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Original Article

Food Consumption and Serum Nutritional Status of People Living in the Kathmandu Valley in Nepal

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Abstract

Objective: The food consumption and serum nutritional status of people living in the Kathmandu valley, Nepal, were examined to obtain actual data for comparison with our previous findings.

Methods: A dietary survey of 45 males and 60 females was carried out in March 1997 by the 24-hr dietary recall method and nutrient intake was calculated from food tables of India and Japan. Fasting venous blood samples were obtained and serum biochemical parameters were measured using clinical kits.

Results: The mean body mass index value was at about the same level in both sexes, although the mean percentage body fat of females was higher than that of males, and vice versa for packed red cell volume. The main foods consumed by both sexes, were rice, potatoes, meats, milk & dairy products and vegetables, with a difference in the amounts consumed. Females did not drink alcoholic beverages. The mean daily intakes of energy, protein, lipids, iron and vitamin B group for the males were higher than those for the females, while those of vitamins A and C for the males were lower than those for the females. The mean values of serum biochemical parameters for both sexes were generally at the normal levels, but those of ALT and TG were at the higher end of the normal range. Differences of correlation between food groups and between serum parameters were observed depending on the sex, however, no clear relationship between food and nutrient intake and serum biochemical parameters were observed.

Conclusions: The present food intake study revealed that the amounts of food consumption for both sexes, especially for the females, were mostly insufficient although the serum parameters were at the normal levels. The energy intake of both sexes was lower than that of estimated requirements and those in Terai region. The relatively high serum TG level of the subjects may be due to the consumption of large amounts of cereals containing much carbohydrate. Our findings suggested a marked influence on food consumption by food price and income in spite of the easier food availability in the city, and also lack of knowledge about nutrients and health, thus there is need for improvement of the nutritional status of this group of people.

Key words: food consumption, nutrient intake, serum biochemical parameter, Nepalese, Kathmandu valley

Introduction

For the past 30 years, we have been conducting dietary surveys in Nepal, in a mountain area (Mountain) (1), the southern Terai region (Level land) (Itahari district, an industrial (2) and Chitwan district, an agricultural (3) region) and a remote hilly village (Hills) (area A and B, area A is located at a rela-

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tively lower altitude and is warmer than area B) in the eastern area (4). These were selected depending on geographical belts (Mountain, Level land and Hills). As the results, the subjects of these studies were generally in apparent good health, despite the fact that their energy intakes, except both sexes in the Itahari district and males in the Chitwan district, were insufficient compared to the estimated requirement of 2250 kcal/person/day (5) and there might have been latent deficiency of some nutrients such as calcium, iron, and fat-soluble vitamins. The subjects living in a mountain area consumed foxtail millet, Japanese barnyard millet and wheat, those in Terai region consumed rice and green vegetables and those of a hilly village consumed rice, maize and milk & dairy products. In these areas, except the Itahari district, people were self-supporting but lived on a low income. Their food habits were influenced greatly by the season of the survey, income and food availability although their dietary patterns were found to be very simple and similar. Kathmandu is the capital of Nepal, and many people go there to work temporarily or to settle down. Many kinds of food are easily available through the year. We studied the food and nutrient intake of some workers who regularly earned an income and were living in Kathmandu valley for comparison with our previous findings.

Subjects and Methods

The workers examined in this study were males working as tempo-drivers (n=45, 31±11 years old) and females working at a carpet factory (n=60, 23±7 years old). A tempo-driver is a person who drives a three-wheeled vehicle. In Nepal, tempo-three-wheeled vehicles are used for public transportation and are much more economical than taxis and other public vehicles. More than 80% of Nepalese used Tempo-vehicles for their transportation.

All subjects lived in Kathmandu valley and practiced Hinduism. We explained the subjects who came to a medical camp for a routine health check, for the purposes of this study and obtained informed consent before participation. The dietary survey was carried out in March 1997 by the 24-hr dietary recall method. Actual food models were used to obtain descriptions of the amounts of food consumed. The data were analyzed and nutrient intake was calculated from food tables of India and Japan. Some green vegetables not listed in the tables were substituted with similar items. The proportion of these vegetables to all food items was less than 5% of total energy.

Height, weight, systolic (SBP) and diastolic (DBP) blood pressure were measured at the same time. The percentage body fat (BF) of the subjects was measured by the method of bio-electrical impedance analysis.

