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FOOD CONSUMPTION AND NUTRIENT INTAKE AND THEIR RELATIONSHIP AMONG NEPALESE

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ABSTRACT

The dietary nutrient intake of persons aged 10-72 years (23 males and 30 females) was investigated using the 24-hour recall method living southeastern Nepal. The mean daily consumption of food averaged 433 and 437 g of cereal, 25 and 20 g of fat, 59 and 60 g of colored vegetable for males and females, respectively. For the majority of the subjects, milk and dairy product (249 and 213 g for males and females, respectively) was almost the sole source of food of animal origin. The levels of energy intake (2427 and 2275 kcal for males and females, respectively), protein (63.0 and 57.3 g), and vitamin B_1 (2.16 and 2.04 mg) were related to the level of consumption of cereal (r = 0.89, r = 0.77 and r = 90, $p < 0.001$, respectively) and rice (r = 0.69, r = 0.50 and r = 0.58, $p < 0.001$, respectively). The energy intake was supplied with 10.9 and 10.4% by protein, 18.6 and 15.8% by fat, and 70.6 and 73.8% by carbohydrate for males and females, respectively. The intake levels of Ca (612 and 466 mg), Fe (13.1 and 11.9 mg), and vitamin B_2 (1.06 and 0.80 mg) were correlated with the protein intake (r = 0.57, r = 0.87 and r = 0.60, $p < 0.001$, respectively). The daily mean intakes of vitamin A and C were 1406 IU and 101.0 mg for males and 1182 IU and 78.9 mg for females, respectively.

KEY WORDS: Food Consumption, Nutrient Intake, Nepal

INTRODUCTION

In developing countries, a high rate of infectious disease is observed in malnourished children (1, 2). In Nepal, child malnutrition (3) and a high incidence of infant mortality (4) have been reported. Recent reports have pointed to possible nutrient deficiencies of lactating Nepalese women (5).

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Nutrition surveys for males and females of different age groups in Nepal were carried out by Brown et al for 19 villages in 1965 (6) and by us in the mountain area in 1974 (7). The former was only the nutrition data of average for 19 villages and the latter was for the mountain area. However, nutrient intakes differ over time. There have been no recent studies and also no data for southeast Nepal. We, therefore, conducted this study in 1987 in southeast Nepal to determine food consumption and nutrientintake and to examine the relationships among them for the population aged 10-72 years. The results were compared with the data of nutritional status of lipid (8) and vitamin A and E (9) studied simultaneously.

METHODS

Our survey was conducted in the Itahari district located in southeast part of the Terai region along the southern border of Nepal in September 1987. The subjects studied were a random sampling from among those who voluntarily came to the medical camp for Japanese encephalitis vaccinations on the general populace at Biratnagar in the Itahari district with a population of about 20,000. The majority of the residents were industrial or commercial workers and about 10% were engaged in agriculture. The 53 who underwent both physical examination and dietary survey were Hindu believers. Their mean ages were 37 years for 23 males (range 16-72 years) and 28 years for 30 females (range 10-48 years). The Rohrer index (RI) (wt/ht^3 in kg/m^3) and body mass index (BMI) (wt/ht^2 in kg/m^2) were calculated from height and weight. Systolic (SBP) and diastolic blood pressure (DBP) were measured for 34 subjects (16 males and 18 females).

The dietary survey was undertaken by a trained nutritionist using the 24-hr recall method of recording food consumption of the previous day. Food models were used to describe the amounts of food consumed. In addition, information was obtained on the usual dietary habits and the consumption of minor food groups, such as seasonings and local foods, from household residents. The data from the 24-hr recall were analyzed and nutrient intakes were calculated from India and Japan food tables.

The variables were analyzed by Student's t test. Pearson's correlation coefficients were computed to examine the relationship between the variables. All data were analyzed with STAX statistical software (Microcomputer in Medicine, Nakayama Shoten, Tokyo).

RESULTS

Physical constitution.

The physical status, blood pressure and stool frequency of subjects are presented in Table 1. Mean values for height were 167 and 150 cm and for weight were 59.7 and 47.7 kg for males and females, respectively, with both values being higher for males ($p < 0.001$, respectively). The mean levels were almost the same for both sexes for RI (12.9 and 14.0) and for BMI (21.5 and 21.0) (for males and females, respectively). SBP and DBP were 123 and 83 mmHg for males and 112 and 77 mmHg for females, respectively, and were increased with age ($r = 0.65$ and $r = 0.76$, $p < 0.001$, respectively). All subjects had stool output every day (7 times/week).

Food consumption and nutrient intake.

