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Protein and amino acid intakes in a rural area of Bangladesh

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Abstract

Background—Few studies have described protein and amino acid intakes in rural Bangladesh, a country with considerable undernutrition.

Objective—The purpose of this population-based study was to assess and describe protein and amino acid intakes in Araihaazar, Bangladesh.

Methods—Study participants were 11,170 adult men and women who participated in the Health Effects of Arsenic Longitudinal Study (HEALS), a 98% participation rate. Dietary exposures were assessed by a food frequency questionnaire that had been designed and validated for the HEALS study population.

Results—Mean body mass index (BMI) was 19.7 among all participants, and 34.9% of women and 44.4% of men had a BMI below 18.5. Average caloric intake was 2142 and 2394 kcal/day among women and men, respectively, while mean protein intakes were 67.5 and 78.2 g/day. The largest sources of protein were from rice and fish. Greater protein intake was related to younger age and several socioeconomic measures, including more years of education, land and television ownership, and employment in business, farming, or as a laborer (among men) or as a homemaker (among women).

Conclusions—This study found a high prevalence of underweight among study participants. Nonetheless most participants had adequate protein intake according to FAO standards for body weight.

Keywords

Bangladesh; Dietary Proteins; Amino Acids; Protein-Energy Malnutrition; Body Mass Index; Socioeconomic Status

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Introduction

Adequate intake of protein is vital for health maintenance, as it is necessary for cognitive, immune, and renal system functioning [1]. While several surveys have reported information on total caloric intake in Bangladesh, there have been few recent large-scale systematic assessments of protein intake. Rice is known to constitute the largest proportion of the Bangladeshi diet, accounting for greater than two-thirds of calories consumed [2]. National surveys done in 1995–96 estimated protein intake to average between 46.4 – 64.5 g/day, with intake lower in rural areas [3, 4]. The Food and Agriculture Organization of the World Health Organization has recommended a minimum protein intake at 0.8 gm/kg of body weight, suggesting a desired range of 37.5–60 g/day for men and 30–56 g/day for women [5]. Research has suggested that intake of nutrients and overall energy intake improved between the 1980's and 1990's in Bangladesh, and it is possible that intakes may have continued to increase since that time [6].

Although total protein may be considered adequate it is also important to evaluate the intake of specific amino acids. A 1996 report by the United Nations Subcommittee on Nutrition found low intake of lysine among Bangladeshis, and overall, lower intakes of amino acids even compared to other developing countries [7]. Rice protein contains satisfactory levels of methionine but is poor in lysine content, while pulses are generally rich in lysine but have low methionine content; therefore those who combine these amino acid sources should have adequate intake of each [8]. Given that the consumption of amino acids is related to economic circumstances, it is expected that a sizable proportion of Bangladeshis may have less than adequate intakes.

We conducted a cross-sectional analysis of dietary protein and amino acid consumption in a rural region of Bangladesh. The purpose of this paper was to describe the sources and amounts of protein and amino acid intakes in this region and their distribution across selected demographic and socioeconomic variables.

Materials and Methods

Study Area and Participants

The Araihaazar Upazila, which is east of Dhaka in the Narayanganj District, is a mostly rural area encompassing 183 km². It has a population of 300,000 living in 315 villages. The Health Effects of Arsenic Longitudinal Study (HEALS) is a population-based cohort established in 2000 in the Araihaazar area to study arsenic and its health effects. The main purpose of the parent HEALS cohort was to prospectively examine the relationship between arsenic intake and the incidence of premalignant and malignant tumors (skin, bladder and lung) as well as other health conditions. The study has been described in detail elsewhere [9]. Briefly, participants were recruited by door-to-door survey based on a predetermined list of participants prepared as part of a pre-cohort survey characterizing all 65,876 residents consuming water from 5,966 hand-pumped tube wells in a well-defined study area [10]. Eligibility criteria included marriage, in order to ensure greater stability in location of residence; minimum five year residence in the same bari and minimum three year use of one of the tested study wells. Of the 12,050 individuals approached for recruitment, 97.5%

agreed to participate, yielding a cohort of 11,746 adult men (n=5043) and women (n=6707) between the ages of 18 and 76. Standardized interviews were conducted in Bengali by trained interviewers and participants underwent clinical evaluation by trained physicians to examine overall as well as arsenic-related health conditions. Questionnaires collected information on demographic and socioeconomic variables, and health characteristics, including sex, age, height and weight, religion, years of education, occupation, and land and television ownership. Land and television ownership are commonly used markers for socioeconomic status in this population [4, 11]. Other environmental exposure data that were collected included use of cigarettes or bidi (tobacco-free cigarettes) and betel leaf, both of which are related to social class in South Asia [12]. Information was not collected on physical activity. Informed consent was obtained and the study was approved by institutional review boards at Columbia University and in Bangladesh.

