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The Hebrew University of Jerusalem

המרכז למחקר בכלכלה חקלאית
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המחלקה לכלכלה חקלאית ומנהל
The Department of Agricultural Economics and Management

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Socio-Economic Determinants of Health and Physical Fitness in Southern Ethiopia

by

Ayal Kimhi

P.O. Box 12, Rehovot 76100

ת.ד. 12, רחובות 76100

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Ayal Kimhi
The Hebrew University

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Abstract

The purpose of this paper is to investigate the dependence of health and physical fitness indicators on the socio-economic situation of rural families in Southern Ethiopia, with particular emphasis on the role of inequality. The literature shows mixed results about the effect of inequality on health, and this paper contributes in several ways: it compares the results of objective and subjective health measures, it distinguishes between wealth inequality and nutrition inequality, and it evaluates the impact of nutrition inequality both at the village level and at the household level.

The subjective health measures are morbidity (the number of days respondents were ill during the last month) and physical fitness (their ability to walk distances, carry heavy loads, and work in the field). The objective health measure is Body Mass Index (BMI). We found that many effects of explanatory variables were significant in some of the equations but not in all of them. In some cases we even obtained contradictory significant effects. This emphasizes the need not to rely on a single health measure.

The results indicate that literacy is negatively associated with morbidity. Per-capita wealth is positively associated with BMI. Availability of satisfactory health facilities is associated positively with physical fitness and negatively with morbidity. Per-capita wealth inequality is associated positively with morbidity and negatively with BMI. Within-household nutrition inequality seems to have a complex association with health: the association is negative with BMI and positive with physical fitness, but only for household members whose nutritional status is above the household mean.

While these results should be examined more carefully with regard to possible endogeneity of some of the determinants, they do indicate several variables with a positive association with health and physical fitness. These include literacy, wealth and satisfactory health facilities. The role of inequality is less clear, and certainly deserves further analyses at both the theoretical and empirical levels.

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Introduction

Health is of interest to economists, first because it is an important element of well-being, and second because it is a component of human capital, and as such is of major importance for growth and development. In poor countries, where physical jobs tend to be more abundant, health may be more important than education in determining labor productivity. The literature on health and economic development has been surveyed by Behrman and Deolalikar (1988), and more recently by Strauss and Thomas (1998).

There is a sizeable body of empirical evidence showing that health is determined by family decisions. Pitt and Rosenzweig (1985) show that health is directly affected by nutritional intakes, while nutritional intakes are clearly affected by factors both outside and within the family. Rosenzweig and Schultz (1983) and Jensen and Richter (2001) show that infant health is determined by maternal behavior. Rosenzweig and Wolpin (1988) show that this behavior seems to respond in turn to unanticipated health outcomes among children as well as to persistent health factors. Pitt et al. (1990), Strauss (1990), and Thomas and Strauss (1992) show that health depends on the source of drinking water.

Most of these studies use anthropometric measures as proxies for health status. These are objective indicators, based on actual measurement of certain body properties such as height and weight. In developing countries, these reflect the interaction of nutrition and environmental variables such as infection (Shetty 2002). Several studies use self-reported indicators of health status, such as days ill and the ability to perform Activities of Daily Living (ADL). While days ill may suffer from reporting errors, ADL-based measures are known to be valid and reliable (Gertler and Gruber 2002). Wallace and Herzog (1995) found a wide array of self-reported health indicators to be quite reliable, in the context of the U.S.

Wolfe and Behrman (1984) treat health status as a latent variable and estimate a system of equations including health status, health indicators and health care utilization.

Identification in their model relies heavily on exclusion restrictions. Croppenstedt and Muller (2000) and Dercon and Krishnan (2000) find a negative association between malnutrition and the ability to perform physical tasks. Alderman and Garcia (1994) show that health indicators affect nutritional status, while Foster (1994) shows that nutritional status affects days ill. Both use instrumental variables because both health and nutritional status are determined endogenously.

Several studies emphasize the importance of intrahousehold resource allocation to individual health. Bolin et al. (2001) present a model of Nash-bargaining between spouses over resource allocation that determines health outcomes. Simple statistics show that health status is negatively related to economic inequality, but more careful empirical studies find the true effect to be questionable (Judge et al. 1998; Smith 1999; Milyo and Mellor 1999).

The purpose of this study is to examine more carefully the effect of inequality on health. In particular, we use indices of inequality, both within families and between families, measured in a 1995 survey in Southern Ethiopia (Kimhi and Sosner 2000). Health and physical fitness are measured by both objective and subjective indicators. The objective indicator is Body Mass Index (BMI), which is based on height and weight measures, and is positively associated with health, longevity and nutritional status (Cole 1991). The subjective indicators are days ill in the last month, and the ability to perform several ADLs. Comparing the results of several alternative health indicators will enable to evaluate the robustness of the results to the choice of health indicator.

The next section portrays the theoretical basis of health determination as a function of household resource allocation decisions. The following four sections describe the data set in general, the health data, the nutrition data, and the other explanatory variables, respectively. Then, the multivariate analysis of health and physical fitness is reported. The final section summarizes the findings.

Theory

We adopt the modeling approach of Thomas and Strauss (1992), in which the human biology approach, represented by the health production function, is integrated with an economic model of household allocations. Specifically, the production function f() shows how the health outcome (h) is affected by health inputs (x), conditional on observed characteristics of the individual (z_i), the household (z_{fh}), and the community (z_c), and on unobserved characteristics (v):

$$(1) \qquad h = \mathrm{f}(x; z_i, z_{fh}, z_c, v).$$

The household is assumed to maximize utility (u) as a function of consumption (c), leisure (l), and health, conditional on observed (z_{fu}) and unobserved (μ) household characteristics.

$$(2) \qquad u = \mathrm{U}(c, l, h; z_{fu}, \mu).$$

Utility maximization is constrained by the production function and by individual time constraints and a household budget constraint. Assuming that available time (t) is split between labor and leisure, we can combine the budget and time constraints into a single constraint:

$$(3) \qquad c = w(t-l)+y$$

where w is wage and y is non-labor income. Note that w, t, l, and h are vectors, with a possibly different entry for each family member.

One of the results of utility maximization is a reduced-form health demand equation, in which health is a function of observed individual, family, and community characteristics, and of unobserved factors:

$$(4) \qquad h = g(w, t, y, z_i, z_{fh}, z_{fu}, z_c, v, \mu).$$

Marginal effects of these characteristics on health, in this reduced-form apparatus, could indicate a direct effect through the health production function or an indirect effect through the household resource allocation process. As a result, most effects are theoretically ambiguous.

Data Source

The data used in this research was collected through a household survey, which was conducted between January and March of 1995 in the Ejana-wolene district of the Guragie administrative zone, in the Southern region of Ethiopia (figure 1).

Nineteen peasant associations out of the sixty-five peasant associations in the district were selected for the survey. Selection was based on accessibility and on an attempt to represent the diverse agro-economical conditions of the district. A total of 583 households were surveyed, about 31 in each of the 19 peasant associations (an average peasant association in Guragie includes around 400 households). In each peasant association the households were chosen at random, using a list of households prepared by the local chief.

