Original Article

Dietary patterns and risk factors for Type 2 diabetes mellitus in Fijian, Japanese and Vietnamese populations

Kazue Tomisaka[1] MSc, Jimaima Lako[1] MSc, Chizuko Maruyama[1] PhD, Nguyen Thi Lan Anh[2] MD, Do Thi Kim Lien[2] MD, PhD, Ha Huy Khoi[2] MD, PhD and Nguyen Van Chuyen[1] PhD

[1]*Department of Food and Nutrition, Japan Women's University, Tokyo, Japan*
[2]*National Institute of Nutrition, Hanoi, Vietnam*

Diabetes mellitus is now a serious and increasing problem in Asian countries, where dietary patterns have shifted toward Westernized foods and people are becoming more sedentary. In order to elucidate the relationship of dietary habits to the development of diabetic risk factors, the dietary patterns of 200 Fijian, 171 Japanese and 181 Vietnamese women of 30–39 years of age were investigated using 3 day–24 h recall or dietary records. Anthropometric measurements and glycosuria tests were also conducted. The dietary trends of Fijians and Japanese have changed drastically in the past 50 years, while Vietnamese have been minimally influenced by Western dietary habits. The mean 24 h dietary intake showed that Fijians had the highest energy intake. Energy intake from fat was only 13% for Vietnamese, but over 30% for Japanese and Fijians. Percentage of body fat was higher in Vietnamese than in Japanese, though there were no significant differences in body mass index (BMI). In the overweight and obese women, Vietnamese had higher abdominal obesity than Japanese. The prevalence of obesity (BMI $\geqq$ 30 kg/m^2) was 63.0% for Fijians, 1.8% for Japanese and 1.1% for Vietnamese. Glycosuria testing yielded the most positive cases among Fijians. Dietary transition and dietary excess appear to be potential risk factors for diabetes in Fijian women.

Key words: body fatness, diabetes mellitus, dietary patterns, Fijian, impedance, Japanese, obesity, Vietnamese, women.

Introduction

Type 2 diabetes mellitus and its risk factors, such as obesity, overeating and lack of exercise, are strongly influenced by lifestyle variables. In fact, the prevalence is increasing rapidly not only in developed countries but also in developing countries where dietary patterns are changing from traditional to Western style.[1,2] In order to prevent or control diabetes mellitus, we investigated, analyzed and compared relationships between dietary patterns and diabetic risk factors in Fijian, Japanese and Vietnamese populations.

It is reasonable to speculate that genetic predispositions for diabetes mellitus differ among these populations. However, environmental influences are the driving force behind increased prevalence in a genetically susceptible population.[3] Diabetic prevalence is determined by interactions between genetic and environmental factors. The relationship between environmental factors and disease has been evaluated in various countries and is thought to be important. Comparisons between different countries may provide valuable information allowing clarification of the causes of disease in each country.

In the case of Fiji, the current rapid change in dietary patterns from traditional food to Western food may increase the risk of disease, such that diabetes is now becoming a serious problem in this nation.[4] This tendency has also been recognized in Asian countries such as Japan.[5–7] In contrast, diabetes prevalence is still low in Vietnam,[8] but the rate may increase in accordance with advancing socioeconomic status.

This study aims to compare anthropometry, dietary patterns, physical activity and prevalence of glycosuria between Fijian, Japanese and Vietnamese women aged 30–39 years.

Subjects and methods

This survey was conducted in urban areas; between the main capital of Suva and Nausori in Fiji, Tokyo in Japan and Hanoi in Vietnam. The sample consisted of 200 Fijians, 171 Japanese (including university students taking a correspondence course) and 181 Vietnamese women aged 30–39. The marital status of subjects was 88, 62 and 94% in Fijians, Japanese and Vietnamese, respectively.

Height in bare feet and body weight in light clothing were measured. Waist and hip circumference in light clothing was

Correspondence address: Nguyen Van Chuyen, Department of Food and Nutrition, Japan Women's University, 2-8-1 Mejirodai, Bunkyo-ku, Tokyo 112-8681, Japan.
Tel: +81 3 5981 3430; Fax: +81 3 5981 3426
Email: nvc@fc.jwu.ac.jp
Accepted 14 May 2001

measured at the level of the narrowest point of the abdomen and the maximum extension of the buttocks. The percentage of body fat was recorded by the impedance method using the same impedance machine (Tanita TBF-511 Body Fat Analyzer, Tokyo, Japan). Body weight status was assessed by body mass index (BMI), waist-to-hip ratio (WHR) and percentage of body fat. Glycosuria testing was carried out using glucose urine Tes-tape (Wako Pure Chemical Industries, Osaka, Japan) dipped into the respondent's fasting urine.

