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ORIGINAL ARTICLE

Gender differences in dietary intake among adults of Hindu communities in lowland Nepal: assessment of portion sizes and food consumption frequencies

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Objective: To elucidate gender differences in dietary intake among adults in lowland Nepalese communities.
Subjects and methods: For 122 male and 195 female subjects aged 20 years and over from 94 randomly selected households, interviews using a 19-item food frequency questionnaire were conducted. To determine the portion sizes of these foods, the samples consumed by 56 subjects in a full 1-day period were weighed. Energy expenditure was estimated by time spent on daily activities.
Results: Gender differences in per-day energy and protein intakes were related to sex differences in body size and energy expenditure. Apparent gender differences in the crude intakes disappeared when they were expressed by nutrient density (mg or μg/MJ) since micronutrient intakes were significantly correlated with energy intake. However, males' iron intake was larger even after adjustment for energy intake, attributing to their larger portion sizes of commonly consumed staple foods and higher frequencies of consuming luxury foods (fish and tea).
Conclusion: The intrahousehold unequal distribution of food incurs risk of iron deficiency among female subjects.
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Keywords: gender difference; lowland Nepal; food frequency questionnaire; weighed food record; intrahousehold food allocation; micronutrient intake

Introduction

High maternal mortality and infant mortality have still been serious public health problems in the developing world. In the low-lying plains of Nepal, called 'Terai,' mortality related to pregnancy was as high as 704 deaths per 100 000 live births (West *et al*., 1999), being 100 times higher than that of Japan, that is, 7.3 in 2002 (Health and Welfare Statistics Association, 2004). The 24-week infant mortality rate in this area was 70.8 per 1000 live births (Katz *et al*., 2000), more than 10 times higher than that in the developed world. Katz *et al*. (2003) pointed out that maternal undernutrition during pregnancy was strongly associated with infant mortality and Christian *et al*. (2004) revealed potential effects of intervention by means of supplementation of micronutrients on improvement of maternal and infant health and survival. Nutritional status of women is worse in the Terai than in other areas of Nepal. According to the governmental statistics, the mean body mass index (BMI: (body weight (kg))/(stature (m)^2)) of women aged 15–49 years in the Terai was 19.1, being lower than 20.5 in the hills

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Contributors: NS was responsible for the nutritional studies in the field, data analysis and preparation of the manuscript with RO. MS collaborated in collection of food records, FFQ and anthropometric measurements and computation of food and nutrient intakes. MM was responsible for field studies from the beginning of the project and liaised with the local health workers. RO organized the study as the chief investigator and was responsible for time allocation study.
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and 20.4 in the mountain area; percentage of women with chronic energy deficiency (CED; BMI < 18.5 kg/m^2) was 40.7% in the Terai but 16.5% in the hills and 13.6% in the mountain area (Ministry of Health, 1997). Furthermore, prevalence of micronutrient deficiency was also high in the Terai. Of women aged 15–49 years in Nawalparasi, one of 20 districts in the Terai, where the present study was conducted, 49.7% were estimated as iron deficiency anaemia with haemoglobin concentration of less than 12 g/dl (New Era, 1986).

Most nutritional assessments for Nepalese have been based on clinical observations for nutrient deficiencies such as night blindness (Christian *et al.*, 1998) or biochemical analyses of nutrient concentrations in blood (Gittelsohn *et al.*, 1997). Dietary method-based assessment of food and nutrient intakes has seldom been carried out due to its time-consuming nature and technical difficulties. It is indispensable, however, to quantify dietary patterns for understanding nutrient deficiency and seeking the fundamental solution to nutritional inadequacy.

Intrahousehold food distribution plays a major role in unequal nutritional status among individuals of different genders and ages in many developing countries, including Nepal (Kennedy, 1983; Hassan and Ahmad, 1986; Messer, 1997; Miller, 1997). In poor Nepalese households, there was weak gender inequality among young children, but female subjects after adolescence were seriously discriminated from male subjects in food distribution within the household, causing their poor nutritional and health status (Anonymous, 1992). This inequality reflects socioculturally low status of women in rural communities in particular.