In addition to physically measuring the food intakes, height and weight of all household members, enumerators also administered a questionnaire, which included questions about personal and family characteristics, food production and expenditures, income and assets, health, and time allocation.

Health Data

The health information was collected in the following way. The respondent (in most cases the female household head or spouse) was asked about disabilities or major chronic health problems of each household member. For household members over the age of seven, she was also asked to evaluate the difficulty of performing each of three physical activities: walk for 5 km; carry 20 liters of water for 20 meters; and hoe a field for a morning. For each activity, the scale of choices was: easily; with a little difficulty; with a lot of difficulty; and not at all. Finally, she was asked whether each household member suffered any illness in the last four weeks. For those who did, she was asked for the number of days they were ill in the last four weeks, whether they are still ill, the amount spent on medicines, the two major symptoms, whether they consulted anyone about the illness, and if not, the reasons.

The dependent variables in this research include days ill in the last month, the three measures of difficulty in performing ADLs, and BMI (weight in kg divided by the square of height in meters). We decided to only use the data for individuals older than 20 years, because the standards of e.g. difficulty in performing ADLs cannot be easily compared for children, adolescents and adults. Figure 2 shows the distribution of BMI values in our sample. The reference level of 18.5 is suggested by Shetty and James (1994) as the level under which individuals are considered as suffering from chronic energy deficiency. There is also some evidence from developing countries of a correlation between BMI levels below 18.5 and the severity of sickness events (WHO 1995). Almost 30% of our sample falls below the 18.5 threshold. The BMI distributions are remarkably similar for males and females, as opposed to the observation of Dercon and Krishnan (2000) that the BMI of males is higher in Southern Ethiopia.

The distributions of the ability to perform ADLs are shown in figure 3. We observe that walking, carrying and hoeing are ordered by difficulty, on average, and that as expected, children and adolescents have more difficulties than adults. 46% of adults in the sample reported difficulties in at least one ADL, while 13% reported difficulties in all ADLs. 12% of the population and 18% of adults reported some illness in the last month. The distribution of the number of days that individuals were ill in the last month is shown in figure 4. We observe concentrations at 7, 15, and 30 days. The 30 days concentration poses a problem if we want to interpret this variable as the severity of illness. This is because we cannot distinguish between those who were ill for exactly 30 days and those who were ill for more than 30 days. In addition, there could be individuals who became ill in the month before and individuals who are still ill. Hence the severity of illness is biased downwards if measured by the days individuals were ill in the last month. According to the survey, some 60% of individuals who reported illness were still ill at the time of the survey. Using this information we can correct for this part of the bias, but not for the part that is related to those who became ill before the start of the month.

Another related measure that we have is the number of days individuals are unable to perform their duties. This is highly correlated with the number of days individuals were ill and hence will not be used here. Table 1 shows the correlations between our health measures: difficulty in performing ADLs, days ill, and BMI. We observe strong correlations, on the order of 50%-70%, between the three difficulty measures. Correlations between the difficulty measures and days ill are weaker, on the order of 10%-17%, but are still statistically significant. Correlations between the difficulty measures and BMI are weaker than that, on the order of 6%-8%, and are less significant. The correlation between BMI and days ill is not statistically significant. We conclude that either the different health indicators are measuring different aspects of health, or that health is measured with different kinds of errors in the different ways. Whatever the interpretation of the correlations may be, there is merit for analyzing all health indicators rather than focusing on one of them.

Nutrition Data, Measurement and Methods

A key element in this survey was the direct measurement of individual food intakes of all household members. This poses a serious problem in the context of Ethiopia, because the common traditional habit among Ethiopian families is eating from a common plate (Enjera, which is the most common Ethiopian dish, is served in a common plate). The main exception of this habit is that Enset (false banana)-based food items are normally eaten from separate dishes, and hence it should be easier to measure individual consumption of Enset-consuming households. This is why an Enset-growing area in Southern Ethiopia, in which Enset comprises the main staple food of the population, was selected for this survey.

It would not be recommended, hence, to generalize our results as representing the situation in Ethiopia as a whole. Dercon and Krishnan (2000) have shown that Enset-growing households in the south are significantly poorer than other rural households. Protein-Energy Malnutrition (PEM) was found to be more prevalent among Enset-consuming households in Southern Ethiopia (Ethiopian Nutrition Institute 1986). Enset is relatively poor in protein and micronutrients (Wolde-Gebriel 1992). Shortage of these nutrients is known to enhance PEM (Latham 1997), hence our energy-based assessment of PEM may be biased downwards.

The preferred method of measuring individual food intakes is direct weighing of servings, because of the measurement errors involved in recall and expenditure methods (Bouis et al. 1992, Strauss and Thomas 1998). However, it involves the risk of changing the eating behavior of subjects (Ferro-Luzzi 2002). This method has been used before in Ethiopia (Ferro-Luzzi et al. 1990) and elsewhere (Senauer et al. 1988; Gawn et al. 1993), and proved useful. In this survey, the following measurement strategy was applied. Every dish was weighed, using mechanical scales, before and after it was served to each person, and the net weight of food intake was calculated. In addition, the ingredients of each receipt were recorded and weighed, and the caloric content of each dish was calculated using available Ethiopian food composition tables. We also asked respondents to recall what they were eating outside of the house. Each household was surveyed for three consecutive days, and here we use the daily average of total calorie intakes for each household member. While this measurement strategy is not free from errors, we believe that it provides more signal than noise. See Kimhi and Sosner (2000) for more details.

The Nutrition Adequacy Ratio (NAR) is calculated as the ratio between an individual's energy intakes (measured as described above) and the energy requirements that are necessary to sustain body weight. Energy requirements were calculated for each individual in three stages, according to the recommendation of the National Research Council (1989). First, resting energy requirements were calculated according to age, gender, and body weight. Then, these requirements were augmented according to physical activity. Finally, an allowance was made for pregnancy and lactation.

These calculations involve several assumptions and possible measurement errors. First, resting energy requirements in our population are assumed to be similar to the standards reported in the literature. It is not at all obvious that this assumption is true: there may be metabolic differences across populations. Second, the definitions of the physical activities are rather vague, and we tried to use our best judgment in classifying them according to the level of difficulty. We did verify that the sensitivity of the results to the classification of physical activities within the survey is not too large. Third, the energy allowances for pregnant and breastfeeding women are not necessarily the same in all populations. There is some evidence from developing countries that pregnant women try to keep their body weight as low as possible in order to avoid large infants. Finally, there is likely to be substantial measurement error in the calculation of energy intakes, for example as a result misreporting food eaten away from home or of using the food composition tables (West and Staveren 1991). Overall, the NAR is likely to include a measurement error that might be correlated with some of the variables in the model. This should be kept in mind when the results are interpreted. However, Bingham and Nelson (1991) and Ferro-Luzzi (2002) claim that this method of measurement of nutritional status is way more precise than alternative methods.

