and energy expenditure are positively correlated, excluding indicators of the latter will bias regression coefficients of the former in a negative direction.

In the case of regressions involving an income instrument, on the other hand, the interactions are more complex. While energy expenditure is still negatively related to BMI, the sign of the relationship between energy

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[18] This result is not presented here due to space limitations.

Table 6 — Conditional Nutrition Regressions, Women 18 Years and Older

Variable	**(1)**	**(2)**	**(3)**	**(4)**
Intercept	0.573 (3.115)	4.642 (3.873)	7.148 (4.209)	10.191 (4.241)
Age (years)	0.215 (0.022)	0.192 (0.026)	0.312 (0.060)	0.294 (0.058)
Age squared	-0.002 (0.0002)	-0.002 (0.0003)	-0.003 (0.0005)	-0.003 (0.005)
Height (cm.)	-0.002 (0.011)	-0.015 (0.013)	-0.019 (0.014)	-0.019 (0.013)
Education				
Primary	0.754 (0.246)	0.540 (0.303)	0.402 (0.324)	0.403 (0.309)
Secondary	0.403 (0.189)	0.334 (0.219)	0.165 (0.242)	-0.057 (0.233)
Postsecondary	0.904 (0.444)	0.757 (0.508)	0.412 (0.555)	0.338 (0.527)
Household size	0.176 (0.025)	0.182 (0.029)	0.193 (0.031)	0.180 (0.030)
Female-headed	0.425 (0.159)	0.508 (0.208)	0.394 (0.223)	0.372 (0.233)
Forest zone	-0.822 (0.168)	-0.562 (0.208)	-0.501 (0.219)	-0.069 (0.228)
Savannah zone	-0.878 (0.214)	-0.392 (0.277)	-0.456 (0.292)	-0.151 (0.295)
2nd quarter	-0.325 (0.188)	-0.453 (0.218)	-0.458 (0.228)	-0.226 (0.230)
3rd quarter	0.432 (0.187)	0.266 (0.223)	0.202 (0.236)	0.336 (0.236)
4th quarter	0.226 (0.195)	0.159 (0.224)	0.055 (0.239)	0.282 (0.254)

(continued)

Table 6 (continued)

Variable	**(1)**	**(2)**	**(3)**	**(4)**
Urban	1.373 (0.184)	1.239 (0.306)	1.155 (0.226)	0.145 (0.276)
Semiurban	0.395 (0.190)	0.412 (0.219)	0.394 (0.249)	0.036 (0.230)
Log per capita expenditures[a]	1.450 (0.247)	1.239 (0.306)	0.889 (0.357)	0.624 (0.368)
Number of days ill in past four weeks	—	-0.057 (0.080)	-0.027 (0.085)	-0.065 (0.084)
Log health care expenditures, past four weeks[a]	—	0.100[d] (0.027)	0.113[d] (0.028)	0.090[d] (0.028)
Parity[a]	—	—	-0.267 (0.120)	-0.236 (0.119)
Agricultural hours, last seven days[a]	—	—	—	-0.053 (0.018)
Nonagricultural hours, last seven days[a]	—	—	—	0.054 (0.018)
Home labor hours, last seven days[a]	—	—	—	0.023 (0.018)
R^2	0.137	0.113	0.105	0.127
N	3,130	3,130	3,130	3,130

Notes: Standard errors are in parentheses below estimates. They, and the R^2 statistics, are corrected to account for the disturbances in the first-stage regressions. The asymptotic standard errors of the estimates in the probit regressions are not corrected, however. Dependent variable is BMI. Sample mean of dependent variable is 21.67. Pregnant and lactating women were excluded from sample.

[a] Endogenous RHS variables.

[b] times 10^{-2}.

[c] Maximum likelihood probit estimation. Dependent variable equals one when BMI < 18.5, and zero otherwise. 522 cases equal one, and 2,608 equal zero.

expenditure and income is murkier, and may well be negative when occupation is not held constant.