The intensity of daily activity was assessed with a simplified motion and time study questionnaire, which asked about the duration of body position in hours per day (reclining, sitting, standing or walking) and the types, frequency and average duration of exercise. Four levels of physical activity were defined according to intensity, as determined by resting metabolic rate (RMR) scores reported in the literature,[9] as very strenuous activities, strenuous activities, moderate activities and light activities.

Dietary data were collected by the 3 day–24 h recall method (Fiji and Vietnam) or 3-day dietary records (Japan). The interviewer checked the accuracy of every recording by asking the subject to identify the specific amount of food intake with the help of food models. The dietary records in Japan were checked using a similar method on the last day of the survey. The questionnaires and measurements were conducted using the same protocol. To increase the reliability, we trained the interviewers from Fiji, Vietnam and Japan on the use of the measuring instrument and the questionnaire was checked for completeness.

Anthropometric data and nutritional intakes of the three ethnic groups were compared by means of a multivariate analysis of variance or by the Kruskal–Wallis test. Categorization of physical activity patterns was assessed using the chi-squared test. Statistical analysis was performed using the SPSS Windows version 7.0 statistical package.

Results

Anthropometric measurements of the Fijian, Japanese and Vietnamese women are shown in Table 1. Measurements of the Fijian women were higher than those of the Japanese and Vietnamese women. Body mass indices (BMI) were similar in Japanese and Vietnamese. However, the percentage body fat was higher in Vietnamese than in Japanese. Figure 1 shows the scatter diagram for percentage of body fat measured by impedance and BMI of the three countries. There was a positive correlation between percentage of body fat and BMI in each country (Fijians, $r = 0.785$; Japanese, $r = 0.937$; Vietnamese, $r = 0.874$).

The prevalence of overweight and obesity among the Asian women is shown in Table 2. BMI and percentage of body fat were used to assess obesity. Abdominal obesity in the overweight and obese subjects was assessed by WHR. When obesity was defined as a BMI value higher than 30, the prevalence of obesity in Fijian, Japanese and Vietnamese women was 63.0, 1.8 and 1.1%, respectively. Thus, Fijian women had the highest prevalence of obesity among the three countries. Moreover, much of this was abdominal obesity.

The glycosuria test revealed positive results of 8, 0.6 and 0% of Fijian, Japanese and Vietnamese cases, respectively. The glycosuria in Fijians was highest among the three countries.

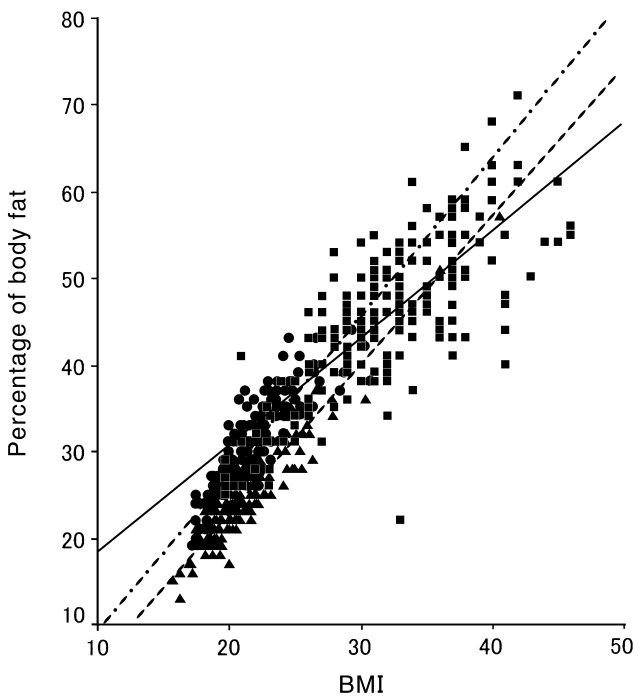

Figure 1. Correlation between percentage of body fat and BMI in (■, —) Fijian, (▲, ---) Japanese and (●, • ⁻• ⁻) Vietnamese women.