Two factors, that is, portion sizes and consumption frequencies of foodstuffs and meals, determine individual-based dietary intakes and thus contribute to the gender differences in nutritional status. Based on our field survey in rural communities in the Terai, this study aimed to reveal the extents to which these two factors caused gender differences in energy and nutrient intakes, using dietary assessment methods, including weighed food record (WFR) and food frequency questionnaire (FFQ), for contributing to improvement of dietary intake of women in this nutritionally vulnerable area.

Subjects and methods

Study sites

Terai region is located in a tropical and subtropical belt in the northern extension of the Gangetic Plain stretching along the Nepal–India border, with the average width of 29 km and the altitude ranging from 60 to 310 m above the sea level. There are 20 districts in this region. Nawalparasi district, the target area of this study, comprises 73 village development committees and one municipality, Parasi, as its headquarters. According to the governmental census in 2001, the total population of this district was 562 870, with an annual growth rate of 2.54% (Informal Sector Research and Study Center, 2002).

The field survey was conducted in three communities, arbitrarily abbreviated as KT, KS, and G, in Nawalparasi district. All villagers are Hindus and have maintained their traditional cultural norms. Most households depend on farming, although some villagers work in the nearby towns or remote areas, including overseas countries. Despite only 2.1 (KT and KS) and 4.1 km (G) away from Parasi, these communities lack basic hygienic facilities such as piped water and latrines.

Subjects

This study was designed to include adult villagers aged 20 years and over from 94 households, who were randomly selected in the three communities. Although all of these household members agreed to participate in the survey, some of them, mostly male subjects, were absent for work in remote places or in the nearby places for long time throughout the survey duration and thus the accessible 122 male and 219 female participants were the subjects. Of the 219 female participants, seven pregnant women in the second and third trimesters and 17 lactating women in the first 6 months after childbirth were excluded from analysis; the female subjects whose data were analysed numbered 195.

This study was reviewed and approved by the Ethics Committee of the National Institute of Public Health (Japan) and the local authorities of the Nawalparasi District Headquarters in Parasi. Written informed consent was obtained from each participant prior to the investigations; their participation was voluntary.

Data collection

The field survey, on which this paper is based, was conducted twice. For a 4-week period in August 2003, WFR survey, anthropometric measurements (height and weight), and time allocation study using compact spot-check method were carried out. For 4 weeks in April 2004, the interview survey of FFQ and additional WFR survey were done. To avoid the influences of day-to-day variations in consumption of expensive foods, which prevail to large extents in developing countries (Willet, 1998), our 19-item FFQ survey was conducted to elucidate each subject's food consumption pattern over the past 1 month.

WFR

For a subset of the subjects, that is, 25 male and 31 female subjects, one-day WFR was obtained by six investigators, that is, two Japanese and four Nepalese; an investigator or a two-investigators' team stationed in each subject's household from early morning to evening, to make thorough observation and measurements for any meals. Firstly, they

weighed all raw ingredients and spices before cooking. After cooking, they weighed cooked dish and calculated proportion coefficient of each raw ingredient involved in it. Secondly, to determine the individual subject's intake of the dish (that is, portion size of the dish), the investigators weighed not only cooked dish again after it was served into individual's plates but also, if any, the amounts of leftover and additionally served dishes. By multiplying the portion size of the dish (in grams) by the proportion coefficient, the subject's intake of each raw ingredient was calculated. Nutrient contents were estimated, using food composition tables, '*Nutrient Contents in Nepalese Foods*' (Ministry of Agriculture, 1994). For those in chicken and mixed spice, which were not available in that book, '*Tables of Nutrient Composition of Bangladeshi Foods*' (Helen Keller International and World Food Programme, 1988) was used. Iron content in chicken, which was not available in both of them, was determined, using Indonesian food composition tables (Hardinsyah and Briawan, 1990).