Average dietary intake according to age and sex are shown in Table 2. There was considerable variation among subjects for weight of food consumption and no dietary patterns were apparent. The usual daily diet patterns in the research area consists of morning tea with milk and two meals a day primarily of boiled rice, pulse soup, stew with potato and vegetable, and salt-pickled vegetable with seasonings. The mean variety of food item came to 18, including several seasonings. The total weight consumed per day was 1169 and 1044 g for males and females, respectively. About 39% of the consumed total weight came from cereal, of which rice accounted for about 86%. Rice is the staple food with a daily mean consumption of 378 and 374 g for males and females, respectively. Vegetable oil was frequently used but not ghee (milk butter). Alcoholic drink was rarely consumed and more frequently by males (4 of 23 subjects) than by females (2 of 30 subjects).

The average daily consumption of food of animal origin including fish, meat and egg was 27 g for males and 12 g for females. The frequency of consumption of these three food group was higher for males (9 of 23 subjects) than females (6 of 30 subjects), and the majority of the subjects had not consumed them in the previous 24-hr period. Milk and dairy product (249 and 213 g for males and females, respectively) was almost the sole source of food of animal origin for the general population in Nepal. Average daily intake trend was higher for males than females except in the cases of cereal and pulse. There was considerable variation among individuals, but no significant differences in mean consumption of food due to sex.

As shown in Table 3, the daily mean nutrient intake varied widely among individuals and the average daily intake of all the nutrients tended to be higher for males than females. The average energy intake of all subjects was 2427 and 2275 kcal for males and females, respectively. The age-specific mean value was the lowest for the 30-39 year age group for males and the level of the 30-49 year group seemed to be higher than those of the younger generation for females. The mean daily intake of protein and the percentage of animal protein were 63.0 g and 19.4% for males, respectively, and 57.3 g and 11.6% for females, tending to be higher for males than ($p < 0.01$ for the mean percentage of protein of animal origin). Daily intake of fat was significantly higher for males (50.0g) than females (38.5 g) ($p < 0.05$) and that of crude fiber was the about same for both sexes (7.66 and 7.38 g for males and females, respectively).

Daily Ca intake tended rise with age ($r = 0.30$, $p < 0.05$ for sex combined) and the intake by males (612 mg) was significantly higher than that by females (466 mg) ($p < 0.05$). Daily mean P and Fe intake were 1594 and 13.1 mg for males and 1429 and 11.9 mg for females, respectively. More than 4-fold variation in vitamin A intake was evident among the participants, from 900 to 3500 IU, but sex difference was not evident for average vitamin A intake for all subjects (1406 and 1182 IU for males and females, respectively). Daily intake levels of vitamin B_1, niacin and vitamin C were 2.16, 18.0 and 101.0 mg for males and 2.04, 16.9 and 78.9 mg for females,respectively. Vitamin B_2 intake increased from 1.04 to 1.25 mg for males and from 0.71 to 0.95 mg for females with age ($r = 0.42$, $p < 0.01$ for sex combined) and the mean for males (1.06 mg) was higher than that for females (0.80 mg) ($p < 0.01$).

The intake of energy-providing nutrient was expressed as a percentage of the total caloric consumption in Table 4. Of the energy intake, 70.6 and 73.8% came from carbohydrate, with rice providing 51.4 and 57.6%, for males and females, respectively. The energy intake from protein was 10.9 and 10.4% and that from fat was 18.6 and 15.8% for males and females, respectively. Males

were characterized by a significantly higher mean energy ratio of fat ($p < 0.05$) and a lower one of carbohydrates ($p < 0.05$). No significant age difference was noted in both sexes for the percentages of energy sources.

Relationship between food consumption and nutrient intake.

The correlation coefficients among item of major food consumption and nutrient intake for all subjects aged 10-72 years in Nepal are shown in Table 5. The levels of cereal and rice consumption displayed relationship to the levels of energy intake ($r = 0.89$ and $r = 0.69$, $p < 0.001$), protein ($r = 0.77$ and $r = 0.50$, $p < 0.001$), and vitamin B_1 ($r = 0.90$ and $r = 0.58$, $p < 0.001$), respectively. The consumption levels of milk and dairy product which provided 76% of protein of animal origin were significantly correlated with the Ca, Fe and vitamin B_2 intake levels ($r = 0.45$, $p < 0.001$, and $r = 0.43$ and $r = 0.42$, $p < 0.01$, respectively). The levels of colored vegetable were related to the intake of vitamin A and vitamin C ($r = 0.92$ and $r = 0.74$, $p < 0.001$, respectively).

Protein intake was dependent on the energy intake ($r = 0.91$, $p < 0.001$). In addition, the intake levels of Ca, Fe, vitamin B_1 and B_2 were also correlated with the energy intake ($r = 0.43$, $p < 0.01$, and $r = 0.73$, $r = 0.92$ and $r = 0.55$, $p < 0.001$, respectively). The levels of protein intake were related to the Ca, Fe, vitamin B_1 and B_2 levels ($r = 0.57$, $r = 0.87$, $r = 0.90$ and $r = 0.60$, $p < 0.001$, respectively).