Fasting venous blood samples were obtained from the subjects and serum was separated by centrifugation at 3500 rpm for 20 min. and stored at −20°C until analysis. Packed red cell volume (PCV) was measured by the microcentrifuge method (11,000 rpm, 5 min.). Total protein (TP), albumin (ALB), iron, urea nitrogen (BUN), creatinine (CRE), aspartate aminotransferase (AST), alanine aminotransferase (ALT), total cholesterol (TC), high density lipoprotein-cholesterol (HDL-C) and triglyceride (TG) in sera were measured using commercial clinical kits (TP, ALB, CRE, TC, HDL-C, TG: Daiichi Chem. Co., Tokyo; iron, BUN: Wako Pure Chemicals Ltd., Osaka; AST, ALT: Shino Test Co. Ltd., Tokyo, Japan). Serum globulin (GLB) was calculated by subtracting the ALB value from the TP value, and the ALB/GLB (A/G) ratio was calculated.

The experimental measurement values were expressed as the mean±SD. The Mann-Whitney U test was used to compare the statistical significance between sexes. Pearson's correlation coefficients were used to examine the relationship between the variables. Calculations were performed using Stat View (SAS Institute Inc., NC, USA).

Results

Table 1 shows the physical characteristics of the subjects. The blood pressure, SBP and DBP of males (133±17 and 81±15 mmHg, respectively) was higher than those of females (SBP; 121±17 mmHg, DBP; 74±14 mmHg). The mean height and weight were higher in males than in females, while BMI were almost at the same levels for both sexes. The mean BF of females (32±7%) was higher than that of males (20±4%) and vice versa in PCV.

As can be seen from the mean daily food consumption of the subjects in Table 2, considerable variation was found among individuals for the amounts of food consumed. Among food groups, rice, potatoes, meats, milk & dairy products and vegetables were frequently consumed by both sexes. The proportion of these foods for all food weights was about 66% for males and about 75% for females. None of the subjects consumed fats, and the females did not drink alcoholic beverages. The males consumed significantly more of other cereals, meats, eggs, milk & dairy products, other vegetables, oils and tea, whereas the females consumed more colored vegetables. The nutrient intakes are shown in Table 3. The energy contribution of carbohydrates to total energy intake was about 69% for males and about 78% for females calculated from Table 3. The mean energy and most of the nutrient intake, with a few exceptions, were higher for males than for females, whereas the mean daily intake of vitamin A was higher for females (316±283 μg) than for males (190±119 μg). The mean carbohydrate, dietary fiber, calcium and vitamin E intakes were almost at the same levels

Table 1 Physical characteristics of Nepalese subjects

Parameter	Male (n=45)	Female (n=60)	p value
Age (years old)	31±11	23±7	<0.001
Blood pressure (mmHg)			
SBP	133±17	121±17	<0.001
DBP	81±15	74±14	0.012
Height (cm)	162.8±6.9	150.4±5.0	<0.001
Weight (kg)	55.4±6.9	48.1±7.6	<0.001
Body mass index (kg/m^2)	20.9±2.3	21.3±3.2	0.708
Percentage body fat (%)	20±4	32±7	<0.001
PCV (%)	48.2±3.8	41.7±4.7	<0.001

p values were determined by the Mann−Whitney U test. Values are mean±SD.

Abbreviations: SBP, systolic blood pressure; DBP, diastolic blood pressure; PCV, packed red cell volume.

Table 2 Mean daily food consumption of Nepalese subjects

Food group (g/day)	Male (n=45)	Female (n=60)	p value
Cereals	372±145	340±123	0.245
Rice	340±140	324±133	0.489
Other cereals	32±62	11±28	0.309
Potatoes	76±72	96±103	0.675
Sugar & sweets	8.9±15.5	8.6±11.6	0.785
Pulses	27±23	21±29	0.051
Meats	74±57	14±38	<0.001
Eggs	10±24	1±7	0.215
Fish	1±8	3±16	0.886
Milk & dairy products	69±78	37±45	0.027
Vegetables			
Colored vegetables	21±25	63±54	<0.001
Other vegetables	57±53	23±37	<0.001
Fruits	22±73	16±51	0.762
Fats & oils			
Oils	9.6±3.9	7.8±3.6	0.001
Tea	175±175	92±138	0.007
Alcoholic beverages	40±95	0	0.056

p values were determined by the Mann–Whitney U test. Values are mean±SD.