FFQ

The 19-food list of the FFQ, which was based on our WFR records, included major contributors to energy intake (i.e. rice, chapati, potato curry, and dal soup), expensive and irregularly consumed animal foods (i.e. meat curry, fried eggs, fish curry, milk, and buffalo milk curd), and purchased foods (i.e. soft drinks and tea divided into two categories with or without milk), carotene-rich green and yellow vegetable curries (i.e. those with bitter gourd, okra, snake gourd, pumpkin leaf, and pumpkin), and fruits (ripen banana and mango). The abovementioned food items other than the energy-supplying foods largely varied in the consumption frequency between genders in our previous study in rural Bangladeshi communities (Sudo *et al*., 2004), in which menus were basically identical with those in the study communities in the Terai. Our FFQ survey, which targeted smaller number of foods compared to many other studies, was especially suitable to the population whose dietary pattern seldom varied from day to day nor differed from household to household mostly because the interview was completed with only 3 min on average for each subject.

Per-day total (one-day) energy or nutrient intake was estimated as the sum of energy or nutrient taken from the 18 food items (except mango because of the reason mentioned later), each of which was the product of energy or nutrient contained in the portion size and the consumption frequency-based weighing factor. The 10 alternatives of the FFQ and their weighing factors were: (1) 'almost never' = 0, (2) '1–3 times per month' = 0.07, (3) 'once per week' = 0.1, (4) '2–4 times per week' = 0.4, (5) '5–6 times per week' = 0.8, (6) 'once per day' = 1, (7) '2 times per day' = 2, (8) '3 times per day' = 3, (9) '4–6 times per day' = 5, and (10) 'more than 6 times per day' = 7.

Anthropometric measurements

In August 2003, a Japanese investigator with a local assistant visited each household to measure height and weight of the subjects, using the standard methods (Weiner and Lourie, 1981). For height, the subject stood erectly for measurement to the nearest 1 mm. Weight with minimum clothing was recorded to the nearest 0.1 kg, using a portable digital scale (Tanita model 1597, Tokyo, Japan). BMI (kg/m^2) was calculated as the indicator of nutritional status and BMI < 18.5 kg/m^2 was classified as CED (Shetty and James, 1994).

Time allocation study

In August 2003, time allocation study using the compact spot-check method was conducted for randomly selected 32 married males and 36 married female subjects in G community. This method was applied to our previous work for rural villagers in Bangladesh, whose subsistence pattern was basically identical with that of the present Nepalese subjects (Ohtsuka *et al*., 2004). Briefly, each subject was observed once every 45 min from 05:30 to 19:00 over two net days. Based on the average time spent on each of 22 activity categories (such as agriculture, animal raising, washing, cooking, resting, and sleeping) by the male or female group and the respective mean body weight, energy expenditure for each activity type was estimated separately for either sex, using FAO/WHO/UNU (1985) equations for basal metabolic rate and James and Schofield's (1990) estimation of integrated energy indices. Then, total (24-h) energy expenditure (TEE) for the male or the female, not at the individual level but at the group level, was estimated by summing up the products of energy expenditure for each activity category and its time spent.

Statistic analysis

One-way analysis of variance (one-way ANOVA) was used for comparisons of anthropometric measurements and portion sizes of foods among age groups. For comparison of anthropometric measurements and energy expenditure between sexes, *t*-test was used. Intersex difference in distribution of the subjects by age groups, that of the CED subjects, and that of food consumption frequencies were examined by χ^2 test. Since the expected frequencies in some cells of the crosstabulations were less than 5, we carried out exact tests that have high reliability, regardless of sample size, distribution, or large numbers of cells with low frequency (or zero). Gender differences in portion size, energy or nutrient intake, and energy-adjusted micronutrient intake (i.e. nutrient density) from each food item were examined by Mann–Whitney's *U*-test. Spearman's correlation coefficients were calculated between energy and nutrient intakes. The level of significance was set at $P < 0.05$. All statistic analyses were performed, using the Statistical Package for Social Sciences (SPSS Inc, 2004).

Results

Age distribution by sex
The number and percentage of the subjects by sex and age group are shown in Table 1. There was no significant gender difference in the percentage of subjects by age groups.

Anthropometric measurements
Table 2 shows anthropometric measurements by sex and age group; the measurements were not conducted for 118 subjects who were absent when the investigator visited their residence several times. Significant interage group differences were found in height and weight for male, and in BMI for female subjects; the lower any value the higher the age. In any age groups, height and weight differed significantly between sexes (t-test, $P<0.05$), but BMI did not. For female subjects, the prevalence of CED significantly differed among age groups, with the highest in the ⩾50 group.

