Serum Nutritional Components and Dietary Food Intake of People Living in a Remote Hilly Village in Eastern Nepal

Yoshimi Ohno,¹ Kazuko Hirai,² Hisa Higuchi,³ Kazumi Sakai,² Kumiko Nagata,⁴ Toshihide Tamura,⁴ Chandra Kala Rai,⁵ and Shiba Kumar Rai⁶

¹Department of Food Science and Nutrition, School of Human Environmental Sciences, Mukogawa Women's University, 6–46, Ikebiraki, Nishinomiya 663–8558, Japan

²Department of Health and Nutrition, Graduate School of Human Life Science, Osaka City University, Osaka 558–8585, Japan

³Osaka Joshibigakuen Junior College, Osaka 543–0077, Japan

⁴Department of Bacteriology, Hyogo College of Medicine, Hyogo 663–8131, Japan

⁵National Institute of Tropical Medicine Public Health Research, Kathmandu, Nepal

⁶Department of Microbiology, Nepal Medical College, Kathmandu, Nepal

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Summary Serum nutritional components and food intake were examined in Nepalese (127 males and 163 females aged 4 to 72 years) living in a remote hilly village (area A and B, area A is located at a relatively lower altitude and is warmer) in the eastern region of Nepal. Mean values of height and weight for the groups covering ages 4 to 19 of both sexes and in both areas increased with age. The mean BMI value for each age group was mostly under 22, and the BMI correlated with age, and with systolic and diastolic blood pressure. The mean values of serum components were about the same levels in both sexes. Mean values of triglyceride (TG) of over 150 mg/dl were found in males 20–50 years old and in females over 50 years old in area A, and generally the mean values of TG of the subjects tended to be in the higher range of normal. The main foods consumed in both areas were rice, maize, potatoes, pulses, milk and dairy products, and vegetables, with a difference in the amounts consumed. Milk and dairy products were almost the sole food source of animal origin. The rather higher serum TG levels of the subjects may be due to large amounts of consumption of cereals containing a lot of carbohydrate, which transformed into lipids in the metabolic pathway. The present food intake study revealed that the amounts of food consumed were not adequate resulting in a latent and chronic deficiency of nutrients, especially such as calcium (Ca), iron (Fe), and fat-soluble vitamins. These results suggest that improvement of the nutritional status is needed in this people group.

Key Words: serum nutritional components, dietary food intake, body mass index, remote hilly area, Nepal

Introduction

Malnutrition is major public health problem in Nepal [1–6] and is aggravated by highly prevalent infectious disease [6]. In view of this situation, we

studied the health and sanitary status in Boya Village Development Committee (VDC), Bhojpur district, Nepal in 1996 and 1997, and suggested a great need for educational and promotional activities with regard to public health and sanitation [7]. Boya VDC is a typical hilly village in Nepal. The altitude ranges approximately from 1,500 to 2,500 m. It is located in Bhojpur district in eastern Nepal, a half-day walk west of the nearest airstrip at Tumlingtar in

* To whom correspondence should be addressed.
Tel: +81–0798–45–9869

Sankhuwasabha district and slightly more than a half-day walk from another airstrip at Taksar near the district headquarters. Boya VDC is devoid of basic developmental infrastructures including roads. People there live on a subsistence agriculture. In this paper, we report the nutritional components in serum and dietary food intake of people living in this remote hilly village located in eastern Nepal.

Subjects and Methods

The present study was conducted in Boya VDC located in northeastern part of Bhojpur district in eastern hilly region in Nepal in 1996 and 1997. In this study, we selected two areas, Taka Bhanjyang (area A) and Popangla (area B) in Boya VDC. The total population in area A and B was approximately 350 and 400, respectively. The subjects who participated in the serum nutritional study in 1996 were 73 males and 102 females in area A, and 54 males and 61 females in area B. Almost all of the subjects were engaged in agriculture and about 83% and 93% of the subjects in area A and B, respectively, were Hindu believers.

Height, weight and blood pressure (systolic and diastolic blood pressure) of the subjects were measured at the same time. Total protein (TP), albumin (Alb), urea nitrogen (BUN), uric acid (UA), triglyceride (TG), total cholesterol (TC), high-density lipoprotein-cholesterol (HDL-C), aspartate aminotransferase (AST) and alanine aminotransferase (ALT) in sera were measured using commercial clinical kits (TP, Alb, TG, TC, HDL-C: Daiichi Chem. Co., Tokyo; BUN: Wako Pure Chemicals Ltd., Osaka; UA, 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 ratio was calculated.

A dietary survey was carried out on 44 males and 48 females in area A and 43 males and 38 females in area B in 1996 and 1997. The survey was conducted by questionnaire on 24-h dietary recalling. The data were analyzed and nutrient intake was calculated from food tables of India and Japan. Foods not listed in the tables were substituted with similar items.

All results were expressed as the mean $\pm$ SD. Student's unpaired *t* test was used to establish the statistical significance of the differences. Two-way factorial analysis of variance (ANOVA) was used to assess the statistical significance of difference among two areas and 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). Four hypertriglyceremic females (over 400 mg TG/dl) aged 40–59 years were excluded from the statistical analysis.