Dietary Assessment

Details of the development and validation of the food frequency questionnaire (FFQ) used in the HEALS were described elsewhere [27]. Briefly, HEALS investigators, in consultation with local nutrition experts, identified all the food items available in local village markets. We then conducted discussions with ten focus groups, each consisting of six to ten participants, which yielded a preliminary FFQ. Only common food items were included in the FFQ, and food items with intake frequencies less than once in a month during the prior year were deemed to be insignificant. The FFQ was finalized after pilot testing with 120 local people who were not part of the cohort study. About 10% of the food items were removed from the original food list because of infrequent consumption.

In the HEALS study interview, we used an open-ended interview method to assess food item consumption. Although a closed-ended format may theoretically help participants describe their dietary patterns, its fixed categorizations are not appropriate for foods that have large differences in seasonal availability and its numerous categories may be cumbersome in an interview setting. Therefore, to simplify the FFQ, open-ended questions for amount per meal, frequency per day, month, and year were used. Different locally used plates and utensils were shown to the participants to define the portion sizes during the interviews. Since nutrient values for foods specific to Bangladesh were not available, we took the nutrient composition of foods from the US Department of Agriculture database for standard reference [13]. The FFQ validation study also took values from an Indian food nutrient database [14]; in the present study we were not able to utilize that data source as not all amino acids were available. While food items listed in the FFQ were closely matched to those in the Indian food composition tables, the USDA data may have more accurate assessments of nutrients. Regardless of the differences in absolute values of dietary intakes derived from USDA and Indian composition tables, in the FFQ validation study, patterns of correlations computed based on different food composition tables were similar [14].

The validation study of the HEALS FFQ did not include validation of amino acid intakes [14]. Using the same methodology, which compared intakes recorded on the FFQ to 2-week food diaries among 200 participants, we ascertained Pearson correlation coefficients between estimates of intake based on FFQ and 2-week food diaries. The Pearson correlation

coefficients, adjusted for total energy and corrected for within-person error, were 0.68 for histidine; 0.65 for isoleucine; 0.58 for leucine; 0.92 for lysine; 0.48 for methionine; 0.59 for phenylalanine; 0.58 for threonine; 0.55 for tryptophan; 0.54 for valine; 0.96 for cysteine; and 0.52 for tyrosine.

In this paper, we describe the sources and amounts of protein and amino acid intakes and their distribution across selected demographic and socioeconomic variables among HEALS study participants.

Statistical Analyses

Selected sociodemographic and health related variables were described across men and women in the population. Males and females were compared using chi-square and t-tests. The contribution of food items to overall protein intake was described. Protein intake was adjusted for body size by expressing intake as g/kg/day, and average intakes were reported by sex, across sociodemographic variables. Mean amino acid intakes were calculated and reported by sex. Generalized linear modeling was used to determine correlates of protein intake.

Results

Of the 11,746 original participants, there were 355 (3.0%) participants who did not have information on dietary protein intake who were excluded from the current analysis. In the manner suggested by Willett, 225 (1.9%) additional participants whose total caloric intake was greater than 3500 Kcal (women) or 4000 (men) per day, or less than 500 Kcal (women) or 800 (men) were eliminated [15]. The final sample size for this analysis was 11,170 persons, including 6424 females and 4746 males.