Explanatory Variables

We now turn to describe the explanatory variables used in this study. They include individual and household characteristics, and several measures on inequality. Individual characteristics include gender, age, literacy and height. Height is affected by nutrition and health at childhood, and we want to see to what extent it is important for current health status. For women, we also know whether they are pregnant or breastfeeding. Among the household characteristics we include per-capita wealth. This is a proxy for permanent expenditures, and is expected to affect health positively if health is a normal commodity. We use wealth because we suspect that income variables in this data set are either endogenous or imperfectly measured. Thomas and Strauss (1992) showed that total income can substitute for the wage and non-labor income variables in the reduced-form demand for health if leisure is separable from consumption and health in the utility function. We divide wealth by the number of adult-equivalent household members. For this purpose, children up to six years of age are equivalent to 0.2 adults, those between the ages of seven and twelve are equivalent to 0.3 adults, and those between the ages of thirteen and seventeen are equivalent to 0.5 adults. These coefficients are based on previous studies in developing countries, e.g. Lopez (forthcoming), and Hentschel and Lanjouw (1996). There is no overall agreement in the literature about equivalence scale coefficients (Deaton 1997). We also include the source of water mostly used by the household for drinking purposes. The dummy variable Well/Pipe is for households whose major source of drinking water is a well or a pipe (outside of the house). We also have the distance to the source of drinking water, but this is highly correlated with the type of source and hence is not used in the analysis.

In table 1 we can see that males are less ill and find it less difficult to hoe a field than females. Age is positively associated with the difficulty to walk and negatively associated with the difficulties to carry and how. Age is also associated positively with illness and negatively with BMI. Literacy is negatively associated with the difficulty measures and with illness. It seems that literacy is an important element in health production. No significant differences are found between single-headed households and other households, and the same is true for the differences between pregnant women and other women. Women who are breastfeeding, however, report significantly lower difficulties to perform ADLs. Per-Capita household wealth is negatively associated with illness, when measured at the household level. When measured at the village level (P/C Wealth PA), it is negatively associated with the difficulty to carry loads and is positively associated with BMI. The NAR is negatively associated with BMI, when measured at the household level. This is counter-intuitive, and perhaps a result of measurement errors. It does not show any significant correlation with the health measures when measured at the village level (HH NAR PA).

Having drinking water from a well or a pipe is negatively associated with all three measures of difficulty, but also with BMI, which is counter-intuitive. The variable Facility measures the quality and availability of health facilities at the village level. In the survey, we asked those who reported some illness whether they sought treatment, and those who did not seek treatment were asked for the reasons. For each village (peasant association) we calculated the fraction of those who did not seek treatment because of reasons related to the quality and availability of health care facilities, out of those who were ill and did not seek treatment. In table 1 we see that this variable is positively associated with illness. In the empirical analysis we use one minus this measure, which indicates the availability of health facilities.

Three inequality measures are included among the explanatory variables, one at the household level and two at the village level. The coefficient of variation of per-capita wealth within the village (PA Wealth CV) is positively associated with both the difficulty to carry loads and illness. The two coefficients of variation of the Nutrition Adequacy Ratio (NAR) measure inequality both within the household and within the village. The NAR The within-village nutrition inequality (PA Nutrition CV) is positively associated with the difficulty to carry loads. At the household level, though, nutrition inequality does not have any statistically significant correlation with any of the health measures.

Multivariate Analysis

The nature of the different health measures implies different estimation methods. The difficulties to perform ADLs are highly correlated, as we have seen earlier. As a result, we conducted a factor analysis and used a single factor (that accounts for more than 75% of the variance) as the dependent variable in a linear regression. Alternatively, we estimated each difficulty measure by ordered probit with unknown thresholds, and the results were qualitatively similar (the ordered probit results are not reported here, they are available upon request). Days of illness are restricted to be between zero and thirty, and hence are estimated by two-sided Tobit. BMI is continuous; however we are most interested whether BMI falls under 18.5, which is correlated with health problems. Hence, we estimate a Probit model for the probability that BMI is under 18.5. For comparison, we also estimate a linear regression for BMI. Each model is estimated for adults over the age of 20. Before proceeding to the estimation results, we can find in table 2 the means of the explanatory variables.

Table 3 includes the estimation results. Note that the dependent variables (except for BMI) are defined in such a way that they measure 'ill health', i.e. a variable with a negative coefficient affects health positively. We can see that males are healthier than females, on average. Health is also deteriorating with age. Literacy has a positive effect on health, but it is significant only in the equation for days ill. Health is poorer in single-headed households, but the effect is significant only in the ADL equation. Pregnant women are less likely to have a low BMI, which is quite obvious. Women who are breastfeeding, on the other hand, seem to be healthier. This does not necessarily reflect causality in this direction, because better health may enable women to provide breastfeeding for longer periods.

Taller individuals have lower difficulties to perform ADLs. Height represents nutritional status and health at early ages, and these seem to influence physical fitness at later ages. Height does not have a statistically significant effect on days ill. However, it does have a significantly positive effect on the probability of having a low BMI. This is contrary to intuition, and raises doubts about the interpretation of BMI in developing countries as an indicator of health status. Taller individuals may not be heavy enough in European standards, but it may have nothing to do with their health.

Per-capita wealth at the household level does not have a significant effect on health in any of the equations. It does have a positive effect on BMI, though, which means that it is perhaps important only at relatively higher levels of BMI. Per-capita wealth has a significantly positive effect when measured at the village level, except for the days ill equation. The Nutrition Adequacy Ratio at the household level does not have a significant effect on health, with the exception of a surprisingly positive effect on days ill and the small negative effect on BMI. This ratio does not affect health significantly in any of the equations when measured at the village level. Perhaps the overall weak performance of the NAR variables is due to measurement errors. Members of households that get drinking water from a well or a pipe report significantly smaller number of days ill, but on the other hand have a significantly higher probability of having a low BMI. The availability of health facilities has a positive effect on health, but it is significant only in the ADL and days ill equations.

We now turn to the inequality measures. At the village level, we find that per-capita wealth inequality has a negative effect on individual health indicators. It significantly raises morbidity (days ill) and increases the likelihood of having a low and risky BMI. Nutrition inequality, at the village level, has mixed effects on individual health indicators, but only one effect is statistically significant: the probability of having a low BMI significantly declines with nutrition inequality. As for the household nutrition inequality, when we included it in the estimated equations we found no significant effect. We then looked for a differential effect. Specifically, inequality could have different effects on individuals at the two ends of the distribution. A mean-preserving increase in the variance of a variable is expected to increase the values of the variable for those above the mean and to decrease the values for those below the mean. Here the situation is somewhat different, because we look at nutrition inequality and measure health outcomes. Still, we expected to find that nutrition inequality has a positive effect on health for those above the mean and a negative effect for those below the mean. In fact, we found almost the opposite: inequality had a negative effect on health for those above the mean, an effect that was statistically significant in all equations except for days ill, while it had practically no effect on health for those below the mean.

While this result seems surprising at first sight, it might be consistent with certain household allocation rules. Suppose that nutrition is an input into health production, and that households are directly averse of inequality in health, not in nutrition. Inequality in nutrition may be desirable if it relaxes some household constraints in such a way that enables the household to compensate individuals who are at health risk. Moreover, health is perhaps not a goal on its own but enters as an argument in the utility function. A decreasing marginal utility of health means that a household may be willing to take action that adversely affects individuals at the high end of the distribution in order not to hurt individuals at the low end of the distribution. Under these assumptions, a negative shock to the total food available for distribution within the household may increase nutrition inequality in such a way that the household reallocates resources from individuals who are better nourished to those who are poorly nourished (Wheeler and Abdullah 1988). This may lead to the observed result that the health of the former deteriorates while the health of the latter does not.