DISCUSSION

The levels of blood pressure (SBP and DBP) for the Nepalese studied were lower than those for Japanese (134 and 80 mmHg for males and 131 and 78 mmHg for females, respectively) (10). The Nepalese studied exhibited no obesity defined as a BMI > 30 kg/m^2 associated with hypertension, and few were overweight as judged by a BMI of 25-30 kg/m^2 (11) (Table 1). Although salt intake was not clear, it seemed to be lower than that of the Japanese (11.7 g/capita/day) (10), because the Nepalese use salt directly for cooking instead of as processed food, like soy sauce and canned food which account for about 90% of the salt intake in Japan (10). The low intake levels of animal fat and cholesterol due to the low consumption of food of animal origin also may lead to such low blood pressure levels.

The stool frequency was higher than those of Japanese college women students (33% for constipation every day) and their parents (52 and 81% for mothers and fathers, respectively) (12) and similar or higher than those of Americans (7.2 and 5.5 stools/week for males and females, respectively, 20-53 years) (13). The level of daily crude fiber intake was higher than those of Japanese (about 4.7 g) (14) and Americans (4.15 and 3.70 g for males and females, respectively) (13). The high consumption of cereal which contained a high crude fiber might account for the occurrence of high stool frequency among Nepalese.

Compared with data for the Japanese population from the national survey of nutrition, the weight of total food intake in Nepal was lower than that of the Japanese in 1987 (1339 g/capita/day) (10) but similar to that in 1955 (1100 g/capita/day) (15). The dietary pattern in Nepal was simple and similar, although there was considerable variation in food consumption weight. The total weight of food intake of Nepalese in this study were related to the intake of nutrient, energy ($r = 0.74$), protein ($r = 0.76$), fat ($r = 0.55$), carbohydrate

(r = 0.69), Ca (r = 0.55), Fe (r = 0.72), vitamin B_1 (r = 0.70), and vitamin B_2 (r = 0.62) ($p < 0.001$, respectively) and animal protein (r = 0.40, $p < 0.01$) and vitamin C (r = 0.32) ($p < 0.05$). This means that the nutrient intake is dependent upon the total weight of food intake, which may be characteristic of developping countries. Comparison of our results with data for developed countries showed that the Nepalese consumed a larger amount of cereal and lesser amount of animal-origin food. Analysis of intake level pointed to a qualitative difference in nutrient intake between Nepalese and people of developed countries.

The average daily intake of energy in the present study was within the range reported in Nepal for the 19 villages (2440 kcal for sex combined) (6), villagers in mountain area (1802 kcal for sex combined) (7), and lactating women in Kathmandu (2150 kcal) (5). Compared with data for other countries, the energy intake level of this study was higher than those of the Japanese (2053 kcal for sex combined) (10) and Polynesians (2120 and 1810 kcal for males and females, respectively) (16) and lower than those of the Danes (3000 kcal) (17) and of the Americans in the United States (2850 kcal) (18).

The percentage distribution of source of energy in this study was similar to those found for people of South Africa (12% for protein, 72% for carbohydrate, and 16% for fat) (19). The energy percentages of carbohydrate for Nepalese in this study, in the mountain area (8.0% for protein,76.9% for carbohydrate and 15.1% for fat) (7) and in Kathmandu (11.6, 73.3 and 8.6%, respectively) (5) were higher than those for people in Japan (60%) (10), Denmark (38%) (16), the USA (41 and 43% for males and females, respectively) (18), and also vegetarians in France (52%) (20) and Great Britain (50%) (21). Over the past two decades, the percentage of carbohydrate energy has decreased while that of fat has increased about 2-fold (75.9% for carbohydrate, 7.7% for fat. and 9.7% for protein in 1965, respectively (6)). It was found that serum cholesterol levels in this study (8) were positively correlated to the percentage of fat energy ($r = 0.32$. $p < 0.05$) and negatively correlated to the percentage of carbohydrate energy ($r = -0.30$, $p < 0.05$), in addition to the positive correlation to the protein intake of animal origin ($r = 0.30$, $p < 0.05$) and the percentage of animal origin protein ($r = 0.37$, $p < 0.01$). These results may suggest that the incidence of coronary heart disease in Nepalese may rise in future.