TEE
Our time allocation study revealed that males spent 5.6 h in subsistence work and 0.8 h in domestic work, on average, in a day while female subjects did, respectively, 2.9 and 4.2 h. In particular, per-day time spent on animal raising, an energy-consuming subsistence work, was 2.4 h for males and 0.9 h for female subjects. Consequently, per-day TEE averaged 9790 kJ for males ($N=32$) and 7686 kJ for female subjects ($N=36$). When these values were converted to those per kg body weight, they were 190 kJ/kg for males and 177 kJ/kg for female subjects.

Table 1 The number and proportion of the subjects by sex and age group

Age group (years)	*Male subjects*		*Female subjects*		*Total*	
	N	%	N	%	N	%
20–29	28	23.0	62	31.8	90	28.4
30–39	36	29.5	49	25.1	85	26.8
40–49	24	19.7	43	22.1	67	21.1
50+	34	27.9	41	21.0	75	23.7
Total	122		195		317	

No significant gender difference in the proportion of the subjects by age groups (χ^2 test, $P=0.23$).

FFQ
Figure 1 shows average food consumption frequencies for 11 food items, which were of significance in this study, by gender; other eight foods listed in the FFQ are omitted because of limited space. The villagers took two or three meals per day. Poor people tended to skip lunch. All males and 97.5% of female subjects ate rice twice or more per day. Almost everyone ate rice at every meal. About 80% of the villagers ate potato curry, the most frequently consumed among the nine types of curry dishes listed in the FFQ, twice or more per day, and more than 40% took dal soup once or more per day. As shown in Figure 1, rice, potato curry, and dal soup comprised the integral parts of meals for both male and female subjects. More interesting was the fact that gender differences were observed in less frequently consumed foods. The consumption frequencies of meat curry, fish curry, banana, tea with sugar, tea with sugar and milk, and soft drinks were significantly different; for any, males consumed more frequently than female subjects.

WFR
Table 3 shows raw weight of foods in portion sizes. There were no interage group differences in portion sizes of any foods for either gender (one-way ANOVA). In contrast, portion sizes of many foods, that is, rice, fish curry, potato curry, okra curry, snake gourd curry, and dal soup, were larger in males whereas that of milk was larger in female subjects. It is noted that mango was consumed by only one female subject throughout the WFR survey and its amount was only 5 g (Table 3) and all males and 99.5% of female subjects 'almost never' consumed it in the FFQ survey; thus, this fruit was excluded from calculation of energy and nutrient intakes.

Table 2 Anthropometric measurements by sex and age group (mean ± s.d.)

	20–29 years		*30–39 years*		*40–49 years*		*50+ years*		*Total*	
	M (N=20)	*F (N=41)*	*M (N=21)*	*F (N=28)*	*M (N=18)*	*F (N=26)*	*M (N=23)*	*F (N=22)*	*M (N=82)*	*F (N=117)*
Height (cm)	163.4±5.1	148.9±5.8	162.0±5.9	147.9±6.0	162.2±5.7	146.9±4.8	158.4±4.7	148.0±5.7	161.4±5.6	148.0±5.6
Weight (kg)	52.1±5.4	43.4±6.3	52.5±6.3	44.9±6.3	51.2±7.0	43.0±8.2	46.7±8.4	38.5±10.6	50.5±7.2	42.8±8.7
BMI (kg/m ^{2})	19.5±1.9	19.5±2.2	20.0±2.1	20.4±3.5	19.5±2.5	19.9±3.7	18.6±3.1	17.4±3.8	19.4±2.5	19.4±3.3
CED (%)	31.0	26.1	16.7	19.6	16.7	23.9	35.7	30.4	35.4	39.3

M = male; F = female; BMI = body mass index; CED = chronic energy deficiency (BMI<18.5).
Significant interage group differences were observed in height and weight for males and BMI for female subjects (t-test, $P<0.05$).
In all age groups, height and weight differed significantly between sexes (t-test, $P<0.05$) but BMI did not.
Significant interage group difference was found in CED for female subjects (χ^2 test, $P=0.048$).