Summary

In this paper we investigated the dependence of health and physical fitness indicators on the socio-economic situation of rural families in Southern Ethiopia, with particular emphasis on the role of inequality. The literature shows mixed conclusions about the effect of inequality on health, and we attempted to contribute in several ways: to compare the results of objective and subjective health measures, to distinguish between wealth inequality and nutrition inequality, and to measure nutrition inequality both at the village level and at the household level.

The subjective health measures are the number of days respondents were ill during the last month, their ability to walk distances, their ability to carry heavy loads, and their ability to work in the field. The objective health measure is having Body Mass Index (BMI) lower than 18.5. We found that many effects of explanatory variables were significant in some of the equations but not in all of them. In some cases we even obtained contradictory significant effects. This emphasizes the need not to rely on a single health measure.

The results indicate that per-capita wealth has a positive effect on health, but the effect is statistically significant only at the village level. Availability of drinking water from a well or a pipe has mixed effects on the different health measures. Availability of satisfactory health facilities has a negative effect on morbidity and a positive effect on physical fitness. Per-capita wealth inequality is positively associated with morbidity and with a low BMI. Within-household nutrition inequality seems to have a complex effect on health and physical fitness: the effect is negative, but only for household members whose nutritional status is above the household mean. This result is counter-intuitive, but it might be consistent with a certain household allocation behavior. For example, it could be that as nutrition inequality rises as a result of food shortage, the household reallocates resources from individuals who are better nourished to those who are poorly nourished, so that the health of the former deteriorates while the health of the latter does not deteriorate. However, if this scenario is true, it might be necessary to model within-household inequality as an endogenous regressor, because nutrition inequality could also respond to unanticipated health outcomes. This is beyond the scope of this paper.

The final conclusion of the paper is that the role of inequality in the determination of health and physical fitness is not simple, and certainly deserves further analyses at both the theoretical and empirical levels.

References

Alderman, Harold, and Marito Garcia. "Food Security and Health Security: Explaining the Levels of Nutritional Status in Pakistan." *Economic Development and Cultural Change* 42, April 1994, pp. 485-507.

Behrman, Jere R, and Anil B. Deolalikar. "Health and Nutrition." In *Handbook of Development Economics* Vol. 1, edited by Hollis Chenery and T.N. Srinivasan. Amsterdam: North Holland, 1988.

Bingham, Sheila A., and Michael Nelson. "Assessment of Food Consumption and Nutrient Intake." In *Design Concepts in Nutritional Epidemiology*. Barrie M. Margetts and Michael Nelson, eds. PP. 153-191. Oxford: Oxford University Press, 1991.

Bouis, Howarth, Lawrence Haddad, and Eileen Kennedy. "Does it Matter how we Survey Demand for Food? Evidence from Kenya and the Philippines." *Food Policy* 17, October 1992, 349-360.

Bolin, Kristian, Lena Jacobsson, and Bjorn Lindgren. "The Family as the Health Producer – When Spouses are Nash-Bargainers." *Journal of Health Economics* 20, May 2001, pp. 349-362.

Cole, T.J. "Weight-Stature Indices to Measure Underweight, Overweight, and Obesity." In *Anthropometric Assessment of Nutritional Status*, edited by John H. Himes. New York: Wiley-Liss, 1991.

Croppenstedt, Andre, and Christophe Muller. "The Impact of Farmers' Health and Nutritional Status on Their Productivity and Efficiency: Evidence from Ethiopia." *Economic Development and Cultural Change* 48, April 2000, pp. 475-502.

Deaton, Angus. *The Analysis of Household Surveys*. Baltimore: John Hopkins University Press, 1997.

Dercon, Stefan, and Pramila Krishnan. "In Sickness and in Health: Risk Sharing within Households in Rural Ethiopia." *Journal of Political Economy* 108, August 2000, pp. 688-727.

Ethiopian Nutrition Institute. *Report on the Base-Line Survey, Part 2.* Joint WHO/UNICEF Nutrition Support Programme in Ethiopia, Addis Ababa, 1986.

Ferro-Luzzi, A., C. Scaccini, S. Taffese, B. Aberra, and T. Demeke. "Seasonal Energy Deficiency in Ethiopian Rural Women." *European Journal of Clinical Nutrition* 44, Suppl. 1, 1990, 7-18.

Ferro-Luzzi, Anna. *Individual Food Intake Survey Methods*. Paper presented at the International Scientific Symposium on Measurement and Assessment of Food Deprivation and Under-nutrition, 26 – 28 June 2002, Rome, Italy.

Foster, Andrew D. "Poverty and Illness in Low-Income Rural Areas." *American Economic Review* 84, May 1994, pp. 216-220.

Gawn, Glynis, Robert Innes, Gordon Rauser, and David Zilberman. "Nutrient Demand and the Allocation of Time: Evidence from Guam." *Applied Economics* 25, June 1993, 811-830.

Gertler, Paul, and Jonathan Gruber. "Insuring Consumption against Illness." *American Economic Review* 92, March 2002, pp. 51-70.

Hentschel, Jesko and Lanjouw, Peter. *Constructing an Indicator of Consumption for the Analysis of Poverty: Principles and Illustrations with Reference in Ecuador.* LSMS Working Paper No. 124, Policy Research Department, World Bank, Washington, DC, 1996.

Jensen, Robert T., and Kaspar Richter. "Understanding the Relationship Between Poverty and Children's Health." *European Economic Review* 45, May 2001, pp. 1031-1039.

Judge, Ken, Jo-Ann Mulligan, and Michaela Menzeval. "Income Inequality and Population Health. *Social Science and Medicine* 46, February-March 1998, pp. 567-579.

Kimhi, Ayal, and Nathan Sosner. *Intrahousehold Allocation of Food in Southern Ethiopia*. Working Paper No. 20002, The Center for Agricultural Economic Research, February 2000.

Latham, Michael C. *Human Nutrition in the Developing World*. FAO Food and Nutrition Series No. 29. Rome: Food and Agriculture Organization of the United Nations, 1997.

Lopez, Ramon. "Rural Poverty in El Salvador: A Quantitative Analysis." *Rural Poverty in Latin America: Analytics, New Empirical Evidence and Policy*, edited by Ramon Lopez and Alberto Valdez (forthcoming).

Milyo, Jeffrey D., and Jennifer M. Mellor. "Is Inequality Bad for Our Health?" *Critical Review* 13, 1999, pp. 359-372.

National Research Council. *Recommended Dietary Alowances*, 10th Edition. Eashington, DC: National Academy Press, November 1989.

Pitt, Mark M., and Mark R. Rosenzweig. "Health and Nutrient Consumption Across and Within Farm Households." *Review of Economics and Statistics* 67, February 1985, pp. 212-223.

Pitt, Mark M., Mark R. Rosenzweig, and Md. Nazmul Hassan. "Productivity, Health, and Inequality in the Intrahousehold Distribution of Food in Low-Income Countries." *American Economic Review* 80, December 1990, pp. 1139-1156.

Rosenzweig, Mark R., and T. Paul Schultz. "Estimating a Household Production Function: Heterogeneity, the Demand for Health Inputs, and Their Effects on Birth Weight." *Journal of Political Economy* 91, October 1983, pp. 723-746.