Results and Discussion

Physical properties of the subjects

Table 1 shows the physical properties of the subjects. Mean values of height and weight for the age groups between 4 to 19 years in both sexes of both areas increased with age. The height of the 4 to 14 age groups of both sexes and areas was lower than that of the same age groups in Terai region of southern Nepal [4, 8]. This might be due to inadequate nutrition for proper growth in this district. The mean value of body mass index (BMI) of both sexes increased with age from the 4 to 9 age group to the 15 to 19 age group in both areas. The mean BMI values of both sexes over 20 years olds except for the 40 to 49 age group of males and the 30 to 39 age group of females in area A were lower than those for the corresponding sex of the same age group in area B. The lower BMI values in area A than those in area B might be explained by the difference in their daily activities between two areas (area A is located at relatively lower altitude and is warmer), but it was unclear. The mean BMI value, 23.2 ± 4.4 , of the 15 to 19 age group for females in area B was the highest in this study. The mean BMI value of each age group for almost all with a few exceptions in area B was under 22 which was considered the lowest morbidity of diseases in 30–59-year-old Japanese [9]. Also, as the mortality was lowest in rural Bangladeshi women 19 years of age, who had a BMI of 16.37 to 20.71 [10], the BMI values of the subjects in this study seemed not to be very low. The mean SBP and DBP for males in both areas, A and B, ranged from 84 ± 8 to 127 ± 9 and from 60 ± 9 to 81 ± 11 mmHg, respectively, whereas those for females ranged from 93 ± 10 to 128 ± 19 and from 57 ± 17 to 86 ± 13 mmHg, respectively. These values of SBP and DBP seemed to be lower than those reported for Nepalese earlier [4], for adults 30–65 years old [11], and rural Japanese 40 years of age or older [12]. The age-specific mean values of SBP and DBP increased with age (SBP, $r=0.436$ for males and $r=0.524$ for females; DBP, $r=0.470$ for males and $r=0.408$ for females, $p<0.001$ for all). The BMI correlated with age ($r=0.229$, $p<0.01$), SBP and DBP (SBP, $r=0.480$;

Table 1. Physical properties of Nepalese subjects aged 4–72 years.

Sex (age group)	Subjects (n)	Height (cm)	Weight (kg)	Body mass index (kg/m ²)	Blood pressure	
					SBP	DBP
					(mmHg)	
Area A						
Male						
4– 9	11	108±16	18.5±3.4	16.4±4.6	84±8*	62±6
10–14	16	124±12	26.3±6.4	17.0±2.8	98±9	68±5
15–19	8	147±16	40.0±11.0	18.2±3.0	106±11	72±5
20–29	10	161±5***,#	49.4±3.8	20.0±3.6	110±14 [#]	75±13
30–39	8	156±7*	48.8±4.1	20.2±2.0	114±16	81±11
40–49	6	159±6*	50.0±6.2*	20.0±2.6	120±21	80±6
50–59	7	155±14	44.0±5.1	18.5±2.7	109±19	77±11
60–72	7	164±6**	47.0±4.6*	17.6±2.4	117±13	80±8
Female						
4– 9	11	110±7	20.5±0.7	16.0±4.2	93±10	65±5
10–14	14	127±9	26.5±4.9	16.2±1.4	95±7	66±5
15–19	11	147±6	45.5±7.9	20.9±3.4	109±14	76±10
20–29	21	150±7	48.2±6.2	21.4±3.1	110±10	75±8
30–39	15	150±5	46.4±3.6	20.8±2.1	110±10	74±7
40–49	13	151±8	40.8±7.6	18.0±3.7 [#]	106±11	70±14
50–59	9	148±6	43.6±5.3	19.8±2.0	118±17	84±14
60–72	8	150±8	41.8±3.0	18.7±1.8 [#]	128±19	86±13
Area B						
Male						
4– 9	2	115±4	20.5±0.7	15.5±0.6	90±0	65±0
10–14	5	129±5	27.8±3.8	16.7±1.1	94±5	60±9
15–19	8	152±9	42.1±6.1	18.2±1.7*	113±7	72±12
20–29	6	156±4***	50.7±2.9	20.9±0.7	127±9	79±7
30–39	12	152±9	52.8±6.0**	22.9±3.4	118±12	76±10
40–49	7	161±9***	49.6±10.1	19.0±2.3	112±8	79±5**
50–59	8	152±8	47.6±7.1	20.5±2.6	111±15	77±10
60–72	6	158±8**	48.0±5.6	19.3±2.0	115±18	79±10
Female						
4– 9	4	105±10	17.8±2.6	16.2±1.7	95±11	57±17
10–14	5	124±9	26.8±3.4	17.3±1.8	93±4	59±13
15–19	4	142±9	46.5±10.3	23.2±4.4	108±14	70±8
20–29	7	146±4	48.0±5.7	22.5±1.6	112±15	72±6
30–39	10	147±5	44.1±5.0	20.3±2.3	109±13	71±11
40–49	17	148±7	45.8±7.1	20.9±2.8	111±10	71±11
50–59	8	145±8	45.5±5.1	21.5±1.4	117±12	78±12
60–72	6	145±3	44.0±4.0	21.0±1.7	122±19	81±14

SBP, systolic blood pressure; DBP, diastolic blood pressure. * $p<0.05$, ** $p<0.01$, *** $p<0.001$ (vs. female, same age group in A or B). # $p<0.05$ (vs. same sex, same age group in B).

DBP, $r=0.431$, $p<0.001$, respectively). Among rural Japanese, a positive association between BMI and mean blood pressure was reported [12]. Present study also showed an association between BMI and blood pressure. However, the cross-sectional study reported that an association between over weight and hypertension differed among ethnic groups studied, and was independent of age [12].

Serum nutritional components and relationship among them

Serum TP, BUN and UA are shown in Table 2. In general no differences were observed in the values of these components between the sexes or areas except for UA. The mean values of TP and Alb of the subjects in each age group in both areas were within the ranges considered normal for Japanese (TP, 6.5–7.9 g/dl, Alb, 4.0–5.0 g/dl for combined sexes) [13].