Mean caloric intake per day was 2142 among women and 2394 among men (Table 1), with mean protein intake of 67.5 g/day among women and 78.2 g/day among men. A notable proportion of participants, 11% of women and 7% of men, had intakes below 1500 kcal/day (data not shown), and 35% of women and 44% of men had a body mass index (BMI) below 18.5. Under the FAO standard of 0.8 g/kg body weight/day, 1.5% of men and 2.2% of women were below recommended intakes. When examining protein intake across selected demographic variables it could be seen that protein intake varied by socioeconomic status, with higher protein intakes among those with the greatest years of formal education, TV ownership, and among men employed in business. Among women, higher protein intake was associated with younger age and land ownership, and among men, with tobacco/bidi use and Muslim faith.

Rice was the primary source of protein for this population (Table 2). The second most common source of protein was from fish, accounting for nearly a fifth of daily protein intake. Milk, eggs, and poultry were not common sources of protein in the HEALS population. Methionine intake averaged 1.61 gm/day, or 34.6 mg/kg/day (Table 3). Cysteine intake averaged 0.87 g/day, or 18.62 mg/kg/day. Among all amino acids, intake was higher in men than women after adjusting for body weight.

In multivariate analysis (Table 4), correlates of higher protein intake among female participants included younger age, higher BMI, non-Muslim religion, and most SES measures, including more years of education, land and television ownership, employment category, and tobacco/bidi use. Among men, predictors of greater protein intake were younger age, more years of education, employment category, land and television ownership, and BMI.

Discussion

This paper found that by the standards set by FAO for minimum recommend intake which are based on body weight [5], consumption of protein and amino acids are more than adequate for the majority of participants in this population. Our findings on amino acid intakes were similar to those found in the 1992 FAO report, with intakes varying less than 4% from those estimated by the FAO [7]. Lysine, however, was 21% greater in this study, which may reflect a greater consumption of fish and legumes in the HEALS study population.

Many studies in Bangladesh have noted a prevalence of undernutrition, particularly in rural areas [3, 16–19]. In our sample, a higher proportion of males than females were underweight, perhaps due to their greater energy expenditure in employment-related activities. Energy requirements are related to age, sex, body size, basal metabolic rate, and physical activity. Although energy requirements of this population are not known, the large proportion (40%) of participants with a BMI below 18.5 suggests that their caloric intakes were not adequate to meet their energy expenditures. It has been suggested that minimum recommended dietary intakes are higher in an undernourished population. One study suggested that an appropriate cysteine intake among undernourished Indian participants should be 16 mg/kg/day [20]; by that standard, 32% of this population would have less than adequate intake.

This study found similar intake of calories among rural Bangladeshis to earlier research. A 1995–1996 study by the Bangladesh Bureau of Statistics found average caloric intake among rural residents to be an equivalent 2251 kcal/day [4]. In contrast, the Bangladesh National Nutritional Survey, also undertaken in 1995–1996, found that average food intake in rural areas was 1892 kcal/day [3]. As noted previously, intake of nutrients and overall energy intake are said to have improved in Bangladesh between the 1980's and 1990's [6]. This is supported by agricultural reports. The Food and Agriculture Organization of the United Nations (FAO) reported that total rice production increased in Bangladesh in the 1999–2000 year to 22.6 million tons, a rise of 3 million tons above the previous year [21]. Although it is not known how Araihaaz residents compare to rural Bangladeshis surveyed in previous studies, our findings of higher caloric intake may be due to increased energy consumption over the past several decades. Alternatively, the inclusion requirement that participants must be married may indicate a higher socioeconomic status among our population than among Bangladeshis in general.

We found rice to be the largest sources of protein intake in this population. Rice is the main staple of the Bangladesh diet, accounting for approximately 80% of energy intake [22]. This

study found higher mean protein intake (72.1 g/day) than that reported in the Bangladesh Bureau of Statistics survey (64.5 grams) [3], despite equivalent energy consumption. This may be due to the greater amounts of animal products consumed by our participants, which accounted for one-fourth of all protein consumption. Consistent with the literature, our findings suggest that intakes of small (length <25 cm) indigenous fish species provide the main and often irreplaceable animal source food in rural households in Bangladesh [23]. Poultry and eggs appear to be a small proportion of overall protein, and supplementation of these foods could be a strategy to increase protein consumption in Bangladesh.