Table 3 Mean daily nutrient intake of Nepalese subjects

Nutrient	Male (n=45)	Female (n=60)	p value
Energy (kcal)	1836±526	1527±474	0.003
Protein (g)	48.0±16.3	32.5±12.5	<0.001
Lipid (g)	30.6±11.4	17.6±7.8	<0.001
Carbohydrate (g)	318.4±110.4	298.7±99.7	0.221
Dietary fiber (g)	8.3±3.3	8.7±3.7	0.662
Ash (g)	5.5±2.3	4.6±1.5	0.028
Calcium (mg)	176±99	177±92	0.825
Phosphorus (mg)	899±275	732±218	<0.001
Iron (mg)	7.5±2.2	6.3±2.0	0.002
Vitamin A (μgRE)	190±119	316±283	0.002
Vitamin E (mg)	5.2±1.2	5.2±1.9	0.433
Vitamin B_1 (mg)	1.13±0.35	0.98±0.29	0.017
Vitamin B_2 (mg)	0.57±0.21	0.42±0.17	<0.001
Niacin (mg)	11.9±4.1	8.4±3.1	<0.001
Vitamin C (mg)	74±84	80±46	0.041

p values were determined by the Mann–Whitney U test. Values are mean±SD.

for both sexes.

Table 4 shows the serum levels of the biochemical parameters examined. The mean value of TP for males (8.0±0.6 g/dl) was at about the same levels as those for females (7.9±0.4 g/dl), while those of ALB for males (5.0±0.3 g/dl) were higher than those for females (4.8±0.3 g/dl). As the result, the mean value of the A/G ratio in males was higher than that in females. The mean level of serum iron for males, 113±40 μg/dl, was significantly higher than that of females (91±32 μg/dl, $p<0.01$). The mean levels of BUN, CRE and AST were significantly higher in males than in females. The mean TC concentrations for males (162±29 mg/dl) were higher than for females (132±27 mg/dl, $p<0.001$). ALT and HDL-C levels did not differ between the

Table 4 Serum biochemical parameter levels of Nepalese subjects

Serum parameter	Male (n=45)	Female (n=60)	p value
Total protein (g/100 ml)	8.0±0.6	7.9±0.4	0.867
Albumin (A, g/100 ml)	5.0±0.3	4.8±0.3	<0.001
A/G ratio	1.68±0.22	1.51±0.21	<0.001
Iron (μg/100 ml)	113±40	91±32	0.004
Urea nitrogen (mg/100 ml)	13.0±3.3	9.1±2.5	<0.001
Creatinine (mg/100 ml)	0.9±0.1	0.7±0.1	<0.001
AST (U/L)	36±15	30±9	0.032
ALT (U/L)	27±26	21±14	0.343
Total cholesterol (mg/100 ml)	162±29	132±27	<0.001
HDL-cholesterol (mg/100 ml)	40±10	37±8	0.489
Triglyceride (mg/100 ml)	131±107	101±48	0.440

p values were determined by the Mann–Whitney U test. Values are mean±SD.

Abbreviations: G, globulin; AST, aspartate aminotransferase; ALT, alanine aminotransferase; HDL, high density lipoprotein.

sexes. The mean TG concentrations were 131±107 mg/dl for the males and 101±48 mg/dl for the females.

Table 5 shows the correlation among physical characteristics of the subjects. Age did not correlate with any of the parameters for the males, but did with BMI and weight for the females. There was a significant positive correlation between SBP and DBP, between height and weight, and between weight and BMI for both sexes. BF correlated strongly with weight and BMI in both sexes. PCV correlated with BMI for the males, while PCV correlated positively with SBP and DBP for the females.

The correlations among food groups are shown in Table 6. The amounts of food consumed were not influenced by age for both sexes. Differences of correlation between food groups were observed depending on the sex. For the males, there was a correlation between rice and pulses, between meat and other vegetables, and potatoes correlated positively with other vegetables and negatively with colored vegetables. Oils correlated positively with other cereals and with meats for the males. There was a correlation between rice and sugar & sweets, between colored vegetables and other vegetables, and between meats and pulses for the females.

For food group and nutrient intake, rice, pulses, meats, milk & dairy products, vegetables and oils correlated with many of the nutrients, such as rice correlating with energy, carbohydrate, dietary fiber, phosphorus and vitamin B_1 (results not shown).