Rosenzweig, Mark R., and Kenneth I. Wolpin. "Heterogeneity, Intrafamily Distribution, and Child Health." *Journal of Human Resources* 23, Fall 1988, pp. 437-461.

Senauer, Benjamin, Marito Garcia, and Elizabeth Jacinto. "Determinants of the Intrahousehold Allocation of Food in the Rural Philippines." *American Journal of Agricultural Economics* 70, February 1988, 170-180.

Shetty, P. *Measures of Nutritional Status from Anthropometric Survey Data*. Paper presented at the International Scientific Symposium on Measurement and Assessment of Food Deprivation and Under-nutrition, 26 – 28 June 2002, Rome, Italy.

Shetty, P.S., and W.P.T James. *Body Mass Index: A Measure of Chronic Energy Deficiency in Adults*. FAO Food and Nutrition Paper 56, 1994.

Smith, James P. "Health Bodies and Thick Wallets: The Dual Relation Between Health and Economic Status." *Journal of Economic Perspectives* 13, Spring 1999, pp. 145-166.

Strauss, John. "Households, Communities, and Preschool Children's Nutritional Outcomes: Evidence from Rural Cote d'Ivoire." *Economic Development and Cultural Change* 38, January 1990, pp. 231-262.

Strauss, John, and Duncan Thomas. "Health, Nutrition, and Economic Development." *Journal of Economic Literature* 36, June 1998, pp. 766-817.

Thomas, Duncan, and John Strauss. "Prices, Infrastructure, Household Characteristics, and Child Height." *Journal of Development Economics* 39, October 1992, pp. 301-331.

Wallace, Robert B., and A. Regula Herzog. "Overview of the Health Measures in the Health and Retirement Study." *Journal of Human Resources* 30, Supplement 1995, pp. S84-S107.

West, C.E., and W.A. van Staveren. "Food Consumption, Nutrient Intake, and the Use of Food Composition Tables." In *Design Concepts in Nutritional Epidemiology*. Barrie M. Margetts and Michael Nelson, eds. PP. 101-119. Oxford: Oxford University Press, 1991.

Wheeler, E.F., and M. Abdullah. "Food Allocation within the Family: Responses to Fluctuating Food Supply and Food Needs." In *Coping with Uncertainty in Food Supply*. I. de Garine and G. A. Harrison, eds. PP.437-451. Oxford: Clarendon Press, 1988.

Wolde-Gebriel, Zewdie. *Micronutrient Deficiencies in Ethiopia and their Inter-relationships*. Ph.D. Thesis, Wageningen: Landbouwuniversiteit Wageningen, 1992.

Wolfe, Barbara L., and Jere R. Behrman. "Determinants of Women's Health Status and Health-Care Utilization in a Developing Country: A Latent Variable Approach." *Review of Economics and Statistics* 66, November 1984, pp. 696-703.

World Health Organization. *Physical Status: The Use and Interpretation of Anthropometry*. WHO Technical Report 854, Geneva, 1995.

Figure 1. Map of Ethiopia and Survey Area

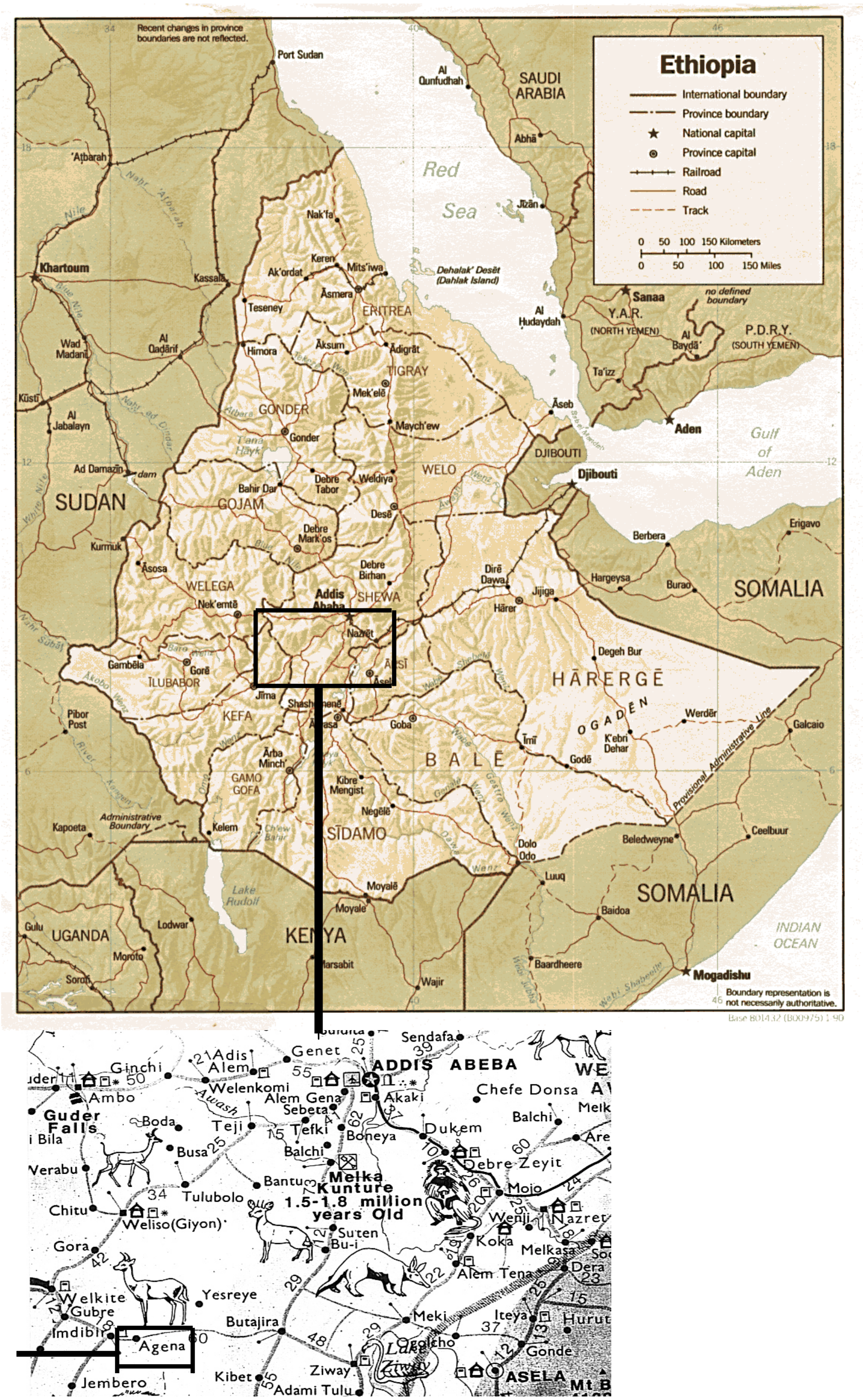
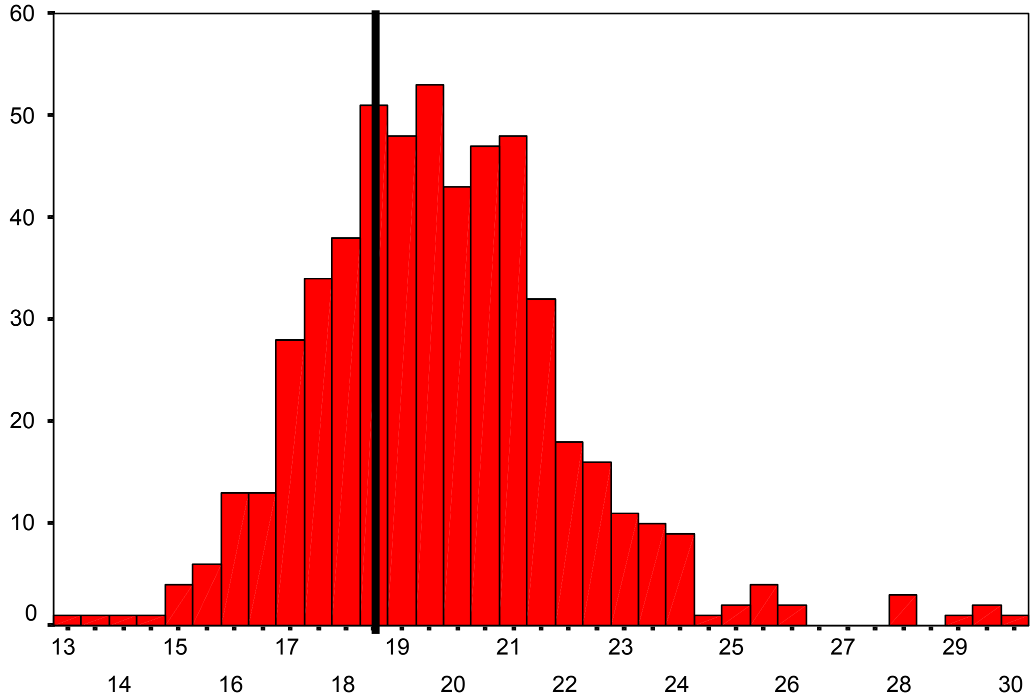