In our study, greater protein intake per kg body weight was associated with greater wealth, as measured by land and television ownership and employment category. The relationship between socioeconomic measures and protein-energy intake has been found in many studies in developing nations. Although it has been possible in Bangladesh to see poor diets across all socioeconomic strata, SES measures are frequently related to food choice, and consequently, to anthropogenic measures [24, 25]. In resource-poor settings, adequate dietary protein may lessen malnutrition and its associated health effects, such as stunting, and may be a marker for better overall health. Nutrition is strongly related to growth, and smaller stature has been associated with lessened strength and work capacity, at times leading to reduced productivity and earnings [26, 27]. In developing country settings, greater intake of protein is associated with better health regardless of SES [28].

Accurate assessment of dietary intake is crucial in nutritional studies. The validation study of the FFQ used in this study indicates that protein intake measured using the FFQ was well correlated with intake level measured using 7-day food diaries. Correlations were higher for meat ($r=0.38$), rice ($r=0.59$), breads ($r=0.56$) and milk ($r=0.78$), which are foods that make up the largest proportion of protein intake among these participants. Despite the fact that many nutrients had reasonable correlations between FFQ and food diary, we cannot exclude the possibility that participants overestimated their consumption, with overestimates most likely to occur for foods with greater social desirability such as tea and fruit [14]. Despite the potential limitation of overestimated intakes, large epidemiologic studies have supported that FFQ taken as a whole can reasonably estimate the distributions of food intakes of a population; in particular, it does not limit the ability to group participants into broad categories of intakes in order to compare participants to one another.

In conclusion, average protein intake in Bangladesh is adequate by international standards for body weight, although the low BMI of many participants suggests that caloric, protein, and amino acid intakes may not meet the needs of a significant proportion of the population.

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Characteristics and Mean Caloric and Protein Intake among the Study Population, by Sex

Table 1

	Women (n=6424)					Men (n=4746)				
	Protein Intake			p [†]		Protein Intake			p [†]	
	%	Kcal/day (SD)	g/day (SD)	g/kg/day		%	Kcal/day (SD)	g/day (SD)	g/kg/day	
Total	100.0	2142.3 (509.1)	67.5 (18.1)	1.54 (0.44)		100.0	2394.0 (592.7)	78.2 (21.0)	1.57 (0.43)	
Age					<0.01					<0.01
<30	43.6	2193.9 (496.5)	69.2 (17.9)	1.58 (0.43)		10.4	2542.0 (571.1)	81.9 (18.9)	1.66 (0.39)	
30–49	58.3	2129.1 (512.5)	67.0 (18.2)	1.52 (0.44)		64.3	2427.5 (581.6)	79.3 (20.9)	1.57 (0.43)	
50+	5.6	1946.6 (499.2)	61.9 (17.4)	1.47 (0.45)		25.3	2247.9 (601.8)	73.6 (21.3)	1.53 (0.44)	
Education (years)					<0.01					0.01
No formal	48.2	2076.8 (506.3)	63.8 (17.3)	1.52 (0.44)		40.2	2362.3 (599.9)	74.8 (19.9)	1.58 (0.43)	
1–5	29.3	2162.4 (506.9)	68.4 (17.6)	1.55 (0.44)		29.7	2394.5 (579.0)	77.6 (20.3)	1.59 (0.44)	
6+	22.5	2256.3 (495.7)	74.5 (18.3)	1.57 (0.43)		30.0	2435.6 (594.8)	83.2 (22.1)	1.54 (0.43)	
Religion					0.2					<0.01
Muslim	95.3	2136.7 (508.8)	67.4 (18.2)	1.54 (0.44)		95.1	2393.8 (590.7)	78.2 (21.0)	1.57 (0.43)	
Hindu/Other [‡]	4.7	2255.6 (502.9)	70.7 (17.0)	1.57 (0.45)		4.9	2398.9 (631.1)	77.7 (20.6)	1.49 (0.44)	
Occupation					0.05					<0.01
Daily Laborer	<1	1859.1 (626.0)	59.0 (21.1)	1.45 (0.63)		8.4	2438.5 (579.0)	75.5 (19.6)	1.63 (0.42)	
Farmer	<1	1995.1 (886.5)	63.2 (17.1)	1.43 (0.31)		13.9	2434.2 (602.6)	77.2 (19.5)	1.63 (0.42)	
Factory worker	1.0	1887.1 (515.0)	57.9 (14.6)	1.44 (0.43)		22.6	2391.0 (562.7)	74.9 (18.3)	1.59 (0.42)	
Business	2.0	2060.9 (421.6)	64.8 (13.9)	1.52 (0.39)		34.2	2385.4 (598.2)	81.6 (22.7)	1.53 (0.44)	
Homemaker	93.9	2151.0 (508.3)	67.8 (18.2)	1.54 (0.44)		<1	2332.7 (570.5)	77.2 (18.7)	1.68 (0.38)	
Unemployed	0.3	1610.7 (584.2)	55.6 (18.7)	1.34 (0.47)		4.5	2153.8 (644.7)	71.4 (24.8)	1.47 (0.51)	
Other	2.7	2075.0 (508.4)	67.3 (17.0)	1.47 (0.38)		16.4	2425.2 (591.2)	79.6 (20.2)	1.56 (0.41)	
Land Ownership					0.01					0.8
No	51.6	2107.0 (504.8)	65.2 (17.6)	1.52 (0.45)		48.5	2369.3 (599.3)	76.1 (20.3)	1.57 (0.43)	
Yes	48.4	2179.6 (511.0)	70.1 (18.4)	1.55 (0.43)		51.5	2417.3 (585.7)	80.1 (21.5)	1.57 (0.43)	
TV Ownership					0.06					0.06
No	65.8	2107.6 (502.1)	64.9 (17.2)	1.53 (0.44)		65.5	2383.8 (588.8)	75.8 (19.7)	1.58 (0.43)	
Yes	34.2	2209.3 (515.8)	72.6 (18.9)	1.55 (0.44)		34.5	2414.0 (599.6)	82.7 (22.5)	1.55 (0.44)	