Table 7 shows the correlation among serum biochemical parameters. For the males, age correlated with ALB, the A/G ratio, serum iron and CRE, while for the females, age correlated with ALB, BUN and CRE. Lipid components did not correlate with age in both sexes in this study. There was correlation between TP and ALB, between TP and the A/G ratio, between AST and ALT, and between TC and TG for both sexes. BUN correlated positively with serum iron and CRE for the males, while ALB correlated with the A/G ratio for the females. ALB correlated with AST and ALT (both are hepatic indices), TC correlated with CRE and AST, while TG correlated with serum iron for the males. TC correlated positively with HDL-C for the

Table 5 Correlation among physical characteristics of Nepalese subjects

Parameter	SBP	DBP	Height	Weight	BMI	BF	PCV
SBP		0.624***	0.069	0.233	0.212	0.140	0.212
DBP	0.561***		–0.068	—	0.054	0.091	0.227
Height	0.021	0.111		0.474***	–0.200	–0.254	–0.072
Weight	0.068	0.038	0.289*		0.765***	0.547***	0.203
BMI	0.063	–0.012	–0.133	0.908***		0.794***	0.280*
BF	0.077	–0.052	–0.194	0.820***	0.933***		0.259
PCV	0.307*	0.370**	–0.086	0.046	0.090	0.157	

Values are Pearson's correlation coefficient. * p<0.05, ** p<0.01, *** p<0.001.
Upper right, male (n=45); lower left, female (n=60).
Abbreviations: SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index; BF, percentage body fat, PCV, packed red cell volume.

Table 6 Correlation among food groups of Nepalese subjects

Food group	Rice	Other cereals	Potatoes	Sugar & sweets	Pulses	Meats	Milk & dairy products	Colored vegetables	Other vegetables	Fruits	Oils
Rice		–0.142	0.162	–0.046	0.325*	–0.025	0.141	0.003	0.179	–0.134	0.192
Other cereals	–0.163		–0.151	–0.085	–0.261	0.215	0.061	–0.015	–0.085	–0.105	0.302*
Potatoes	0.126	–0.138		–0.116	0.090	–0.022	–0.128	–0.359**	0.440***	0.001	–0.058
Sugar & sweets	–0.286*	–0.052	0.008		–0.161	0.125	0.197	–0.099	–0.100	–0.043	–0.064
Pulses	–0.009	–0.090	–0.071	–0.009		0.018	0.014	0.013	0.048	0.003	–0.002
Meats	0.002	0.189	–0.152	0.158	0.438***		0.102	–0.194	0.023	0.009	0.306*
Milk & dairy products	0.207	0.004	–0.088	0.029	–0.235	–0.160		–0.059	–0.371**	–0.093	–0.103
Colored vegetables	0.245	0.113	–0.236	–0.142	–0.017	–0.087	0.182		–0.170	–0.047	0.015
Other vegetables	0.071	–0.173	0.086	–0.006	–0.112	–0.032	–0.071	–0.296*		0.007	0.113
Fruits	–0.185	0.026	0.218	–0.042	0.104	–0.116	–0.035	–0.074	0.090		–0.041
Oils	0.074	0.136	0.080	–0.150	0.053	0.034	–0.013	0.012	0.154	0.076	

Values are Pearson's correlation coefficient. * p<0.05, ** p<0.01, *** p<0.001. Upper right, male (n=45); lower left, female (n=60).

Table 7 Correlation among serum biochemical parameters

Parameter	TP	ALB	A/G ratio	Iron	BUN	CRE	AST	ALT	TC	HDL-C	TG
TP		0.678***	–0.571***	–0.038	–0.157	0.068	0.251	0.164	0.140	–0.074	0.209
ALB	0.527***		0.200	0.086	–0.121	–0.075	0.312*	0.294*	0.160	–0.044	0.183
A/G ratio	–0.270*	0.670***		0.123	0.077	–0.141	–0.008	0.081	0.025	0.027	–0.038
Iron	–0.051	0.096	0.160		0.339*	0.148	0.117	0.169	0.138	–0.033	0.290*
BUN	–0.017	0.033	0.058	–0.079		0.422**	–0.011	0.081	0.198	0.056	0.130
CRE	0.141	0.116	0.026	0.230	0.081		0.126	0.125	0.441***	0.001	0.255
AST	0.218	0.020	–0.151	0.077	–0.061	0.024		0.805***	0.342*	–0.074	0.240
ALT	0.124	–0.055	–0.139	0.057	–0.103	0.007	0.810***		0.258	–0.134	0.210
TC	–0.070	–0.016	0.041	0.173	0.073	–0.020	–0.082	–0.257		0.205	0.531***
HDL-C	–0.069	0.082	0.166	0.127	0.060	–0.047	0.019	–0.069	0.433***		–0.456***
TG	0.112	0.149	0.058	0.071	–0.065	–0.028	0.034	–0.124	0.330*	–0.172	