Figure 2. Distribution of BMI, ages 21+

A. Males
(N=542, Mean=19.7; Std. Dev.=2.34)



B. Females (excluding pregnant)
(N=634, Mean=19.7; Std. Dev.=2.44)

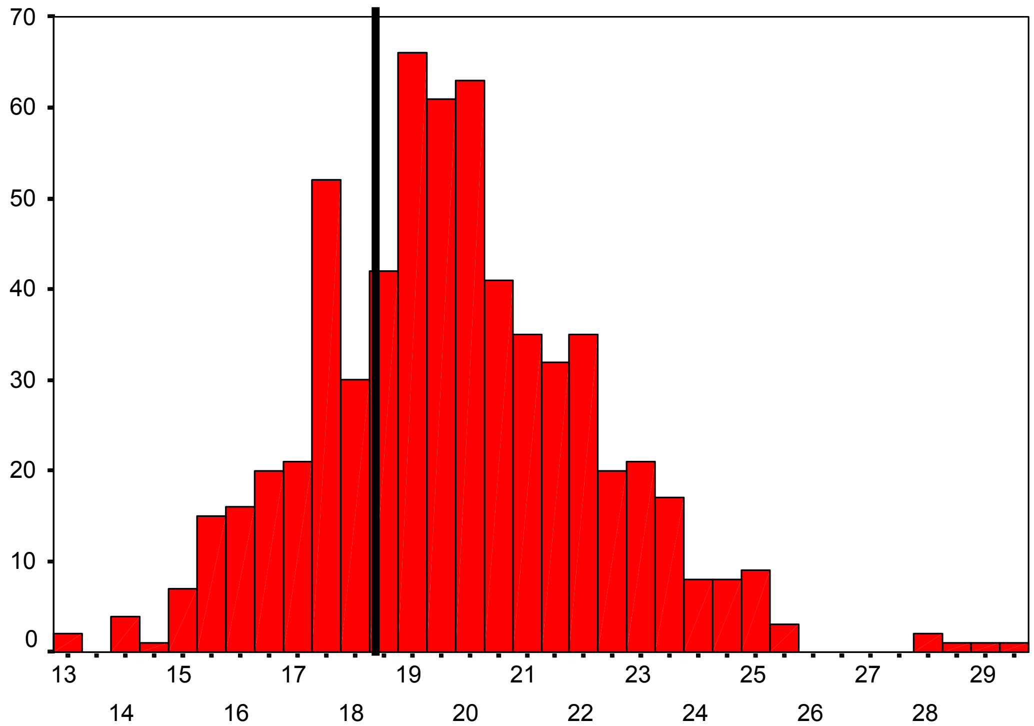
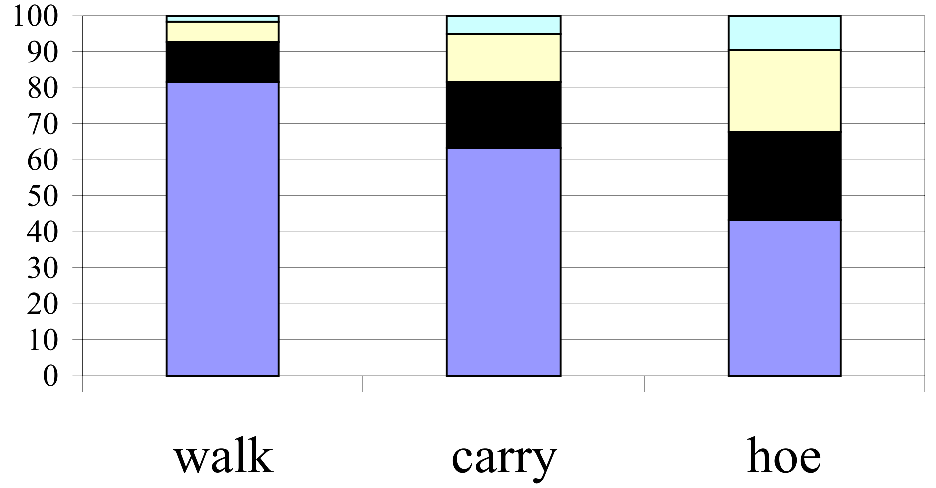
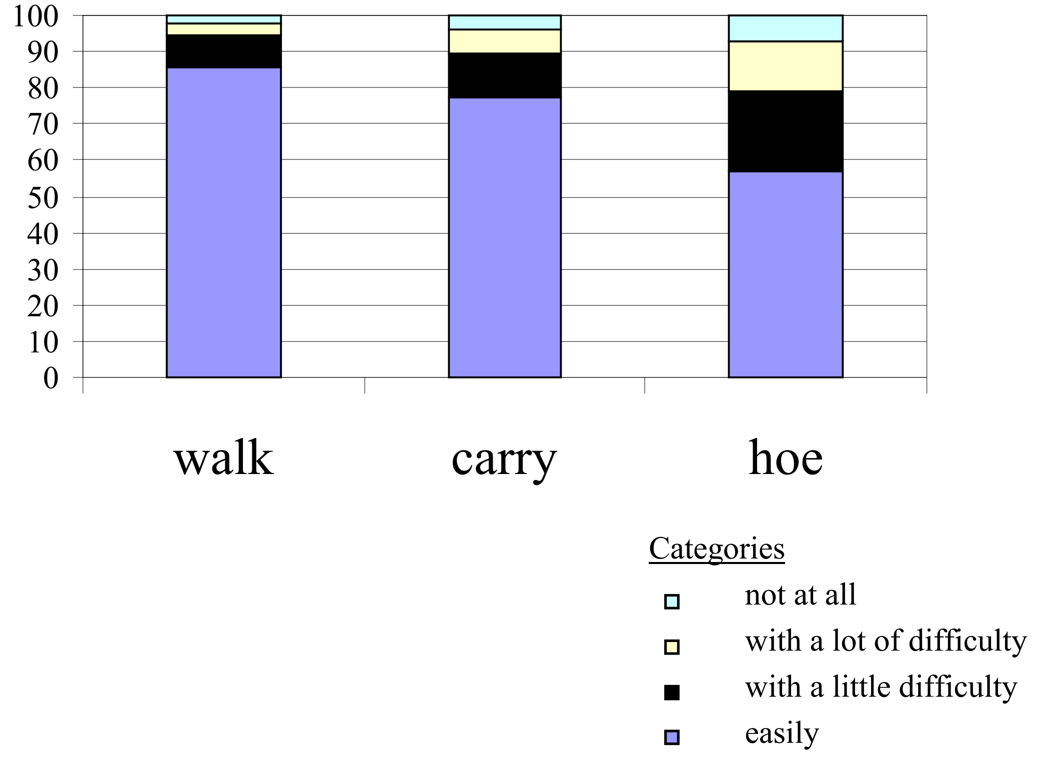