	Women (n=6424)					Men (n=4746)				
	Protein Intake					Protein Intake				
	%	Kcal/day (SD)	g/day (SD)	g/kg/day	p [†]	%	Kcal/day (SD)	g/day (SD)	g/kg/day	p [†]
<i>BMI</i>					<0.01					<0.01
<18.5	34.9	2044.5 (507.3)	63.4 (17.7)	1.68 (0.49)		44.4	2309.0 (599.3)	73.7 (19.8)	1.67 (0.46)	
18.5-<25	55.1	2188.0 (496.2)	69.1 (17.7)	1.49 (0.39)		47.7	2458.4 (574.0)	81.0 (20.4)	1.51 (0.39)	
25+	10.0	2231.8 (533.1)	73.2 (19.4)	1.26 (0.34)		7.9	2483.0 (605.6)	85.9 (25.2)	1.28 (0.34)	
<i>Tobacco/Bidi use</i>					0.5					<0.01
No	96.3	2148.9 (506.8)	67.8 (18.1)	1.54 (0.44)		37.4	2440.8 (588.0)	79.3 (20.8)	1.53 (0.43)	
Yes	3.7	1972.0 (539.4)	60.8 (17.4)	1.56 (0.48)		62.6	2366.0 (593.9)	77.5 (21.1)	1.59 (0.43)	
<i>Betel Leaf use</i>					0.01					0.4
No	67.8	2186.8 (503.1)	68.6 (18.1)	1.55 (0.43)		59.9	2431.3 (590.2)	78.3 (20.2)	1.57 (0.42)	
Yes	32.2	2048.6 (509.0)	65.2 (18.0)	1.52 (0.46)		40.1	2338.0 (592.2)	77.9 (22.2)	1.56 (0.45)	