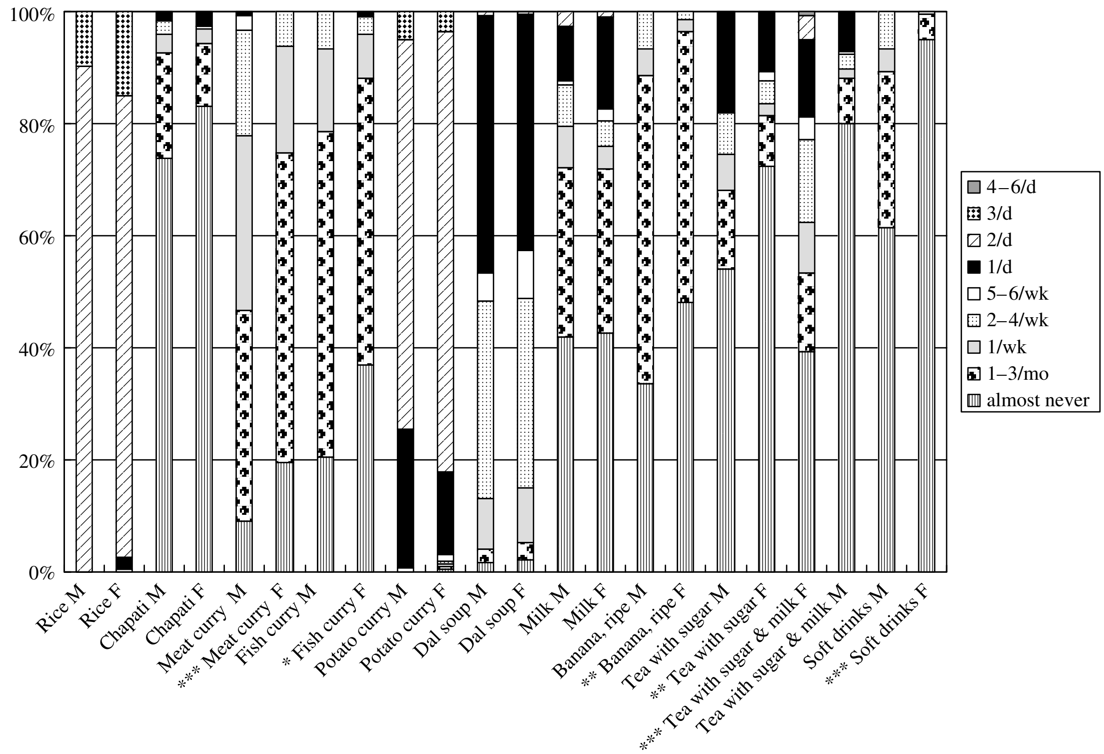

Figure 1 Average food consumption frequency for 11 food items by gender. M = males (N = 122); F = females (N = 195). χ^2 test (exact test): ***$P<0.001$, **$P<0.01$, *$P<0.05$. Note: An alternative of '6 + per day' was included in the FFQ, but no subjects chose this for any foods.

Table 3 Raw weights of food in portion size (g)

	Male subjects				*Female subjects*				
	N	*Median*	*25%*	*75%*	N	*Median*	*25%*	*75%*	
Rice	131	223.9	179.3	279.0	148	180.4	149.2	227.3	***
Chapati	19	201.5	138.0	250.0	29	147.6	104.5	222.2	
Meat curry	10	107.8	83.0	134.5	8	120.0	90.3	184.8	
Fried eggs	1	62.3	0						
Fish curry	13	196.0	157.7	229.0	11	159.3	100.0	164.8	*
Potato curry	99	89.8	59.9	119.4	111	69.2	44.9	101.9	**
Bitter gourd curry	17	78.8	39.8	144.8	27	52.0	28.9	95.2	
Okra curry	18	121.1	77.9	165.5	16	71.4	38.3	122.5	*
Snake gourd curry	18	110.8	73.2	157.6	20	63.2	41.8	91.4	*
Pumpkin leaf curry	9	53.1	29.8	150.9	13	56.4	41.4	106.8	
Pumpkin curry	10	85.2	58.8	115.6	12	127.4	68.6	155.1	
Dal soup	116	36.3	27.5	49.7	127	27.0	21.4	38.3	***
Milk	8	152.4	74.6	169.5	9	221.8	169.2	319.7	*
Buffalo milk curd	3	164.0	157.0	212.0	3	150.0	122.5	157.5	
Banana, ripe	1	97.0			1	86.0			
Mango, ripe	0				1	5.0			
Tea with sugar	3	13.5	13.2	—	3	16.0	5.1	—	
Tea with sugar and milk	1	17.4			2	16.9	16.6	—	
Soft drinks	0				0				