Table 1. Anthropometric indicators in Fijian, Japanese and Vietnamese women aged 30–39 years

	Fiji	Japan	Vietnam
Age (mean years ± SD)	35 ± 3.1	34 ± 2.8	36 ± 3.1
Height (cm)	163.9 ± 6.6[a]	158.0 ± 4.9[b]	154.2 ± 5.0[c]
Weight (kg)	83 ± 15.0[a]	52.8 ± 8.3[b]	51.2 ± 6.4[b]
BMI (mean ± SD)	31.3 ± 5.8[a]	21.2 ± 3.1[b]	21.5 ± 2.4[b]
Body fat (%)	44.7 ± 9.2[a]	24.7 ± 5.6[c]	30.0 ± 5.2[b]
Waist (cm)	93.9 ± 12.5[a]	68.3 ± 7.4[c]	74.9 ± 7.0[b]
Hip (cm)	110.2 ± 11.1[a]	91.5 ± 6.7[b]	89.6 ± 6.8[b]
WHR (mean ± SD)	0.85 ± 0.07[a]	0.75 ± 0.07[b]	0.84 ± 0.06[a]

BMI, body mass index; WHR, waist-to-hip circumference ratio. Values within a row with different superscript letters are significantly different ($P < 0.05$).

Table 3 shows the intensities of physical activity in Fijian, Japanese and Vietnamese subjects. There were no significant differences for all activity levels between the Fijians and the Japanese, with the majority of subjects engaging in light or moderate physical activity. On the other hand, the number of Vietnamese subjects involved in strenuous activity was higher than in the other two countries. Organized exercise or sports was practised by 6.5% of Fijians, 22.2% of Japanese and 2.8% of Vietnamese.

Table 4 presents the average daily nutritional intake by ethnicity. The total energy, protein, fat, Ca, Fe and vitamin B_1 intakes of Fijian women were the highest among the three countries. However, when nutrient intakes were divided by standard body weight (Table 5), intakes of energy and protein were not significantly different between Fijians and Vietnamese (although fat intake was still highest for Fijians). Intakes of fat and B group vitamins were lowest in Vietnamese. As a result, the percentage of energy derived from fat was higher in the Fijian and Japanese women than in the Vietnamese women. In contrast, the percentage of energy from carbohydrates was highest in the Vietnamese women.

Table 2. Prevalence of obesity in Fijian, Japanese and Vietnamese women aged 30–39 years

	Fiji	Japan	Vietnam
Overweight and obese by BMI (%)	73.5[a]	8.8[b]	8.3[b]
Obese by BMI (%)	63.0[a]	1.8[b]	1.1[b]
Obese by body fat (%)	85.0[a]	4.1[c]	22.1[b]
Abdominal obesity by WHR (%) in overweight and obese by BMI	84.0[a]	13.3[b]	93.3[a]

BMI, body mass index; Obese BMI ≧ 30, Body fat ≧ 35% and WHR > 0.8; Overweight 30 > BMI ≧ 25; WHR, waist-to-hip circumference ratio. Values within a row with different superscript letters are significantly different ($P < 0.05$).

Table 3. Intensity of physical activity in Fijian, Japanese and Vietnamese women aged 30–39 years

Physical activity level (%)	Fiji	Japan	Vietnam
Light activity	16.0	18.1	0.6
Moderate activity	56.0	52.6	56.4
Strenuous activity	24.5	23.4	42.0***
Very strenuous activity	3.5	5.8	1.1

Statistical significance (chi-squared test): ***$P < 0.001$.

Discussion

Diabetes mellitus usually develops in people over 50 years of age. The development of diabetes usually takes from 10 to 20 years. Therefore, in designing diabetes prevention strategies for people over 50 years of age, information on the dietary habits of people 10 or 20 years younger is very important. Thus, we chose the 30–39 year age group.

In this study, anthropometric measurements revealed a difference in body size among Fijian, Japanese and Vietnamese women. Height was greatest in the Fijian women, followed by the Japanese and the Vietnamese. Although height is mainly determined by genetic factors in populations

Table 5. Nutritional intakes in relation to SBW in Fijian, Japanese and Vietnamese women aged 30–39 years

Nutrients	Fiji Mean SD	Japan Mean SD	Vietnam Mean SD
Total energy (kJ/kg)	159 ± 38[a]	134 ± 21[b]	155 ± 34[a]
Protein (g/kg)	1.5 ± 0.6[a]	1.2 ± 0.2[b]	1.4 ± 0.4[a]
Fat (g/kg)	1.4 ± 0.5[a]	1.1 ± 0.3[b]	0.6 ± 0.3[c]
Carbohydrate (g/kg)	4.8 ± 1.4[b]	4.2 ± 0.8[c]	6.4 ± 1.4[a]

SBW, standard body weight = height $(m)^2 \times 22$. Values within a row with different superscript letters are significantly different ($P < 0.05$).