Figure 3. Distribution of Abilities to Perform ADL's

A. Ages 7 and up



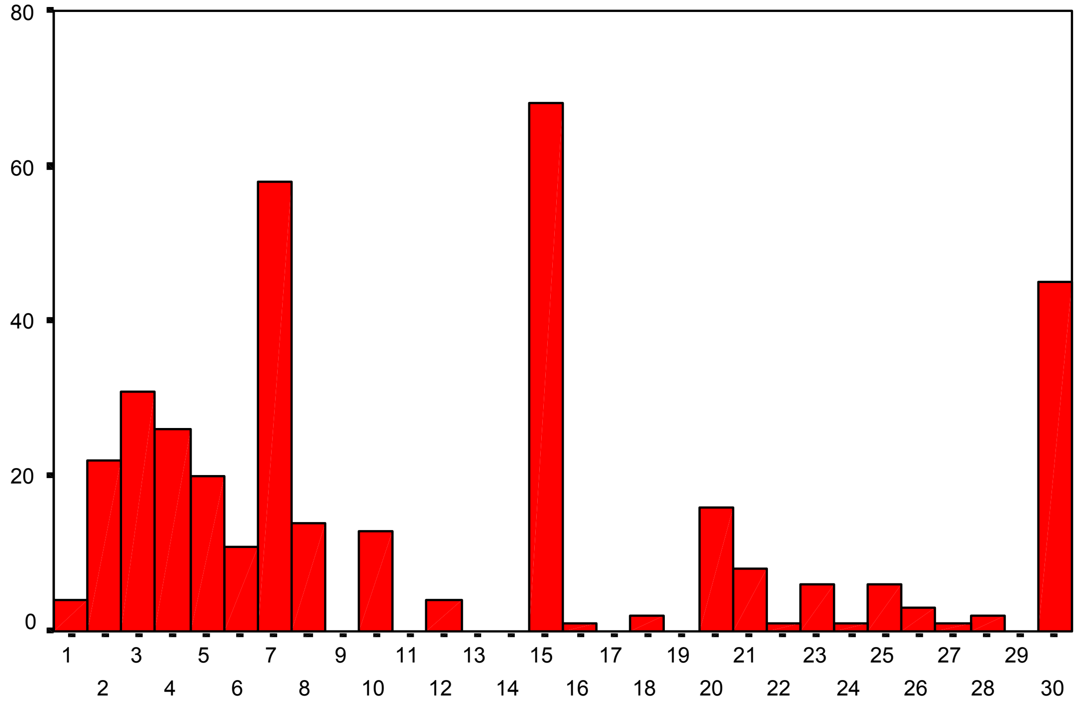
B. Ages 21 and up



Variables: can …. perform the following activities?
Walk for 5 km
Carry 20 liters of water for 20 meters
Hoe a field for a morning