N = the total number of the subjects who ate each food item during weighed food record survey; 25% = 25 percentile; 75% = 75 percentile.
Mann–Whitney's U-test: ***$P<0.001$, **$P<0.01$, *$P<0.05$.

Gender differences in energy and nutrient intakes estimated by FFQ

Following the aforementioned procedures, per-day intakes of energy and nutrients were estimated. As shown in Table 4, the intakes of energy and all nutrients were significantly larger in male than in female subjects. When the intake of either energy or protein was converted to that of per kg body weight for comparison between genders, the median did not

Table 4 Gender differences in energy and nutrient intakes estimated by food frequency questionnaire

		Male subjects (N = 122)			*Female subjects (N = 195)*			
		Median	*25%*	*75%*	Median	*25%*	*75%*	
Energy	kJ/day	8723	8446	9668	7120	6703	8226	***
	kJ/kg[a]	176	162	212	184	156	218	
Protein	g/day	54.4	49.0	63.8	43.7	38.5	51.7	***
	g/kg[a]	1.08	0.96	1.31	1.07	0.93	1.34	
Carotene	μg/day	236	170	338	189	133	309	**
	μg/MJ	26.4	19.9	35.2	25.6	19.2	41.7	
Vitamin B_1	μg/day	1299	1249	1392	1084	1015	1177	***
	μg/MJ	148	143	150	150	145	152	**
Vitamin B_2	mg/day	0.92	0.87	1.03	0.74	0.70	0.94	***
	mg/MJ	0.11	0.10	0.11	0.10	0.10	0.11	
Vitamin C	mg/day	31	20	32	25	24	27	***
	mg/MJ	3.5	2.3	3.7	3.5	2.6	3.7	
Calcium	mg/day	192	167	283	164	125	302	***
	mg/MJ	22.0	19.7	29.3	22.8	18.0	36.8	
Iron	mg/day	20.5	19.3	21.8	16.4	15.1	17.3	***
	mg/MJ	2.29	2.24	2.37	2.26	2.20	2.32	**

[a]Energy (kJ) and protein (g) intakes per kg body weight: the means of 82 male and 117 female subjects.
Mann–Whitney's *U*-test: ***$P<0.001$, **$P<0.01$.

significantly differ. Since the intake of any micronutrient was significantly correlated with the energy intake ($P<0.01$ for any), further analysis treated nutrient density, that is, the amount of nutrient (mg or μg) per MJ of energy. Table 4 revealed significant gender differences in the nutrient densities of vitamin B_1 and iron; the former being higher in female subjects and the latter in males. Thus, the amounts of these two micronutrients taken from each food source were compared. For vitamin B_1, its amounts from dal soup and fish curry were significantly larger in males, but female subjects' 2.6 times larger intake from milk resulted in their larger total intake (Figure 2).

For iron, its amounts taken from fish curry, potato curry, dal soup, and two kinds of tea were significantly larger in males (Figure 3). Fish curry provided 6.4 and 4.4 mg of iron per portion size for male and female subjects, respectively. Iron contents in portion size of potato curry were 1.2 and 0.9 mg for male and female subjects, and those of dal soup were 2.7 and 2.0 mg. For the two kinds of tea, each provided 0.1 mg of iron for either male or female subjects. Since their portion sizes did not significantly differ, the average value was used. In Nepal, spices like pepper, ginger, and clove are admixed in tea in addition to sugar and milk; in fact, these spices contributed to 80.9 or 87.5% of the total iron content, respectively, for tea with sugar and milk or tea with sugar.