Values are Pearson's correlation coefficient. * p<0.05, ** p<0.01, *** p<0.001. Upper right, male (n=45); lower left, female (n=60).
Abbreviations: TP, total proteins; ALB and A, albumin; G, globulin; BUN, urea nitrogen; CRE, creatinine; AST, aspartate aminotransferase; ALT, alanine aminotransferase; TC, total cholesterol; HDL, high density lipoprotein; TG, triglyceride.

females, and TG correlated negatively with HDL-C for the males.

As shown in Table 8, negative correlation between SBP and milk & dairy products, and DBP and carbohydrate were observed in males. Positive correlation between SBP and energy, SBP and protein, weight and rice, weight and energy, weight and carbohydrate, BMI and rice, BMI and energy, BMI and carbohydrate, BF and energy, and BF and carbohydrate were observed in females. TG correlated positively with BMI and BF in both sexes, and TG also correlated with SBP and weight in males. Physical characteristics except SBP correlated with TC in males.

Table 9-1 shows the correlation between serum biochemical parameters and food groups or nutrient intake for the males. ALB correlated positively with rice, other vegetables, energy, carbohydrate and vitamin B_1. The A/G ratio correlated with rice. Serum iron correlated with vitamin C. AST correlated with other cereals. ALT correlated with other cereals and other vegetables. TC correlated positively with meats and lipid, while TG correlated negatively with pulses. For the females, as shown in Table 9-2, TP correlated negatively with pulses, meats, protein, lipid and vitamin B_1. The A/G ratio correlated with meats and lipid for the females. Serum iron correlated with only other cereals. ALT correlated with rice, protein and carbohy-

Table 8-1 Correlation between physical characteristics and food groups, nutrient and serum lipid components of Nepalese subjects (male)

Parameter	SBP	DBP	Weight	BMI	BF
Rice	–0.025	–0.261	–0.050	–0.089	–0.108
Potatoes	0.033	–0.162	0.033	–0.044	–0.006
Meats	0.211	0.188	0.201	0.240	0.082
Milk & dairy products	–0.288*	–0.243	–0.190	–0.184	–0.252
Energy	–0.018	–0.228	0.036	0.099	0.079
Protein	0.114	–0.034	0.215	0.256	0.083
Lipid	0.085	0.131	–0.008	0.148	0.161
Carbohydrate	–0.062	–0.282*	0.050	0.058	0.023
Total cholesterol	0.195	0.355**	0.316*	0.495***	0.475***
HDL-cholesterol	0.027	0.101	–0.177	–0.177	–0.133
Triglyceride	0.279*	0.256	0.390**	0.495***	0.421**

Values are Pearson's correlation coefficient. * $p<0.05$, ** $p<0.01$, *** $p<0.001$.
Abbreviations: SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index; BF, percentage body fat; HDL, high density lipoprotein.

Table 8-2 Correlation between physical characteristics and food groups, nutrient and serum lipid components of Nepalese subjects (female)

Parameter	SBP	DBP	Weight	BMI	BF
Rice	0.174	–0.097	0.274*	0.283*	0.239
Potatoes	0.045	–0.013	0.032	0.084	0.127
Meats	0.359**	0.122	–0.058	–0.141	–0.162
Milk & dairy products	–0.033	–0.093	0.133	0.132	0.156
Energy	0.272*	–0.032	0.392**	0.401**	0.339**
Protein	0.380**	0.052	0.243	0.237	0.200
Lipid	0.091	–0.003	0.139	0.139	0.130
Carbohydrate	0.247	–0.042	0.394**	0.405**	0.342**
Total cholesterol	–0.064	–0.135	0.081	0.137	0.177
HDL-cholesterol	–0.015	0.033	–0.039	–0.087	–0.130
Triglyceride	0.036	–0.053	0.227	0.285*	0.329*

Values are Pearson's correlation coefficient. * $p<0.05$, ** $p<0.01$, *** $p<0.001$.
Abbreviations: SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index; BF, percentage body fat; HDL, high density lipoprotein.

drate, while TG correlated with potatoes and meats. ALB, AST and TC did not correlate with any food group or nutrient intake for the females.