[†] p-values were computed using analysis of variance testing

[‡] Other religions were reported by <0.5% of participants

Table 2

Sources of Protein Intake in the Study Population, by Sex

Protein Sources	Protein g/100 g	Women		Men	
		Average intake per day, grams [†]	% daily protein intake [‡]	Average intake per day, grams [†]	% daily protein intake [‡]
Rice	2.58	727.1 (274.5)	59.7	713.7 (271.3)	54.5
Wheat bread (brown)	23.37	22.5 (52.6)	1.2	53.9 (76.9)	3.8
Small fish (fresh water)	13.22	34.6 (21.8)	9.4	40.7 (24.3)	9.7
Big fish (fresh water)	24.9	32.5 (16.2)	7.0	37.2 (21.4)	7.3
Salted fish	0.85	5.4 (11.1)	0.1	4.3 (10.2)	0.1
Dried fish	0.85	6.8 (8.8)	0.8	7.1 (10.6)	0.7
Poultry (duck or fowl)	23.11	9.4 (23.9)	0.8	15.1 (32.0)	1.1
Beef or mutton	25.59	33.1 (39.5)	4.0	50.3 (57.5)	5.3
Eggs	12.58	24.2 (26.6)	1.1	33.7 (32.5)	1.5
Lentils	12.02	105.2 (36.5)	4.8	114.9 (37.9)	4.5
Milk	3.29	51.1 (55.7)	1.0	66.0 (67.1)	1.2
Banana	1.03	85.2 (65.0)	0.4	114.6 (72.4)	0.6
Green papaya	0.61	27.5 (44.9)	0.1	33.8 (50.6)	0.1
Guava	0.82	70.7 (85.3)	0.1	68.4 (86.1)	0.1
Jack fruit	9.02	154.3 (107.6)	0.3	222.8 (147.7)	0.4
Mango	0.51	155.2 (98.8)	0.2	169.7 (106.3)	0.2
Watermelon	0.62	82.5 (117.3)	<0.1	101.8 (127.3)	<0.1
Beans (scarlet runner)	1.89	72.9 (51.3)	1.9	97.5 (62.3)	2.3
Bitter gourd (a kind of squash)	20.75	42.0 (24.0)	0.1	48.7 (25.8)	0.1
Bottle gourd (a kind of squash)	21.4	99.7 (55.9)	0.2	118.8 (62.5)	0.2
Cauliflower	1.84	96.5 (38.8)	0.6	109.5 (40.2)	0.6
Cabbage	1.02	63.3 (42.8)	0.1	72.4 (48.6)	0.1
Eggplant	0.83	39.4 (42.4)	0.2	41.6 (47.7)	0.2
Okra	1.87	48.1 (30.6)	0.2	53.9 (32.1)	0.2
Parwar or Ghosala squash	0.64	86.4 (61.9)	0.1	86.5 (63.4)	0.1
Potato	1.71	77.5 (47.2)	2.7	86.2 (51.5)	2.7
Pumpkin	0.72	26.1 (40.6)	<0.1	26.0 (49.1)	<0.1

Protein Sources	Women			Men		
	Protein g/100 g	Average intake per day, grams [†]	% daily protein intake [‡]	Average intake per day, grams [†]	% daily protein intake [‡]	% daily protein intake [‡]
Ridge gourd (a kind of squash)	19.8	39.4 (47.9)	<0.1	37.4 (49.3)	<0.1	<0.1
Snake gourd (a kind of squash)	1.23	55.3 (47.4)	0.1	64.0 (51.7)	0.1	0.1
Spinach	2.97	59.2 (37.0)	0.7	66.0 (38.5)	0.7	0.7
Tomato	1.07	102.0 (47.3)	0.8	109.3 (51.3)	0.8	0.7
Radish	13.74	92.5 (64.8)	0.1	99.3 (69.3)	0.1	0.1
Stems (Spinach stalks)	23.24	81.7 (61.0)	0.6	91.0 (64.6)	0.6	0.5
Sweet potato	1.72	55.9 (54.2)	0.1	55.8 (59.6)	0.1	0.1
Yam	25.18	64.0 (58.9)	0.2	74.6 (63.2)	0.2	0.2

[†] Average daily intake during the months of the year that the food is eaten.

[‡] Average protein intake over the course of a year.