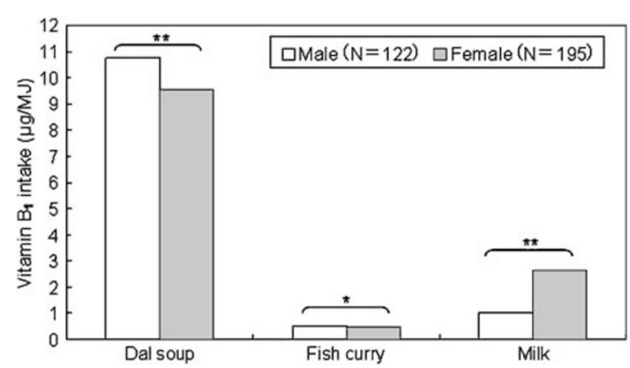

Figure 2 Vitamin B_1 intake (μg/MJ) from dal soup, fish curry, and milk, which significantly differed between genders. Mann–Whitney's *U*-test: **$P<0.01$, *$P<0.05$.

Discussion

One of the most important findings of this study was that significant gender difference in energy intake disappeared when the value was converted to that per kg body weight. Two major determinants of energy intake are, in general, body size and energy expenditure. Height and weight are significantly larger in males than in female subjects. It is also commonly observed that males have larger lean body mass than female subjects, causing more metabolically active and energy-expending in the former. For the present subjects, males spent more time in energy-consuming works than female subjects, as revealed by the time allocation study. As a result, TEE differed between sexes even when it was expressed per kg body weight (190 kJ/kg in males and 177 kJ/kg in female subjects). It is thus considered that the observed gender differences in the 'crude' intakes of energy and protein were due to the sex differences in body size and physical activity level. This is supported by the identical BMI in the male and female subjects of this study, 19.4 kg/m^2 as the mean for either sex.

Also revealed was that nutrient densities of most micronutrients did not significantly differ between genders, in

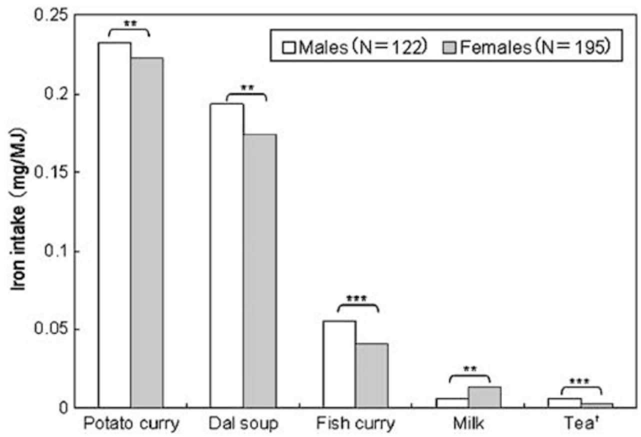

Figure 3 Iron intake (mg/MJ) from five food sources, which significantly differed between genders. Mann–Whitney's *U*-test: $^{***}P<0.001$, $^{**}P<0.01$, $^{*}P<0.05$. †Two kinds of tea, with sugar and with sugar and milk, were combined.

accordance with general patterns that the intakes of most nutrients are positively correlated with energy intake (Willet and Stampeer, 1998). However, some micronutrients were taken differently between genders in terms of nutrient densities. As pointed out by Gittelsohn *et al*. (1997), intakes of some micronutrients abound in expensive and luxury foods are not correlated with energy intake. Our study disclosed that vitamin B_1 and iron intakes were significantly different between genders, irrespectively of the energy intake.

Female subjects' vitamin B_1 intake in terms of nutrient density was larger than males'. Broken down into the food sources, 2.6 times larger intake from milk by female than by male subjects mostly contributed to the gender difference (Figure 2). Since there was no significant gender difference in its consumption frequencies (Figure 1), this difference was attributable to that in the portion sizes (Table 3). It is noted, however, that the portion size of milk was obtained from only eight male and nine female subjects, and consequently the gender difference in vitamin B_1 intake should be reassessed, using more samples for portion size measurements.