Table 2. Serum protein, albumin (Alb), globulin (Glb), Alb/Glb ratio, urea nitrogen and uric acid levels of Nepalese subjects aged 4-72 years.

Sex (age group)	Subjects (n)	Total protein (g/dl)	Albumin (Alb) (g/dl)	Globulin (Glb) (g/dl)	Alb/Glb ratio	Urea nitrogen (mg/dl)	Uric acid (mg/dl)
Area A							
Male							
4- 9	11	7.4±0.3**	4.2±0.3	3.2±0.3	1.3±0.2	8.2±1.7	3.7±0.9
10-14	16	7.4±0.5	4.3±0.1	3.1±0.5	1.4±0.2	10.6±4.2	3.7±1.1
15-19	8	7.4±0.3*	4.3±0.2	3.0±0.2*	1.4±0.1	11.4±3.5	5.0±0.9*
20-29	10	7.5±0.5	4.4±0.4	3.2±0.4	1.4±0.3	8.7±3.7	4.7±1.3
30-39	8	7.6±0.5	4.3±0.5	3.3±0.5#	1.3±0.3	10.7±1.7*	4.9±1.1***
40-49	6	7.0±0.7	3.9±0.2	3.1±0.6	1.3±0.3	11.2±2.6	4.8±1.0
50-59	7	7.3±0.6	4.1±0.4	3.2±0.6	1.4±0.4	8.7±2.2	5.2±1.1*
60-72	7	7.3±0.3	4.0±0.3	3.3±0.3	1.2±0.2	8.9±3.5	5.5±1.0*
Female							
4- 9	11	7.1±0.2	4.1±0.2	3.0±0.2	1.4±0.2	8.4±2.4	3.6±0.5
10-14	14	7.7±0.7	4.3±0.3	3.4±0.9	1.3±0.3	8.7±1.6	4.3±0.9
15-19	11	7.8±0.4	4.5±0.2	3.3±0.3	1.4±0.1	8.7±2.8	3.9±0.9
20-29	21	7.2±0.6	4.1±0.5	3.1±0.3	1.3±0.3	9.7±3.2	4.2±1.1
30-39	15	7.3±0.5	4.1±0.4	3.1±0.4	1.4±0.3	8.3±2.5	3.5±0.5##
40-49	12	7.3±0.5	4.1±0.3	3.2±0.4	1.3±0.2	9.6±2.4	3.8±1.1
50-59	8	7.4±0.6	4.1±0.5	3.3±0.2	1.2±0.1#	9.8±3.8	3.9±0.7
60-72	8	7.5±0.4	4.3±0.3	3.2±0.3	1.3±0.2	9.8±2.7	4.3±0.8#
Area B							
Male							
4- 9	2	7.0±0.3	4.2±0.1	2.8±0.1	1.5±0.03	11.5±4.2	5.0±1.3
10-14	5	7.2±0.3	4.3±0.2	2.9±0.4	1.5±0.3	11.1±3.3	3.3±0.7
15-19	8	7.4±0.4	4.4±0.4	3.0±0.4	1.5±0.3	9.9±3.1	4.9±1.5
20-29	6	8.0±0.4*	4.7±0.3*	3.3±0.3	1.4±0.2	10.3±4.1	5.6±0.9*
30-39	12	7.3±0.4	4.4±0.4	2.9±0.3	1.5±0.5	11.0±3.3	5.8±1.0**
40-49	7	7.3±0.3	4.0±0.5	3.2±0.6	1.3±0.3	12.6±3.2	5.5±1.2
50-59	8	7.6±0.4	4.4±0.4	3.2±0.3	1.4±0.2	9.3±4.3	6.0±0.7**
60-72	6	7.4±0.3	4.3±0.4	3.1±3.2	1.4±0.2	11.0±3.1	5.4±1.2
Female							
4- 9	4	7.4±0.4	4.4±0.2	3.0±0.5	1.5±0.2	10.8±3.0	3.9±0.6
10-14	5	7.1±0.3	4.4±0.1	2.7±0.3	1.7±0.2	10.2±2.2	3.8±0.6
15-19	4	7.9±0.4	4.6±0.1	3.3±0.4	1.4±0.2	12.5±4.5	5.3±1.8
20-29	7	7.3±0.4	4.3±0.3	3.0±0.3	1.4±0.2	12.5±3.8	4.3±0.7
30-39	10	7.3±0.4	4.4±0.3	2.9±0.2	1.5±0.1	9.4±2.7	4.5±1.2
40-49	17	7.4±0.3	4.2±0.3	3.1±0.4	1.4±0.2	11.1±6.0	4.1±0.9
50-59	6	7.5±0.2	4.4±0.2	3.1±0.3	1.4±0.2	10.1±3.4	4.4±0.8
60-72	6	7.6±0.3	4.4±0.3	3.2±0.3	1.4±0.2	9.9±3.8	5.4±1.1

* $p<0.05$, ** $p<0.01$, *** $p<0.001$ (vs. female, same age group in A or B). # $p<0.05$, ## $p<0.01$ (vs. same sex, same age group in B).

The TP level of the subjects in this study was about the same as that for the residents in Itahari district, Terai region [8], but to be lower than that of people in an agricultural Chitwan district, Terai region, Nepal [14]. The BUN and UA levels were within the ranges normal for Japanese (BUN, 8–20 mg/dl, for both sexes; UA, 4.0–7.5 mg/dl for males, 3.0–6.5 for females) [13]. The mean UA value of males tended to be higher than that of females as the normal range

was higher for males than for females. UA level of females in area A was lower than that of females in area B (age groups of 30–39 and 60–72 years, $p<0.01$ and $p<0.05$, respectively).