Figure 4. Distribution of Days of Illness in the Last Month

A. All



B. Ages 21 and up

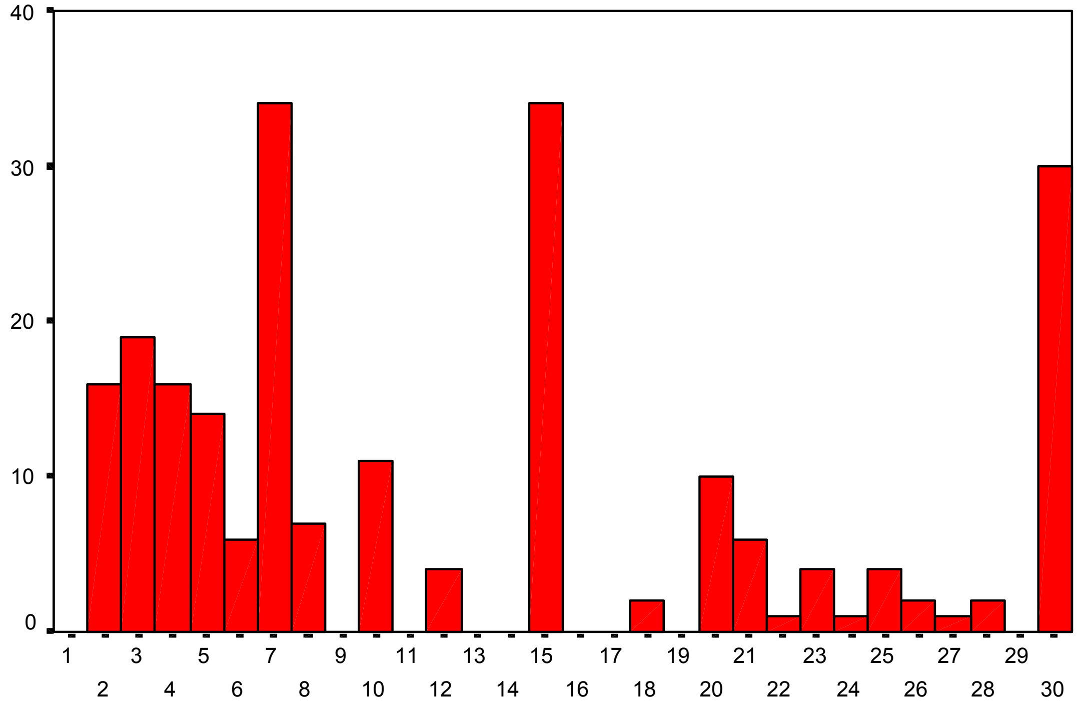


Table 1. Correlations Between Health Measures and Explanatory Variables

Variable	Walk 5 km	Carry 20 liters	Hoe a field	Days ill	BMI
Walk 5 km	1.000 (2615)				
Carry 20 liters	0.692** (2609)	1.000 (2614)			
Hoe a field	0.487** (2594)	0.687** (2593)	1.000 (2597)		
Days ill	0.165** (2544)	0.120** (2543)	0.096** (2526)	1.000 (2682)	
BMI	-0.064* (1222)	-0.081** (1220)	-0.059* (1207)	-0.041 (1216)	1.000 (1239)
Male	-0.022 (2615)	0.002 (2614)	-0.220** (2597)	-0.047* (2682)	-0.034 (1239)
Age	0.067** (2615)	-0.114** (2614)	-0.171** (2597)	0.212** (2682)	-0.097** (1239)
Literate	-0.164** (2609)	-0.156** (2608)	-0.212** (2591)	-0.100** (2674)	0.003 (1236)
Single head	0.032 (2615)	0.036 (2614)	-0.006 (2597)	0.023 (2682)	-0.035 (1239)
Pregnant	0.018 (900)	0.021 (898)	0.045 (887)	0.006 (903)	0.058 (587)
Breastfeeding	-0.095** (900)	-0.146** (898)	-0.069* (887)	-0.022 (903)	-0.038 (587)
Height	-0.330** (2044)	-0.524** (2442)	-0.487** (2424)	0.080** (2473)	-0.270 (1239)
Per-capita Wealth	-0.0347 (2605)	-0.036 (2604)	0.038 (2587)	-0.053** (2672)	0.027 (1232)
P/C Wealth PA	-0.012 (2615)	-0.044* (2614)	-0.015 (2597)	-0.015 (2682)	0.056* (1239)
Household NAR	-0.034 (2615)	0.001 (2614)	-0.025 (2597)	0.035 (2682)	-0.072* (1239)
HH NAR PA	-0.012 (2615)	-0.008 (2614)	-0.019 (2597)	0.035 (2682)	-0.055 (1239)
Well/Pipe	-0.045** (2609)	-0.040** (2608)	-0.039** (2591)	-0.030 (2676)	-0.069* (1236)
Facility	-0.002 (2615)	0.024 (2614)	0.002 (2597)	0.043* (2682)	-0.027 (1239)
PA Wealth CV	0.009 (2615)	0.042* (2614)	0.020 (2597)	0.061** (2682)	-0.036 (1239)
PA Nutrition CV	0.037 (2615)	0.044* (2614)	0.026 (2597)	0.027 (2682)	0.035 (1239)
HH Nutrition CV	0.004 (2613)	0.001 (2612)	0.012 (2595)	-0.019 (2681)	0.021 (1238)

Notes

BMI correlations are based on individuals older than 20 years of age. Pregnant and Breastfeeding correlations are based on females between the ages of 14 and 50. Other correlations are based on individuals older than 6 years of age. The numbers in parentheses are the number of observations. Significance levels: ** - 1%; * - 5%.

Table 2. Means of Explanatory Variables

Variable	Units	All	Age>6	Age>20
Male	Dummy	0.507 (4022)	0.508 (3237)	0.510 (1600)
Age	Years	21.92 (4021)	26.38 (3237)	40.08 (1600)
Literate	Dummy	0.302 (3978)	0.372 (3203)	0.313 (1583)
Single head	Dummy	0.100 (4027)	0.107 (3237)	0.111 (1600)
Pregnant	Dummy	0.015 (4027)	0.018 (3237)	0.034 (1600)
Breastfeeding	Dummy	0.058 (4027)	0.072 (3237)	0.143 (1600)
Height	Centimeters	134.3 (3232)	147.8 (2504)	160.2 (1244)
Per-capita Wealth	1000 Birr	2.652 (4009)	2.619 (3224)	2.574 (1593)
P/C Wealth PA	1000 Birr	2.651 (4027)	2.647 (3237)	2.609 (1600)
HH NAR	Ratio	0.868 (4027)	0.867 (3237)	0.878 (1600)
HH NAR PA	Ratio	0.858 (4027)	0.858 (3237)	0.860 (1600)
Well/Pipe	Dummy	0.118 (4015)	0.121 (3226)	0.133 (1592)
Facility	Fraction	0.385 (4027)	0.386 (3237)	0.393 (1600)
PA Wealth CV	Coefficient of Variation	0.737 (4027)	0.737 (3237)	0.745 (1600)
PA Nutrition CV	Coefficient of Variation	0.332 (4027)	0.332 (3237)	0.335 (1600)
HH Nutrition CV	Coefficient of Variation	0.310 (4017)	0.301 (3232)	0.334 (1600)

Notes
Number of observations in parentheses.

Table 3. Estimation Results (ages 21 and up)

	ADL Factor		Days ill		BMI<18.5		BMI	
Variable	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat	Coeff.	t-stat
Intercept	1.91**	3.18	-44.27*	-1.69	-3.26**	-2.98	39.48**	21.40
Male	-0.52**	-7.52	-4.76	-1.64	-0.34**	-2.89	1.48**	7.00
Age 26-35	0.14	1.50	12.89**	2.49	0.38*	2.17	-0.46	-1.67
Age 36-45	0.22*	2.51	13.44**	2.64	0.56**	3.29	-0.93**	-3.44
Age 46-55	0.50**	5.13	20.02**	3.77	0.74**	4.14	-1.41**	-4.77
Age 56 and up	1.32**	12.69	23.05**	4.20	1.05**	5.60	-1.74**	-5.52
Literate	0.05	0.65	-6.28*	-1.85	-0.04	-0.37	0.19	0.90
Single head	0.20*	2.33	1.67	0.46	0.07	0.47	-0.25	-0.96
Pregnant	0.02	0.18	-5.04	-0.89	-0.68**	-2.61	1.79**	4.80
Breastfeeding	-0.29**	-3.69	-4.00	-1.14	-0.33*	-2.31	-0.14	-0.58
Height	-0.02**	-5.06	-0.08	-0.59	0.02**	4.13	-0.13**	-14.04
P/C Wealth	0.00	0.06	-0.69	-1.17	-0.03	-1.43	0.09**	2.57
P/C Wealth PA	-0.08	-1.94	-2.73	-1.41	-0.44**	-5.41	0.70**	5.23
HH NAR	-0.03	-0.35	6.80*	2.00	0.23	1.62	-0.53*	-2.07
HH NAR PA	0.56	1.53	22.84	1.41	-0.33	-0.52	0.12	0.11
Well/Pipe	-0.07	-0.84	-7.60*	-2.04	0.23*	1.66	-0.33	-1.31
Facility	-0.83*	-1.98	-37.11*	-2.05	-0.32	-0.45	0.19	0.15
PA Wealth CV	0.26	1.68	15.34**	2.34	0.61**	2.39	-0.97*	-2.06
PA Nutr. CV	0.85	1.76	27.13	1.26	-1.55*	-1.88	3.34*	2.25
HH Nutr. CV (-)	0.11	0.72	-1.38	-0.20	-0.19	-0.71	0.22	0.46
HH Nutr. CV (+)	0.61**	2.83	6.47	0.71	0.92**	2.55	-2.41**	-3.66
Standard error	0.81		24.31				2.50	
R-squared	0.31						0.25	
Number of Cases	1206		1222		1217		1217	

Significance levels: ** - 1%; * - 5%.

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