Table 3

Amino Acid Intakes in the Study Population, by Sex

	Women (n=6424)		Men (n=4746)	
	g/d Mean (SD)	mg/kg body weight/d Mean (SD)	g/day Mean (SD)	mg/kg body weight/d Mean (SD)
<i>Essential Amino Acids</i>				
Histidine	1.78 (0.50)	40.43 (12.06)	2.07 (0.59)	41.57 (12.11)
Isoleucine	2.90 (0.80)	65.95 (19.30)	3.35 (0.93)	67.33 (19.05)
Leucine	5.35 (1.43)	121.80 (34.76)	6.16 (1.66)	123.76 (34.35)
Lysine	3.64 (1.27)	82.61 (29.86)	4.27 (1.48)	85.51 (29.51)
Methionine	1.51 (0.44)	34.35 (10.51)	1.75 (0.51)	35.04 (10.45)
Phenylalanine	3.17 (0.80)	72.21 (19.76)	3.64 (0.93)	73.17 (19.50)
Threonine	2.59 (0.73)	58.85 (17.51)	2.99 (0.85)	60.10 (17.31)
Tryptophan	0.82 (0.21)	18.68 (5.20)	0.95 (0.25)	19.13 (5.16)
Valine	3.72 (0.97)	84.77 (23.68)	4.27 (1.12)	85.80 (23.35)
<i>Conditionally Essential Amino Acids</i>				
Cysteine	0.80 (0.22)	18.25 (5.18)	0.95 (0.27)	19.13 (5.33)
Tyrosine	2.38 (0.62)	54.08 (15.20)	2.73 (0.72)	54.83 (15.05)
<i>Non-essential Amino Acids</i>				
Alanine	3.76 (1.03)	85.64 (24.88)	4.31 (1.19)	86.53 (24.74)
Arginine	4.60 (1.18)	104.86 (29.10)	5.23 (1.36)	105.17 (28.85)
Aspartic Acid	6.78 (1.82)	154.44 (44.46)	7.75 (2.06)	155.73 (43.31)
Glutamic Acid	12.41 (3.15)	282.73 (77.21)	14.46 (3.73)	290.34 (77.08)
Glycine	3.15 (0.86)	71.71 (20.73)	3.63 (1.01)	72.91 (20.74)
Proline	3.01 (0.81)	68.39 (19.34)	3.60 (1.03)	72.11 (20.19)
Serine	3.25 (0.83)	73.95 (20.30)	3.74 (0.95)	75.13 (20.01)

Table 4 Correlates of Protein Intake (g/day), by Sex[†]

	Women		Men	
	Least squares adjusted mean (SE)	p-value	Least squares adjusted mean (SE)	p-value
Age		<0.01		<0.01
Below 30	66.3 (2.2)		84.2 (1.7)	
39–49	65.3 (2.2)		79.9 (1.4)	
50+	61.2 (2.3)		74.7 (1.5)	
Education		<0.01		<0.01
No formal	61.2 (2.2)		77.5 (1.5)	
1–5 years	64.0 (2.2)		79.2 (1.5)	
6 or more years	67.5 (2.2)		82.0 (1.5)	
Religion		0.02		0.5
Muslim	63.1 (2.1)		80.6 (1.3)	
Hindu, Other	65.5 (2.3)		78.5 (1.8)	
Occupation		<0.01		<0.01
Daily Laborer	62.8 (5.5)		81.1 (1.3)	
Farmer	62.2 (12.2)		81.2 (1.2)	
Factory worker	62.8 (2.3)		77.4 (1.0)	
Business	66.9 (1.7)		81.2 (0.9)	
Homemaker	69.0 (0.8)		79.7 (8.3)	
Unemployed	59.1 (3.8)		76.0 (1.6)	
Other	67.2 (1.5)		80.4 (1.0)	
Land Ownership		<0.01		<0.01
No	63.1 (2.2)		78.8 (1.5)	
Yes	65.5 (2.2)		80.3 (1.5)	
TV Ownership		<0.01		<0.01
No	61.9 (2.2)		77.6 (1.4)	
Yes	66.6 (2.2)		81.5 (1.5)	
Tobacco or Bidi Use		0.02		0.7
No	65.0 (2.1)		79.3 (1.5)	
Yes	63.5 (2.4)		79.9 (1.5)	
Betel Leaf Use		0.07		0.1
No	64.7 (2.2)		79.2 (1.5)	
Yes	63.9 (2.2)		80.0 (1.5)	
Body Mass Index		<0.01		<0.01
<18.5	60.9 (2.2)		75.0 (1.5)	
18.5–<25	64.8 (2.2)		80.2 (1.4)	
25 or more	67.0 (2.3)		83.5 (1.7)	

[†] Computed by generalized linear modeling. All estimates are adjusted for other variables in the table.