Table 3 shows the serum lipid and transferase levels of the subjects. The mean value, 132 ± 55 mg/dl of TG for males in the 4–9 age group in area A was high compared with that of any of the other same age groups because 2 subjects had TG value, over

Table 3. Serum lipid and aminotransferase levels of Nepalese subjects aged 4–72 years.

Sex (age group)	Subjects (n)	Triglyceride (mg/dl)	Total cholesterol (mg/dl)	HDL-cholesterol (mg/dl)	AST (U/liter)	ALT (U/liter)
Area A						
Male						
4–9	11	132±55*	111±19	31±7 [#]	30±16	15±5
10–14	16	90±39	127±27	36±7	27±10	14±5
15–19	8	118±26	128±33	36±6	21±2	11±3
20–29	10	154±66	122±25	35±10 ^{##}	28±11	14±9
30–39	8	165±75	136±32	40±13 [#]	27±9	17±12
40–49	6	151±66	126±29	39±16	23±7	16±7
50–59	7	124±77	128±22 ^{**}	37±10 [#]	22±5	12±5
60–72	7	117±63	129±34	36±11	22±7	14±8
Female						
4–9	11	91±29	108±18	30±9	29±9	15±8
10–14	14	109±47	122±14	33±7	27±9	14±5
15–19	11	115±47	135±21	38±5	25±10	16±8
20–29	21	120±60	142±34	39±9	22±7	15±6
30–39	15	132±52	139±28	39±7 [#]	26±17	15±6
40–49	12	113±35	137±25	37±9	20±5	13±5
50–59	8	155±75	169±21	40±2	27±15	14±7
60–72	8	160±93	149±31	37±4	19±2 ^{##}	11±3
Area B						
Male						
4–9	2	54±15	138±1*	46±1	24±2	20±7
10–14	5	91±32	131±29	34±4*	22±2	16±6
15–19	8	100±58	116±20	40±9	28±7	15±4
20–29	6	106±45	143±22	52±6	33±11	18±5
30–39	12	117±54	152±33	53±10	34±19	22±15
40–49	7	137±64	138±20	40±10	23±5	15±3
50–59	8	114±48	157±33	55±13	46±27	19±8
60–72	6	121±66	148±15	42±5*	25±9	13±5
Female						
4–9	4	75±17	97±10	36±6	22±2	12±5
10–14	5	99±63	117±28	43±7	24±5	14±4
15–19	4	133±14	145±35	39±12	21±4	13±3
20–29	7	148±92	142±31	40±9	24±4	15±4
30–39	10	121±94	129±22	47±11	23±4	17±8
40–49	17	122±56	141±30	44±12	27±18	17±11
50–59	6	145±64	152±11	51±14	24±8	13±6
60–72	6	135±46	160±37	52±9	30±9	15±13

AST, aspartate aminotransferase; ALT, alanine aminotransferase; HDL, high density lipoprotein. $p<0.05$, $^{**}p<0.01$ (*vs.* female, same age group in A or B). $^{#}p<0.05$, $^{##}p<0.01$ (*vs.* same sex, same age group in B).

200 mg/dl. The normal range of TG was considered 80–150 mg/dl for males and 70–130 mg/dl for females [13]. The mean value of TG over 150 mg/dl was found in the subjects of 20–49 age groups of males and over 50 years old females in area A, and generally the mean values of TG of the subjects tended to be at the higher ranges of the normal. Similar findings have been observed in elsewhere in Nepal [8]. Lim and Heo reported the TG level of 126.0 ± 0.9 mg/dl in Korean males aged 23 to 72

years [15]. Compared with the normal range of TC (150–230 mg/dl), the mean TC levels were at the lower ranges of normal ranges and the levels of TC were almost the same as TG levels in this study. The mean HDL-C levels in area A tended to be lower than those in area B, especially the values of females except those in the 50 to 59 age group were lower than normal ranges (35–50 mg/dl and 40–60 mg/dl as normal ranges for male and for female, respectively) [13]. Judging from the values of TC, the pro-

Table 4. Correlations among all parameters in sera measured for Nepalese subjects aged 4–72 years.

Parameter	Age	TP	Alb	Glb	A/G ratio	BUN	UA	TG	TC	HDL-C	AST	ALT
Age		-0.04	-0.16	0.10	-0.14	0.00	0.46***	0.12	0.27**	0.25**	0.03	0.02
TP	0.03		0.52***	0.63***	-0.25**	0.01	0.25**	0.01	0.12	0.09	0.11	-0.03
Alb	-0.05	0.52***		-0.33***	0.68***	0.05	0.08	0.07	0.21*	0.25**	0.15	0.03
Glb	0.08	0.72***	-0.23**		-0.90***	-0.03	0.21*	-0.05	-0.06	-0.12	-0.02	-0.06
A/G ratio	-0.12	-0.26***	0.66***	-0.83***		0.03	-0.15	0.07	0.14	0.21*	0.09	0.07
BUN	0.07	0.16*	0.20*	0.02	0.08		0.07	-0.20*	0.03	0.02	-0.19*	0.02
UA	0.13	0.35***	0.18*	0.25**	-0.06	0.06		0.07	0.20*	0.34***	0.20*	0.16
TG	0.24**	0.12	-0.02	0.15	-0.16*	0.05	0.10		0.33***	0.03	0.08	0.17
TC	0.41***	0.03	-0.09	0.11	-0.15	-0.02	0.11	0.46***		0.55***	0.16	0.18
HDL-C	0.35***	0.00	0.20*	-0.17*	0.22**	0.00	0.17*	-0.02	0.46***		0.31***	0.28**
AST	-0.06	0.14	0.13	0.05	0.04	0.18*	0.09	0.07	0.10	0.06		0.72***
ALT	-0.04	0.07	0.20*	-0.09	0.17*	0.34***	0.01	0.05	0.01	0.09	0.61***	