Discussion

The mean BMI value of both sexes was close to 22, which is considered to indicate the lowest morbidity due to disease in 30–59-yearold Japanese (6). Another report on rural Bangladeshi women 19 years of age gave the lowest mortality for those who had a BMI of 16.37–20.71 (7). Therefore, the mean BMI value of the subjects seemed to be adequate. However, the mean BF value of males (20±4%) was about the same as that of Japanese approximately 46-yearold males (20.4%), while that of females (32±7%) was higher than that of Japanese females (24.2%) (8). The BF values of Australian males and females 17–21-years old were 14.2±6.2 and 27.6±8.2%, respectively (9). Thus, the females in this study tended to be obese in spite of having an adequate BMI. The difference of BF between sexes might be related to the difference of correlation between BF and energy, carbohydrate and TC in both sexes (Table 8). With respect to their PCV, as higher altitude exposure leads to its increase (10), the higher ranges of normal levels (42.0–52.0% for males, 35.0–45.0% for females) (11), were considered to be attributable to their adaptation to living at 1300–1400 m above sea level.

The consumption of rice was almost at the same level as those in the Itahari district (300–330 g for both sexes) and a remote hilly village (243–294 g for both sexes), and lower than that in the Chitwan district (408–464 g for both sexes). The consumption of meat, important as a protein source and for minerals and vitamins, was 74±57 g/day for the males in this study, which was higher than those in Terai region (Itahari district; 10±26 g for the males, none for the females, Chitwan district; 14±41 g for the males, 24±45 g for the females) (2, 3). However, this amount was less than 94 g/day of the Japanese intake in 2000 reported by a national nutrition survey (12). The consumption of milk & dairy products and vegetables were very low for both sexes compared to those in the Itahari district (153–261 g and 150–153 g for both sexes) and in the Chitwan district (91–111 g and 250–260 g for both sexes, respectively). People living in a remote hilly village consumed more milk & dairy products (131–150 g for both sexes and areas) than those in this study, while those of vegetables (67–99 g for both sexes and areas) were at about the same levels. In particular, the mean milk & dairy products and vegetables consumption of females in this study was very low compared to females in the Chitwan district (3), where their only animal-origin food was milk & dairy products.

Table 10 summarized the daily average nutrient intakes of

Table 9-1 Correlation between serum biochemical parameters and food groups or nutrient intake of Nepalese subjects (male)

Parameter	TP	ALB	A/G ratio	Serum iron	AST	ALT	TC	TG
Food group								
Rice	0.075	0.308*	0.281*	0.067	–0.051	0.046	–0.126	–0.066
Other cereals	0.026	–0.060	–0.082	–0.073	0.538***	0.437***	0.234	0.128
Potatoes	0.213	0.231	–0.075	0.258	–0.027	0.087	–0.084	0.052
Pulses	–0.065	–0.049	0.042	0.070	–0.074	–0.033	–0.134	–0.305*
Meats	–0.061	0.055	–0.031	0.079	0.254	0.141	0.330*	–0.107
Milk & dairy products	0.049	–0.068	–0.155	–0.220	–0.211	–0.191	–0.239	–0.147
Colored vegetable	–0.168	–0.102	0.125	–0.115	0.085	–0.014	–0.158	–0.056
Other vegetables	0.188	0.305*	0.040	0.103	0.240	0.346*	0.196	0.124
Nutrient intake								
Energy	0.101	0.296*	0.228	0.082	0.194	0.241	0.030	–0.086
Protein	0.109	0.155	0.050	0.037	0.282*	0.213	0.225	–0.071
Lipid	–0.012	0.019	0.056	–0.034	0.260	0.181	0.296*	–0.132
Carbohydrate	0.112	0.306*	0.226	0.077	0.115	0.195	–0.056	–0.060
Calcium	0.016	–0.094	–0.135	–0.226	–0.107	–0.135	–0.230	–0.193
Iron	0.035	0.159	0.155	0.016	0.067	0.087	0.031	–0.211
Vitamin A	–0.042	–0.019	0.014	–0.218	0.026	–0.089	–0.060	–0.054
Vitamin B_1	0.109	0.274*	0.196	0.069	0.001	0.096	–0.055	0.076
Vitamin B_2	0.025	–0.019	–0.057	–0.113	0.032	–0.060	0.103	–0.164
Vitamin C	–0.040	0.088	0.144	0.311*	–0.037	0.001	0.001	–0.046

Values are Pearson's correlation coefficient. * $p<0.05$, *** $p<0.001$.