Iron intake in terms of nutrient density was significantly larger in male than in female subjects (Table 4) and its intakes from fish curry, potato curry, dal soup, and two kinds of tea were significantly larger in males (Figure 3). About a half of the subjects consumed potato curry and dal soup more than once a day, without significant gender difference (Figure 1), implying that the differences in portion sizes of these two foods played a determining role. On the other hand, there were significant gender differences in the consumption frequencies of fish curry and two kinds of tea (Figure 1), which were typical luxury foods in the study communities. When fish are purchased from the nearby markets and consumed, they are served to adult males and children first and small portions that remained in the pot are eaten by female subjects. In most households in the study villages, tea is not served to the household members but to their guests. However, males occasionally take tea at street vendors on the ways to, or from, work or shopping.

Iron deficiency anaemia (IDA) is the most widespread nutritional disorder in the world (Garrow *et al*., 2000; Ohtsuka *et al*., 2002); World Health Organization (1997) estimated that around 2 billion of the world population had marked IDA. For gender difference in prevalence of anaemia in developing countries, 45% of nonpregnant women and 60% of pregnant women were anaemic, whereas the proportion of adult men was only 25% (De Maeyer, 1989). Higher prevalence of IDA among women in reproductive age is related to their increased iron need due to menstruation or pregnancy. The present study revealed that the gender difference in iron intake was caused by two factors: the portion sizes of frequently consumed foods and the consumption frequencies of expensive luxury foods.

One of the ways for reducing the gender gap in iron intake would be to enlarge the female subjects' portion sizes of frequently consumed foods such as potato curry and dal soup. Taking into account the finding that 93% of iron was derived from plant staple foods (rice, potato curry, and dal soup; data not shown in Results); however, further increase in consumption of these foods would be less recommendable owing to their low bioavailability of non-haem iron. Another and more effective way for increasing female subjects' iron intake would be to raise their consumption frequency of animal food. To this goal, increase of homestead animal farming is recommended (Gittelsohn and Vastine, 2003). Homestead food production has been focused on growing plants such as yellow and dark-green leafy vegetables and fruits in home gardens to combat with vitamin A deficiency and its effects have been proven in many interventions (Helen Keller International/Asia-Pacific, 2001; Faber *et al*., 2002; Ramakrishnan and Darnton-Hill, 2002). Historically, Nepalese households have possessed cattle and buffaloes but they are primarily utilized for tillage and transport or for selling their milk to markets. Small animals like duck and chicken have been commonly raised for food but in very small scales (Silwal, 1995). It does not seem so difficult for them to keep larger numbers of such animals. Nutritional education is necessary to enhance the homestead animal farming and to increase the consumed amounts of these animal foods.

The final discussion focuses on cultural factors on difference in intrahousehold food distribution by gender. As has been pointed out, males have had responsibilities for household cash income in Nepal and its adjacent countries, leading to gender discrimination in dietary pattern (Chaudhury, 1988; Gittelsohn, 1991; Gittelsohn *et al*., 1997; Ohtsuka *et al*., 2004), despite the fact that women in rural Nepal (Gurung, 1994; Panter-Brick, 1996, 2003) or in developing countries in general (Awumbila and Momsen, 1995; Momsen, 1996; UNICEF, 1998) spend more time in unpaid works for not only housekeeping but also food production. Such

inequitably distributed onerous labour comes from the cultural norms in societies about how women are valued. The UNICEF report emphasizes that in countries where nutrition improvement has lagged behind economic growth, social discrimination against girls and women is common (Gillespie, 1998). In contrast, for instance, women in Thailand, where nutritional status has been improved remarkably in the last several decades, have played significant roles in social and household-level decision making, together with increased literacy and participation in various labours.

Unequal dietary intake of women causes not only their malnourished situation but also child malnutrition, which accounts for 55% of child deaths (UNICEF, 1998; Katz *et al*., 2003). It is thus concluded that intrahousehold food distribution, revealed by the analysis of portion sizes and consumption frequencies of foods, should be regarded as the central focus in improvement of nutritional and health status of not only women but also children in male-dominant societies within and beyond Nepal.

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