Upper right, male ($n=127$); lower left, female ($n=159$). * $p<0.05$, ** $p<0.01$, *** $p<0.001$. TP, total protein; Alb, albumin; Glb, globulin; BUN, urea nitrogen; UA, uric acid; TG, triglyceride; TC, total cholesterol; HDL-C, high density lipoprotein cholesterol; AST, aspartate aminotransferase; ALT, alanine aminotransferase.

portion of HDL-C was rather higher than that of above normal ranges of TC and HDL-C.

AST was within the normal range or rather higher than it (AST, 5–25 U/liter for both sexes) in this study. ALT was within the normal range (ALT, 3–30 U/liter for both sexes) for both sexes and in both the areas and was almost the same as that of residents in Chitwan district, Terai region, Nepal [16]. The ALT level for males, however, was lower than that reported by Saxena and Shulman (37.1 U/liter for Asian males and 18.1 U/liter for Asian females) [17].

Table 4 shows the correlation coefficients for the serum parameters examined. TP, Alb and Glb showed correlations with each other for both sexes. There was significant positive correlation between age and UA ($r=0.46$, $p<0.001$), TC ($r=0.27$, $p<0.01$) and HDL-C ($r=0.25$, $p<0.01$) for males, and TG ($r=0.24$, $p<0.01$), TC ($r=0.41$, $p<0.001$) and HDL-C ($r=0.35$, $p<0.001$) for females. BUN correlated negatively with AST in males ($r=-0.19$, $p<0.05$), while positively with that in females ($r=0.18$, $p<0.05$). UA was related with protein metabolism and showed the correlation with age in only males.

Food consumption and nutrient intake among the subjects

It is well known that blood profiles indicate the nutritional status of people. Therefore, the food consumption of some of the subjects was examined (Table 5). The food consumption was greatly influ-

enced by food availability and food habits. The main foods consumed were rice, maize, potatoes, pulses, milk and dairy products and vegetables in both areas with no difference in food item consumption. However, the amounts of food consumed in area A differed from area B. The total amount of cereals consumed in area A was higher (about 400 g/day) than that in area B (about 370 g/day). Among cereals, people in area A consumed rice more than those in area B, whereas maize consumption was higher in area B. People in area A consumed more oils than those in area B, and *vice versa* for potatoes. In the upper part of area B, potato is one of the major crops. Males in both areas consumed significantly more alcoholic beverages ("jhand", like beer and distilled jhand, "raksi") than females, and females consumed more other vegetables and tea than males.

Rice consumption correlated significantly with that of maize ($r=-0.408$, $p<0.001$) or colored vegetables ($r=0.170$, $p<0.05$). Maize correlated with pulses ($r=0.218$, $p<0.01$), and potatoes did with fats ($r=0.173$, $p<0.05$) and with pulses ($r=-0.165$, $p<0.05$). Alcoholic beverages correlated negatively with tea ($r=-0.316$, $p<0.001$) and milk and dairy products ($r=-0.200$, $p<0.01$). These results indicate that the main food for subjects was rice or maize, and that most people consumed rice with vegetables or maize with pulses. Generally, people drink water during meals, however, males drank more alcoholic beverages than females and most females drank more tea or milk in this study.

Table 6 shows the nutrient composition of the

Table 5. Average daily consumption of various food groups by subjects living in Boya village, Bhojpur district, Nepal.

Food group (g/day)	Area A		Area B		Statistical analysis (Total)
	Male (n=44)	Female (n=48)	Male (n=43)	Female (n=38)	
Cereals: Rice	294±111 [#]	294±103 [#]	243±95	250±95	$p<0.01$, A:B
Maize	98±100	116±98	128±79	105±89	
Other	6±24	5±20	8±30	19±46	
Potatoes	77±76 ^{###}	97±73 [#]	154±110	136±95	$p<0.001$, A:B
Fats and oils: Fats	1.1±1.8	1.3±2.0	1.2±1.3 [*]	1.9±1.8	
Oils	2.3±1.8 [#]	2.2±2.2	1.5±1.5	1.5±2.3	$p<0.05$, A:B
Pulses	29±28 [#]	27±28	17±19	25±21	
Meats	24±40	11±34	31±57	24±52	
Fish	5±17	2±8	1±9	0	
Milk and dairy products	144±186	132±199	131±202	150±207	
Vegetables: Colored	34±38	44±35	43±35	48±51	
Other	33±39 ^{**#}	59±55	49±29	50±42	$p<0.05$, sex
Alcoholic beverages ^{a)}	409±422 [*]	261±285	414±329 [*]	242±264	$p<0.01$, sex
Tea	42±61	59±77	47±69	82±96	$p<0.05$, sex

^{a)} "jhand", like beer and "raksi", distilled "jhand", like whisky. ^{*} $p<0.01$, ^{**} $p<0.01$ (vs. female, same area). [#] $p<0.05$, ^{##} $p<0.01$, ^{###} $p<0.001$ (vs. same sex in B).

Table 6. Daily average intake of nutrients by subjects living in Boya village, Bhojpur district, Nepal.