The daily protein intake level in the present study was within the range reported for Nepalese in the 19 villages (66 g) (6), the mountain area (42 g) (7) and Kathmandu (62 g) (5), and similar to those for vegetarian in France (63 and 51 g, for males and females, respectively) (20). Compared with developed countries, the protein intake levels was lower than those for Japanese (78.5 g for sex combined) (10), Danes (94 and 83 g for males and females, respectively) (17), and Americans (106 g) (22). The percentage of protein of animal origin was similar or higher than those in the mountain area in Nepal (12.9%) (7), vegetarians in France (12%) (20) and Nigeria (15%) (22), but was lower than the levels in developed countries like Japan (51%) (10), the USA (69%) (22) and Great Britain (64%) (21). The coefficients of variation for animal protein intake were 58.8% for males and 74.1% for females and only 28% of the subjects consumed the animal protein from fish, meats and eggs in this study. Therefore, despite the fact that the mean protein intake was above the level of 1 g per kg of body weight, high quality amino acids seem to be lacking.

The daily fat intake level of this study was high in comparison with the levels of 35 g for the 19 villages (6) and 20.9 g for females in Kathmandu

(5) in Nepal, and the high fat intake resulted from the high consumption of vegetable oil. In comparison with people of other countries, the average fat intake level was lower than those for Japanese (56.6 g) (10), Polynesians (83 and 80 g for males and females, respectively) (16), in vegetarians in France (79 and 68 g for males and females, respectively) (20). Therefore, the lower percentage of energy from fat was recorded for the Nepalese than those countries (35 and 38% (10), 35 and 38% (16)) and also vagetarian in France (34 and 36%) (20). We already reported that the Nepalelse tended to have higher serum level of triglyceride (8). However, the serum triglyceride level was not related to the levels of fat intake and of other variables. The high triglyceride level in Nepalese may due to th quality of fatty acid in diet.

The high consumption of milk and dairy product in this study lead to the high intake of Ca in comparison with those of Nepalese in the 19 villages (357 mg) (6) and the mountain area (369 mg) (7). The Fe intake was comparable to the 12.6 mg for the 19 villages (6) and the 11 mg for the mountain area (7). The daily intake levels of Ca and Fe were higher or similar to those of Japanese (551 and 10.5 mg for Ca and Fe, respectively) (10), but lower than those of Danes (1408 and 18 mg, respectively) (17). The intake levels of Ca and Fe were not related to the serum levels of Ca and Fe (8), respectively.

Although the daily vitamin A intake was within the range of those for Nepalese in the 19 villages (1960 IU) (6) and in the mountain area (1210 IU) (7), the coefficient of variation for vitamin A intake (89.3 and 76.5% for males and females, respectively) was the largest compared with those of other nutrient intake level. Vitamin A intake level was low in marked contrast to those of developed countries, such as levels among the Japanese (2119 IU) (10), and Danes (2523 IU) (17). In this study, the serum retinol level was in low as reported previously (9). Serum retinol level was not related to the intake of colored vegetable but positively related to the protein intake of animal origin ($r = 0.37$, $p < 0.01$) and vitamin A intake of animal origin ($r = 0.36$, $p < 0.01$). These results mean that the low consumption of food of animal origin lead to low levels of retinol intake of animal origin vitamin A and finally may induce the low levels of retinol in serum.

The vitamin B_1 intake was considerably greater among the subjects than for the Japanese (1.3 mg) (10) and Americans (1.33 and 1.03 mg, for males and females, respectively) (18). Similar results were obtained for Nepalese in the 19 villages (2.1 mg) (6) and vegetarian in France (2.7 and 2.5 mg, for males and females, respectively) (20). The high B_1 intake level found in this study was largely associated with the consumption of crude grain cereal ($r = 0.90$, $p < 0.001$) (Table 5). Despite the fact that the vitamin B_2 intake was somewhat higher than those of Nepalese in the 19 villages (0.7 mg) (6) and the mountain area (0.74 mg) (7), it was lower than those of Japanese (1.25 mg), Danes (2.80 mg) (17) and vegetarian in France (2.0 and 1.8 mg) (20). The variation coefficient of vitamin C intake was in high (85.7% for males and 68.1% for females, respectively) and the mean daily intake of vitamin C was higher than that found for the 19 villages in Nepal (5 mg) (6) and was lower than that found for the mountain area (138 mg) (7).

In general, food intake depends on the local dietary habits, the availability of foods, and socioeconomic conditions. To obtain the values for the average Nepalese, we will have to do repeated surveys in different regions, seasons, and socioeconomic status levels. In this study, only about 18 food items including several seasonings were found to be regularly consumed. As would be expected from the results, cereals, especially rice, contributed

greatly to the nutrient intake among the Nepalese studied. The proportion of protein of animal origin was low, and milk and dairy products was the only supply of protein and vitamin A (retinol) of animal origin for the majority of the subjects. For the β-carotene supply, green leaf vegetable was often consumed but they are, unfortunately, seasonal product. These facts indicate that deficiencies in nutrients will depend on the availability of these food groups and that nutrient inadequacies in amino acids and fatty acids can occur. On the basis of the idea that more widespread consumption should provide an adequate amount of nutrients, one way to improve the nutritional conditions of the Nepalese would be to have them consume a greater variety of food items.

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