Abbreviations: TP, total proteins; ALB and A, albumin; G, globulin; AST, aspartate aminotransferase; ALT, alanine aminotransferase; TC, total cholesterol; TG, triglyceride.

Table 9-2 Correlation between serum biochemical parameters and food groups or nutrient intake of Nepalese subjects (female)

Parameter	TP	ALB	A/G ratio	Serum iron	AST	ALT	TC	TG
Food group								
Rice	–0.080	–0.064	0.035	0.164	0.176	0.319*	–0.050	0.065
Other cereals	0.160	0.100	–0.044	–0.058	–0.100	–0.078	–0.141	–0.197
Potatoes	–0.064	0.028	0.064	0.078	0.071	0.048	0.097	0.274*
Pulses	–0.327*	–0.082	0.205	0.117	–0.129	–0.094	–0.103	–0.228
Meats	–0.315*	–0.030	0.261*	–0.140	–0.007	0.039	–0.218	–0.361**
Milk & dairy products	0.076	0.121	0.067	–0.061	–0.221	–0.256	0.253	0.217
Colored vegetable	0.060	–0.172	–0.228	–0.064	0.055	0.079	0.033	0.022
Other vegetables	–0.107	0.035	0.130	0.312*	–0.134	–0.155	–0.093	–0.063
Nutrient intake								
Energy	–0.146	–0.059	0.087	0.127	0.162	0.270*	–0.078	0.065
Protein	–0.336**	–0.092	0.218	0.040	0.024	0.106	–0.130	–0.178
Lipid	–0.277*	0.016	0.259*	–0.016	–0.093	–0.011	–0.223	–0.242
Carbohydrate	–0.077	–0.059	0.028	0.143	0.196	0.293*	–0.035	0.139
Calcium	0.059	–0.056	–0.105	–0.030	–0.060	–0.088	0.112	0.053
Iron	–0.239	–0.110	0.110	0.030	0.032	0.116	–0.186	–0.067
Vitamin A	0.012	–0.069	–0.086	–0.053	0.042	–0.073	0.116	0.187
Vitamin B_1	–0.270*	–0.060	0.157	0.131	0.082	0.107	–0.116	0.076
Vitamin B_2	–0.167	–0.078	0.067	–0.126	0.035	–0.103	0.087	0.158
Vitamin C	–0.050	–0.066	–0.040	0.127	0.077	0.005	0.023	0.211

Values are Pearson's correlation coefficient. * $p<0.05$, ** $p<0.01$.

Abbreviations: TP, total proteins; ALB and A, albumin; G, globulin; AST, aspartate aminotransferase; ALT, alanine aminotransferase; TC, total cholesterol; TG, triglyceride.

Nepalese reported previously (1–4). The nutrient intakes of the subjects in this study were lower than those of Nepalese shown in Table 10 as a whole. There may be a latent deficiency of protein, calcium, iron, vitamins B_1 and B_2 for the subjects in this study.

Serum nutritional parameters, TP and ALB levels were within normal ranges (6.5–7.9 g/dl and 4.0–5.0 g/dl for both sexes, respectively) (13), and these values were almost at the same levels as those in the Terai region (8.6–8.7 g/dl and 4.5–4.6 g/dl for both sexes and both districts, respectively, except TP) (14) and a remote hilly village (7.6–7.8 g/dl and 4.2–4.4 g/dl for both sexes and both areas, respectively) (4). Serum iron level was also at the same level as that in Terai region (94–102 μg/dl for both sexes and both districts) (14). The mean

Table 10 Comparison of daily average nutrient intakes of Nepalese

Nutrient	Sherpa[1]	Itahari[2]		Chitwan[3]		Village[4] (A)		Village[4] (B)	
	(all, n=94)	Male (n=23)	Female (n=30)	Male (n=55)	Female (n=54)	Male (n=44)	Female (n=48)	Male (n=43)	Female (n=38)
Energy (kcal)	1802	2427	2275	2340	1930	1915	1945	1887	1842
Protein (g)	42	63.0	57.3	51.9	47.4	49.3	49.3	48.4	47.4
Lipid (g)	—	50.0	38.5	23.0	26.1	19.8	21.7	20.2	23.7
Carbohydrate (g)	—	419	410	449	359	350	365	341	335
Dietary fiber (g)	—	—	—	15.9	15.8	28.5	21.4	21.1	20.0
Calcium (mg)	369	612	466	412	395	263	287	265	297
Iron (mg)	11	13.1	11.9	8.5	6.7	9.0	9.5	8.7	8.8
Vitamin A (μgRE)	202	235	197	270	260	162	192	205	197
Vitamin E (mg)	—	—	—	4.4	3.7	5.0	5.5	4.9	4.9
Vitamin B_1 (mg)	1.23	2.16	2.04	1.88	1.72	1.41	1.46	1.37	1.39
Vitamin B_2 (mg)	0.74	1.06	0.80	0.73	0.68	0.69	0.70	0.72	0.70
Vitamin C (mg)	138	101	79	120	114	45	59	78	71