Nutrient	Area A		Area B		Statistical analysis (Total)
	Male (n=44)	Female (n=48)	Male (n=43)	Female (n=38)	
Energy (kcal)	1,915±500	1,945±328	1,887±378	1,842±387	
Protein (g)	49.3±18.3	49.3±14.3	48.4±14.9	47.4±13.7	
Fat (g)	19.8±8.3	21.7±12.8	20.2±11.4	23.7±15.2	
Carbohydrate (g)	350.1±101.8	364.9±60.8	340.9±78.6	334.9±73.7	
Dietary fiber (g)	28.5±10.9	21.4±10.6	21.1±8.4	20.0±9.7	
Calcium (mg)	263±213	287±238	265±216	297±238	
Phosphorus (mg)	1,201±415	1,230±325	1,204±332	1,141±317	
Iron (mg)	9.0±3.5	9.5±3.0	8.7±2.3	8.8±2.6	
Potassium (mg)	2,062±807	2,243±786	2,310±701	2,250±669	
Vitamin A (µgRE)	162±126	192±141	205±114	197±139	
Vitamin E (mg)	5.0±2.3	5.5±1.9	4.9±1.6	4.9±1.9	
Vitamin B ₁ (mg)	1.41±0.47	1.46±0.35	1.37±0.32	1.39±0.34	
Vitamin B ₂ (mg)	0.69±0.36	0.70±0.35	0.72±0.35	0.70±0.35	
Niacin (mg)	13.9±4.1	12.5±3.1	14.9±4.6 ^{**}	12.5±3.4	$p<0.01$, sex $p<0.001$, A:B ($p<0.05$, A:B, sex)
Vitamin C (mg)	45±29 ^{*###}	59±30	78±39	71±39	

^{*} $p<0.01$, ^{**} $p<0.01$ (vs. female, same area). ^{###} $p<0.001$ (vs. same sex in B).

food consumed. There were not many differences about the nutrient intake between the two areas although the amounts of food items consumed were different between the two areas. The small amount of vitamin C intake by males in area A seemed to be due to less consumption of potatoes and vegetables. Males in area B received more niacin due to the intake of maize and meats that they consumed more than other groups. The relationships between food intake and nutrients are indicated in Table 7. Rice and maize correlated positively with energy ($r=0.443$ and $r=0.446$, respectively, $p<0.001$) and

carbohydrate ($r=0.555$ and $r=0.435$, respectively, $p<0.001$). The large intake of cereal containing much carbohydrate might have contributed to higher serum TG level. Serum TG level of the subjects became higher because the excess intake of carbohydrate was transformed into lipids in the metabolic pathway. Another reason for the high TG level in Nepalese may be due to the low intake of lipids, especially polyunsaturated fatty acids that normally inhibit the synthesis of TG *in situ* in the cell. Replacing fats with carbohydrates increased the fasting TG serum level, whereas *n-3* polyunsaturated

Table 7. Correlations among food consumption and nutrient intake.

Nutrient	Rice	Maize	Potatoes	Pulse	Meats	Milk and dairy products	Colored vegetables	Other vegetables	Alcoholic beverages	Tea
Energy	0.44***	0.45***	-0.02	0.25***	-0.01	0.17*	0.17*	0.12	0.21*	-0.14
Protein	0.06	0.37***	-0.07	0.57***	0.33***	0.53***	0.02	0.09	-0.03	-0.01
Fat	-0.07	0.23**	-0.08	0.33***	0.49***	0.13	-0.13	0.01	-0.05	0.04
Carbohydrate	0.56***	0.44***	0.04	0.12	-0.26***	0.12	0.24**	0.12	—	-0.09
Calcium	0.01	0.05	0.05	0.31***	-0.04	0.93***	0.23**	0.18*	-0.13	0.13
Iron	0.07	0.57***	-0.08	0.72***	-0.07	0.18*	0.11	0.19*	-0.04	0.01
Vitamin A	0.07	0.13	-0.04	-0.04	-0.15*	0.27***	0.71***	0.14	-0.08	0.14
Vitamin E	-0.06	0.72***	-0.18*	0.49***	-0.25***	0.05	0.26***	0.20**	-0.01	0.01
Vitamin B ₁	0.20**	0.57***	0.06	0.56***	-0.15*	0.30***	0.13	0.17*	-0.10	0.02
Vitamin B ₂	-0.08	0.23**	0.05	0.35***	0.13	0.87***	0.15*	0.17*	0.01	0.07
Niacin	0.05	0.27***	0.14	0.09	0.46***	—	0.06	0.02	0.66***	-0.23**
Vitamin C	-0.05	0.05	0.84***	-0.14	-0.17**	0.22**	0.39***	0.19*	-0.07	0.15*
Dietary fiber	-0.31***	0.89***	0.04	0.51***	-0.26***	0.05	0.11	0.26***	-0.03	-0.02

p*<0.05, *p*<0.01, ****p*<0.001 (*n*=173).

Table 8. Correlations among food groups and serum components.