As suggested in the preceding discussion, BMI probably bears a nonlinear relationship to nutritional health, with both the lower and upper tails implying serious, if rather different, health problems. To focus on the likelihood of serious consequences due to energy deficiency, alternative specifications of both sets of regressions were run to model the probability of being malnourished. The dependent variable in these equations is a dummy variable, which takes on a value of unity if BMI is below 18.5, and zero otherwise. The maximum likelihood probit estimates of these models are presented in Appendix Table 2. Similarly, since the data presented in Table 3 suggest that obesity may be a significant source of risk, even in a poor nation such as Ghana, probit regressions reported in Appendix Table 3 report the probability of a women being obese.[19]

In regards to undernutrition, lack of calorie availability seems to counts for less than overwork, lack of utilization of health care and parity.

Calorie availability (and income), however, do contribute to the probability of obesity. This is consistent with the existence of nonlinearities in the central results modeled and reported in Tables 5 and 6. Alternatively, or additionally, the population of overweight women in Ghana are more homogeneous than those who are in chronic energy deficit and, hence, our prediction equations are more precise.

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[19] The categories, although mutually exclusive, are not exhaustive. The signs of most variables in Table A2 are expected to be the opposite of those in Table A3. Unlike the main results, the T-statistics are not corrected for first-stage prediction error and should be taken as suggestive only.

5. CONCLUSIONS AND DISCUSSION

The poor health and nutrition of African women are among the most serious problems facing governments and development planners there. While statistics on morbidity and mortality in Africa are rare, there is ample evidence that women in sub-Saharan Africa suffer extremely high rates of morbidity and mortality. Major causal factors include insufficient and seasonally fluctuating nutrient availability, high levels of energy expenditure, and high fertility, as well as endemic diseases and poor provision of health care services (see Kennedy and Bentley [forthcoming] and the references therein).

The results of this study suggest:

- The demanding physical labor performed by Ghanaian women, especially in agriculture, but possibly also in food preparation (such as processing grain and pounding roots to make staples such as *fufu*) and other household tasks, has a significant negative effect on their nutritional status. Moreover, such nutritional impacts may affect the prospects for their children as well. This implies that the introduction of labor-saving devices may have a direct impact on nutrition similar to the increase of food consumption. It also suggests that the energy consequences of public work projects involving women in physical labor be considered, especially when the programs are designed in response to chronic or acute food shortages.

- The extremely high fertility rate of Ghanaian women, in concert with disease and inadequate health care and nutrient availability, also takes a measurable toll. Thus, increased education for women and family planning programs may be considered facets of nutritional planning as well as programs justified in their own right. It also underscores the importance of supplementation programs for pregnant and lactating women for rural women and women residing in the Savannah regions of the country.

APPENDIX TABLES

Table A.1 — OLS Nutrition Regressions — Ignoring Endogeneity (Women Aged 18 Years and Older)

Variable	**(1)**		**(2)**	
Intercept	7.949	(2.210)	13.992	(1.965)
Age (years)	0.204	(0.025)	0.210	(0.026)
Age squared	-0.002	(0.0003)	-0.002	(0.0003)
Height (centimeters)	-0.001	(0.011)	0.002	(0.011)
Education				
Primary	0.752	(0.185)	0.799	(0.245)
Secondary	0.409	(0.185)	0.523	(0.185)
Postsecondary	1.077	(0.432)	1.388	(0.431)
Household size	0.139	(0.021)	0.106	(0.020)
Female-headed	0.364	(0.155)	0.257	(0.155)
Forest zone	-0.716	(0.165)	-0.817	(0.165)
Savannah zone	-0.855	(0.204)	-1.077	(0.202)
2nd quarter	-0.194	(0.185)	-0.152	(0.187)
3rd quarter	0.475	(0.185)	0.448	(0.186)
4th quarter	0.270	(0.192)	0.151	(0.192)
Urban	1.092	(0.182)	1.326	(0.180)
Semiurban	0.290	(0.188)	0.357	(0.189)
Log per capita calories available	—		0.255	(0.104)
Log per capita expenditures	-0.783	(0.127)	—	
Number of days ill in past four weeks	-0.019	(0.012)	-0.015	(0.012)
Log health care expenditures, past four weeks	0.007[a]	(0.003)	0.007[a]	(0.003)
Parity	0.033	(0.029)	0.025	(0.029)
Agricultural hours, last seven days	-0.028	(0.005)	-0.029	(0.005)
Nonagricultural hours, last seven days	0.015	(0.004)	0.017	(0.004)
Home labor hours, last seven days	0.011	(0.006)	0.013	(0.006)
R^2	0.159	0.150		
N	3,130		3,130	