serum iron value was about the normal value of Japanese (109±27 μg/dl for the males and 95±22 μg/dl for the females) (13). However, as shown in Table 3, the amount of iron intake was lower than that of the nutrient requirement, 10 mg/day for 30–49-yearold males, and 12 mg/day for 18–29-yearold females (Japanese data) (15), in particular the mean iron intake of females was about half of the requirement. It indicated an insufficient nutrient intake although serum iron level was normal because of control by metabolic regulation. The serum BUN and CRE levels were also at the normal ranges of Japanese (BUN; 8–12 mg/dl for both sexes, CRE; 0.8–1.2 mg/dl for the males and 0.6–0.9 mg/dl for the females) (13). AST, a hepatic function index, was higher than that of the normal range for Japanese (5–25 U/L) (13). Similar results were obtained from the subjects in the Chitwan districts (36±16 U/L for the males and 29±10 U/L for the females) (Nepal) and a remote hilly village, area B (34±19 U/L for the males and 24±4 U/L for the females). ALT was within the normal ranges of the Japanese (ALT: 3–30 U/L) (13). However, ALT level for males was lower than those reported by Saxena and Shulman (Asian people; 37.1 U/L for males and 18.1 U/L for females, Hispanic; 42.8 U/L for males and 26.5 U/L for females, white and black males; 30.5–34.2 U/L) (16). Therefore, the normal ALT value may vary among countries and also with living conditions. Compared with the normal range of TC (150–230 mg/dl), the mean TC level was at the lower range of normal levels (13), whereas the mean value of TG was at the higher range of normal levels in this study. Similar findings of high TG levels have been reported previously for other people (132–165 mg/dl in a remote hilly village, 175 mg/dl for the males in the Itahari district, 98–134 mg/dl for both sexes in the Chitwan district) in Nepal (4, 17, 18) and 23 to 72-yearold males (126.0±0.9 mg/dl) in Korea (19). The large intake of cereals containing much carbohydrate may have contributed to the higher serum TG level because excess carbohydrate intake is converted to fat in the human body. There were reports that high-carbohydrate diets increased serum TG (20, 21). It indicates that the correlation between BF and serum TG ($r=0.421$, $p<0.01$ for the male and $r=0.329$, $p<0.05$ for the females) was observed. Another reason for the high TG level in Nepalese may be the low intake of lipids, especially polyunsaturated fatty acids. Replacing fats with carbohydrates increased the fasting TG serum level, whereas *n*-3 polyunsaturated fatty acids (PUFA) from fish oils decreased it (22, 23). Saturated fatty acids increased hypercholesterolemia, whereas *cis*-PUFA elicited the most potent hypocholesterolemic effect (24) and TC was not materially affected by *n*-3 PUFA (22). The mean amounts of PUFA of males and females in this study were 6.26±4.22 and 4.71±1.75 g/day, respectively, which was less than half of the nutrient intake for Japanese (about 17 g/day) calculated for the past decade by National Nutrition Survey. High-carbohydrate and low-fat and -protein diets in addition to poor eating habits may have caused the rather high serum TG of the subjects although no correlation was found between rice or energy and TC or TG. The high proportion of carbohydrate intake of all the nutrients for the Nepalese subjects might influence the metabolism pathway including that related to carbohydrates and TG as shown in Table 8. However, the results revealed no clear relationship between food and nutrient intake and serum biochemical parameters due to lack of food consumption and nutrient intake in general.

The results obtained in this study indicated that food consumption of the subjects was not enough compared to other people studied previously. The status of food consumption might be greatly influenced by food price and income in spite of the easier food availability in the city and also lack of knowledge about nutrients and health. The female subjects were in their twenties and in the child-bearing and nursing years (25, 26), making nutritional education particularly important for young females. A support system for improving their nutritional status is needed for this group.

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