Food group	TP	Alb	Glb	A/G ratio	BUN	UA	TG	TC	HDL- C	AST	ALT
Cereals: Rice	0.27**	-0.12	0.41***	-0.35***	-0.10	-0.09	—	-0.09	-0.14	-0.17	-0.18
Maize	-0.17	-0.06	-0.14	0.06	-0.01	-0.02	-0.27**	-0.09	-0.01	-0.08	0.02
Other	-0.01	0.01	-0.01	0.01	0.06	0.10	0.01	-0.10	-0.05	-0.09	0.06
Potatoes	0.18	0.10	0.10	0.01	0.04	-0.10	0.08	-0.06	-0.20	-0.03	-0.01
Pulses	-0.15	-0.11	-0.06	—	0.16	-0.17	-0.08	-0.14	-0.18	—	0.12
Meats	-0.03	0.01	-0.05	0.07	0.24*	0.11	0.37***	0.18	0.24*	0.11	0.19
Fish	-0.13	0.09	-0.22*	0.21*	-0.03	-0.02	0.01	0.06	-0.03	-0.03	-0.07
Milk and dairy products	-0.07	-0.03	-0.04	0.07	0.19	-0.17	0.20*	0.05	-0.06	0.08	0.19
Vegetables: Colored	0.21*	0.01	0.23*	-0.19	-0.04	-0.01	-0.12	0.13	-0.04	0.01	-0.18
Other	0.08	-0.03	0.11	-0.09	0.01	-0.08	0.17	0.16	0.05	-0.09	-0.06
Alcoholic beverages	0.10	0.02	0.09	-0.05	-0.24*	0.22*	0.07	0.14	0.24*	0.18	0.09
Tea	0.04	0.12	-0.08	0.12	-0.12	-0.19	-0.07	0.10	-0.06	0.02	-0.06

p*<0.05, *p*<0.01, ****p*<0.001 (*n*=101).

fatty acids (PUFA) from fish oils decreased it [18, 19]. High-carbohydrate diets increased serum TG [20, 21]. Saturated fatty acids increased hypercholesterolemia, whereas *cis*-PUFA elicited the most potent hypocholesterolemic effect [22] and TC was not materially affected by *n*-3 PUFA [18]. The mean amount of PUFA of the subjects in this study was 7.23±4.11 g/day, which was about a half amount of Japanese [23]. High-carbohydrate and low-fat and -protein diets plus poor eating habits may have caused the rather high serum TG of the subjects. Meats contain protein, minerals and vitamins and are important food as one of protein source, but the amount of meat intake was very low, the same as in other districts reported previously [4, 24]. Consumption of alcoholic beverages correlated with energy (*r*=0.206, *p*<0.01) and niacin (*r*=0.657, *p*<0.001).

Relationship between food intake and serum biochemical components

The relationship between food intake and serum components was examined. As shown in Table 8, rice (*r*=0.267, *p*<0.01) and colored vegetables (*r*=0.213, *p*<0.05) correlated positively with TP. Meats correlated positively with BUN (*r*=0.243, *p*<0.05), TG (*r*=0.367, *p*<0.001) and HDL-C (*r*=0.240, *p*<0.005); milk and dairy products with TG (*r*=0.196, *p*<0.05), alcoholic beverages with BUN (*r*=-0.237, *p*<0.05), UA (*r*=0.215, *p*<0.05), and HDL-C (*r*=0.244, *p*<0.05). Serum Glb correlated positively with rice (*r*=0.414, *p*<0.001), colored vegetables (*r*=0.228, *p*<0.05) and negatively with fish (*r*=-0.223, *p*<0.05).

Most of food groups and nutrients did not indicate any direct and clear association with serum components. It is well known that the UA value

increases with the intakes of high-protein food such as meats, eggs, milk and dairy products, and alcoholic beverages. Total amounts of meats and fish consumed were very low in this study. Milk and dairy products were almost the sole food source of animal origin. These results indicated that relationships concerning BUN and UA for males were related to the more amounts of consumption of meats, pulses and alcoholic beverages by them than females. The difference between sexes or areas as shown in Table 4 can not be explained from the differences in the amount of food group consumption. The insufficient amount of food taken by the people resulted in a latent and chronic deficiency of nutrients, especially such as calcium (Ca), iron (Fe), fat-soluble vitamins such as vitamins A and E. Murray-Kolb *et al.* reported that soybeans appear to be a good source of nutritional iron in marginally iron-deficient individuals [25]. Nepalese use many kinds of pulses (beans, peas, lentils) as soups [26] and among pulses, black gram contains about 15 mg/100 g of Fe [5]. Therefore, to improve the nutritional status, Nepalese people should be encouraged to consume more pulses (thicker soups), sufficient amount of food of animal origin, and some of nutrient supplements. Further, there is a need to support these people to consume more qualified foods and to provide educational programs so as to create more awareness among the people as to improve about food intake and nutrition, and increase their knowledge in these areas.