Notes: Standard errors are in parentheses. Dependent variable: BMI. Sample mean of dependent variable is 21.67. Models (1) and (2) are equivalent to model (4) in Tables 8 and 9, respectively. Pregnant and lactating women were excluded from sample.

[a] times 10^{-2}.

Table A.2 — Probit Regressions of Undernutrition Risk (Women Aged 18 Years and Older)

Variable	Undernutrition[d] (1)	(2)	(3)	(4)
Intercept	-0.207 (1.130)	-0.499 (1.178)	0.566 (1.214)	-1.026 (1.317)
Age (years)	-0.017 (0.009)	-0.028 (0.019)	-0.016 (0.009)	-0.030 (0.019)
Age squared	0.040[e] (0.009)	0.020[e] (0.003)	0.040[e] (0.009)	0.041[e] (0.016)
Height (centimeters)	0.002 (0.004)	0.003 (0.004)	0.003 (0.004)	0.003 (0.004)
Education				
Primary	-0.099 (0.104)	0.007 (0.111)	-0.092 (0.105)	0.012 (0.111)
Secondary	-0.172 (0.810)	-0.063 (0.087)	-0.156 (0.082)	-0.065 (0.087)
Postsecondary	-0.131 (0.202)	0.086 (0.214)	-0.095 (0.204)	0.080 (0.214)
Household size	-0.036 (0.010)	-0.035 (0.011)	-0.043 (0.011)	-0.031 (0.012)
Female-headed	-0.065 (0.065)	-0.036 (0.074)	-0.087 (0.067)	-0.020 (0.080)
Forest zone	0.192 (0.068)	0.062 (0.075)	0.173 (0.069)	0.065 (0.076)
Savannah zone	0.355 (0.081)	0.197 (0.092)	0.304 (0.085)	0.202 (0.092)
2nd quarter	0.037 (0.077)	0.058 (0.082)	0.045 (0.077)	0.058 (0.082)
3rd quarter	-0.093 (0.078)	-0.076 (0.081)	-0.097 (0.078)	-0.071 (0.082)
4th quarter	0.016 (0.077)	-0.051 (0.082)	-0.012 (0.079)	-0.044 (0.084)
Urban	-0.285 (0.072)	0.005 (0.091)	-0.223 (0.074)	0.002 (0.090)
Semiurban	-0.131 (0.076)	-0.065 (0.079)	-0.108 (0.075)	-0.066 (0.079)
Log per capita calories available	-0.116 (0.111)	-0.016 (0.122)	—	—
Log per capita expenditures*	—	—	-0.152 (0.089)	0.039 (0.402)
Number of days ill in past four weeks	—	0.003 (0.018)	—	0.001 (0.018)
Health care expenditures, past four weeks*	—	-0.025[e] (0.007)	—	(-0.026)[e] (0.008)
Parity*	—	0.048 (0.039)	—	0.054 (0.040)
Agricultural hours, last seven days*	—	0.009 (0.004)	—	0.008 (0.004)
Nonagricultural hours, last seven days	—	-0.008 (0.004)	—	-0.008 (0.004)
Home labor hours, last seven days*	—	-0.013 (0.005)	—	-0.013 (0.005)
Log likelihood ratio	213.4	254.9	215.3	255.0
n	3,130	3,130	3,130	3,130

* Endogenous RHS variables.