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References

- [1] Chen, L.C., Chowdhury, A.K.M.A., and Huffman, S.A.: Anthropometric assessment of energy-protein malnutrition and subsequent risk of mortality among preschool aged children. *Am. J. Clin. Nutr.*, **33**, 1836–1845, 1980.
- [2] Ramalingaswami, V.: New global perspectives on overcoming malnutrition. *Am. J. Clin. Nutr.*, **61**, 259–263, 1995.
- [3] Forman, M.R., Hundt, G.L., Berendes, H.W., Abu-Saad, K., Zangwill, L., Chang, D., Bellmaker, I., Abu-Saad, I., and Graubard, B.: Undernutrition among Bedouin Arab children: a follow-up of the Bedouin infant feeding study. *Am. J. Clin. Nutr.*, **61**, 495–500, 1995.
- [4] Ohno, Y., Hirai, K., Sato, N., Ito, M., Yamamoto, T., Tamura, T., and Shrestha, M.P.: Food consumption pattern and nutrient intake among Nepalese living in the southern rural Terai region. *Asia Pacific J. Clin. Nutr.*, **6**, 251–255, 1997.
- [5] Ohno, Y., Hirai, K., Nagata, K., Tamura, T., Rai, S.K., Onta, S., Devkota, M., and Shrestha, M.P.: Evaluation of the iron status in Nepalese living in southern Nepal. *Nutr. Res.*, **18**, 1847–1855, 1998.
- [6] Rai, S.K., Hirai, K., Abe, A., and Ohno, Y.: Infectious diseases and malnutrition status in Nepal: an overview. *Mal. J. Nutr.*, **8**, 191–200, 2002.
- [7] Rai, S.K., Hirai, K., Ohno, Y., and Matsumura, T.: Village health and sanitary profile from eastern hilly region, Nepal. *Kobe J. Med. Sci.*, **43**, 121–133, 1997.
- [8] Hirai, K., Okuno, Y., Nagata, K., Tamura, T., Ohno, Y., Nakayama, J., Rai, S.K., Sakya, H.N., and Shrestha, M.P.: Nutritional survey on the serum status of lipid, protein, and calcium levels in Nepalese. *J. Clin. Biochem. Nutr.*, **9**, 205–213, 1990.
- [9] Tokunaga, K., Matsuzawa, Y., Kotani, K., Keno, Y., Kobatake, T., Fujioka, S., and Tarui, S.: Ideal body weight estimated from the body mass index with the lowest morbidity. *Int. J. Obes.*, **15**, 1–5, 1991.
- [10] Hosegood, V. and Campbell, O.M.R.: Body mass index, height, weight, arm circumference, and mortality in rural Bangladeshi women: a 19-y longitudinal study. *Am. J. Clin. Nutr.*, **77**, 341–347, 2003.
- [11] Bell, A.C., Adair, L.S., and Popkin, B.M.: Ethnic differences in the association between body mass index and hypertension. *Am. J. Epidemiol.*, **155**, 346–353, 2002.
- [12] Jiang, J., Kitano, T., Shono, M., Wakamiya, J., and Futatsuka, M.: Serial study on the association between body mass index and hypertension in rural Japanese. *Environ. Health Preventive Med.*, **8**, 90–94, 2003.
- [13] Shiina, S., Hosoya, K., and Kamei, S.: The serum parameters and their pathology for patient care and dietary guidelines, ed. by Shiina, S., Ishiyaku Publishing Co., Tokyo, pp.47–49 (TP and Alb), p.38 (BUN), p.43 (UA), p.26 (TG), p.25 (HDL-C), 1996 (in Japanese).
- [14] Ohno, Y., Hirai, K., Nagata, K., Tamura, T., and Shrestha, M.P.: Serum mineral levels among Nepalese living in the southern agricultural Terai region. *Environ. Health Preventive Med.*, **5**, 1–5, 2000.

- [15] Lim, H.S. and Heo, Y.R.: Plasma total homocysteine, folate, and vitamin B₁₂ status in Korean adults. *J. Nutr. Sci. Vitaminol.*, **48**, 290–297, 2002.
- [16] Ohno, Y., Shibata, H., Hirai, K., Nakanishi, M., Nagata, K., Tamura, K., Rai, S.K., and Shrestha, M.P.: Study on physical and serum parameters in inhabitants living in agricultural Terai region, Nepal. *Nepal Med. College J.*, **5**, 1–5, 2003.
- [17] Saxena, S. and Shulman, I.A.: The impact of screening a heterogeneous donor population for alanine aminotransferase and hepatitis B core antibody. *Am. J. Clin. Pathol.*, **93**, 533–537, 1990.
- [18] Harris, W.S.: n-3 Fatty acids and serum lipoproteins: human studies. *Am. J. Clin. Nutr.*, **65** (Suppl.), 1645S–1654S, 1997.
- [19] Mensink, R.P., Zock, P.L., Kester, A.D.M., and Katan, M.B.: Effects of dietary fatty acids and carbohydrates on the ratio of serum total to HDL cholesterol and on serum lipids and apolipoproteins: a meta-analysis of 60 controlled trials. *Am. J. Clin. Nutr.*, **77**, 1146–1155, 1997.
- [20] Parks, E.J.: Dietary carbohydrate's effects on lipogenesis and the relationship of lipogenesis to blood insulin and glucose concentration. *Br. J. Nutr.*, **87** (Suppl. 2), S247–S253, 2002.
- [21] Treuth, M.S., Sunehag, A.L., Trautwein, L.M., Bier, D.M., Haymond, M.W., and Butte, N.: Metabolic adaptation to high-fat and high-carbohydrate diets in children and adolescents. *Am. J. Clin. Nutr.*, **77**, 479–489, 2003.
- [22] Kris-Etherton, P.M. and Yu, S.: Individual fatty acids on plasma lipids and lipoproteins: human studies. *Am. J. Clin. Nutr.*, **65** (Suppl.), 1628S–1644S, 1997.
- [23] Section of Nutrition, Bureau of Public Health Ministry of Health and Welfare: National Nutrition Survey, Daiichi Publishing Co., Tokyo, 2002.
- [24] Hirai, K., Nakayama, J., Sonoda, M., Ohno, Y., Okuno, Y., Nagata, K., Tamura, T., Sakya, H.N., and Shrestha, M.P.: Food consumption and nutrient intake and their relationship among Nepalese. *Nutr. Res.*, **13**, 987–994, 1993.
- [25] Murray-Kolb, L.E., Welch, R., Theil, E., and Beard, J.L.: Women with low iron stores absorb iron from soybeans. *Am. J. Clin. Nutr.*, **77**, 180–184, 2003.
- [26] Majupuria, I.: Joys of Nepalese Cooking. Craftsman Press, Bangkok, 1989.