[a] Maximum likelihood probit estimates.

[b] Asymptotic standard errors are located in parentheses below estimates. These are not corrected to account for first-stage prediction errors.

[c] Pregnant and lactating women were excluded from sample.

[d] Dependent variable equals one if BMI < 18.5 and zero otherwise. 523 cases equal unity.

[e] times 10^{-2}.

Table A.3 — Probit Regressions of Overweight Risk (Women Aged 18 Years and Older)

Variable	Overweight[d] (1)	(2)	(3)	(4)
Intercept	-6.283 (1.058)	-6.090 (1.096)	-7.325 (1.118)	-6.091 (1.317)
Age (years)	0.090 (0.009)	0.105 (0.019)	0.090 (0.009)	0.104 (0.020)
Age squared	-0.096[e] (0.011)	-0.103[e] (0.018)	-0.095[e] (0.011)	-0.102[e] (0.018)
Height (centimeters)	0.005 (0.004)	0.004 (0.004)	0.004 (0.004)	0.004 (0.004)
Education				
Primary	0.241 (0.089)	0.213 (0.095)	0.231 (0.089)	0.217 (0.095)
Secondary	-0.107 (0.069)	-0.012 (0.075)	0.077 (0.070)	-0.016 (0.075)
Postsecondary	0.477 (0.148)	0.301 (0.160)	0.417 (0.150)	0.294 (0.160)
Household size	0.045 (0.009)	0.048 (0.010)	0.056 (0.010)	0.051 (0.011)
Female-headed	0.094 (0.057)	0.113 (0.066)	0.142 (0.060)	0.139 (0.071)
Forest zone	-0.217 (0.059)	-0.029 (0.065)	-0.178 (0.061)	0.016 (0.066)
Savannah zone	-0.421 (0.076)	-0.228 (0.084)	-0.308 (0.079)	-0.165 (0.086)
2nd quarter	-0.121 (0.070)	-0.110 (0.074)	-0.141 (0.070)	-0.121 (0.074)
3rd quarter	0.087 (0.068)	0.104 (0.081)	0.090 (0.068)	0.108 (0.072)
4th quarter	0.086 (0.072)	0.022 (0.076)	-0.025 (0.073)	0.058 (0.077)
Urban	0.604 (0.065)	0.178 (0.084)	0.452 (0.066)	0.087 (0.082)
Semiurban	0.285 (0.072)	0.168 (0.076)	0.234 (0.071)	0.136 (0.075)
Log per capita calories available	0.337 (0.103)	0.283 (0.112)	—	—
Log per capita expenditures*	—	—	-0.333 (0.080)	0.203 (0.094)
Number of days ill in past four weeks	—	0.033 (0.016)	—	0.035 (0.017)
Health care expenditures, past four weeks*	—	-0.013[e] (0.006)	—	-0.013[e] (0.006)
Parity*	—	-0.410 (0.037)	—	-0.037 (0.038)
Agricultural hours, last seven days*	—	-0.021 (0.004)	—	-0.021 (0.004)
Nonagricultural hours, last seven days	—	-0.012 (0.003)	—	-0.012 (0.003)
Home labor hours, last seven days*	—	-0.008 (0.005)	—	0.008 (0.005)
Log likelihood ratio	330.9	416.9	337.5	415.1
n	3,130	3,130	3,130	3,130

* Endogenous RHS variables.

[a] Maximum likelihood probit estimates.

[b] Asymptotic standard errors are located in parentheses below estimates. These are not corrected to account for first-stage prediction errors.

[c] Pregnant and lactating women were excluded from sample.

[d] Dependent variable equals one if BMI > 23.0 and zero otherwise. 816 cases equal unity.

[e] times 10^{-2}.

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