Table 4. Nutritional intake of Fijian, Japanese and Vietnamese women aged 30–39 years

Nutrients	Fiji Mean SD	Japan Mean SD	Vietnam Mean SD
Total energy (kJ)	9460 ± 2386[a]	1760 ± 270[c]	1950 ± 380[b]
Protein (g)	87 ± 36[a]	65 ± 14[c]	74 ± 20[b]
Fat (g)	84 ± 32[a]	60 ± 14[b]	30 ± 15[c]
Carbohydrate (g)	282 ± 84[b]	233 ± 42[c]	335 ± 67[a]
Protein (%)*	16 ± 4	15 ± 4	15 ± 3
Fat (%)*	33 ± 7[a]	31 ± 5[b]	13 ± 5[c]
Carbohydrate (%)*	52 ± 9[b]	53 ± 6[b]	69 ± 6[a]
Ca (mg)	710 ± 300[a]	560 ± 190[b]	730 ± 110[a]
Fe (mg)	15 ± 6[a]	9 ± 2[b]	11 ± 4[b]
Retinol (μg)	400 ± 1680	240 ± 470	160 ± 270
Carotene (μg)	5430 ± 3580[a]	3210 ± 2000[b]	4990 ± 4020
Vitamin B_1 (mg)	1.1 ± 0.4[a]	0.9 ± 0.2[b]	0.8 ± 0.3[c]
Vitamin B_2 (mg)	1.4 ± 0.7[a]	1.4 ± 0.6[a]	0.6 ± 0.3[b]
Niacin (mg)	20 ± 11[a]	13 ± 4[b]	11 ± 5[c]
Vitamin C (mg)	160 ± 90[a]	160 ± 370[a]	110 ± 80[b]

* Expressed as percentage of total energy. Values within a row with different superscript letters are significantly different ($P < 0.05$).

where food is widely available, it may reflect nutritional factors in a developing country such as Vietnam.

We used BMI and percentage of body fat to assess obesity. The determination of obesity varies according to the standards used to define obesity in each country. In contrast, our study considered a BMI value higher than 30.0 as an indication of obesity[10] for all three countries. If the standard Japanese BMI cut-off point of 25 was used, 9% of the Japanese candidates would be considered obese instead of 1.8% in our study. Even so, the prevalence of obesity in Fiji was far higher than in Japan. This result suggested that obesity was a significant problem for Fijians.

Although a number of methods may be used to measure the percentage of body fat, we prefer the impedance method. It is easier and more practical than other methods, such as densitometry (underwater weighing), when conducting a nutritional survey. Using the impedance method, we found a high correlation between percentage body fat and BMI in all three countries (Fig. 1).

The role of obesity in the pathogenesis of insulin resistance, leading to various levels of glucose intolerance and the development of non-insulin-dependent diabetes mellitus (NIDDM), is widely accepted. Furthermore, abdominal obesity, which is characterized by excess fat above the hips, is also associated with a higher risk of NIDDM.[11] Our investigation suggested that both the overall and abdominal obesity of Fijian women are extremely high, such that they have a higher risk of diabetes. Positive glycosuria in this study may be used as a weak indicator of diabetes since hyperglycemia is often accompanied by glycosuria, and the test was carried out before the meal. In our study, glycosuria was relatively high in young Fijian women. It was postulated that in the future, a great number of these Fijian subjects could develop complications of obesity such as diabetes, unless environmental factors are improved.

Diet is one of the most frequently cited factors among the environmental variables. We used the 24 h recall method to record the diets of Fijians and Vietnamese because many of the Fijian subjects were illiterate and the nutrition education in both of these countries was behind, compared with Japan. Although the 24 h recall method tends to underestimate the amount of energy consumed,[12] we thought that the survey was satisfactory for use in our analyses as it showed that the energy intake of Fijians and Vietnamese was significantly higher than that of the Japanese.

The primary problem in comparing the different population groups is that factors other than dietary factors, such as genetic predisposition, availability of total energy intake and lifestyle, may vary among the countries.[12] We therefore adjusted the energy intake by calculating the ratio of energy, protein, fat and carbohydrate to standard body weight as shown in Table 5, because the differences in body size between each country were determined to some extent by heredity, and this affected their energy requirements.

We found that Fijian women consumed more energy than Japanese women, especially that derived from fat, although there was no significant difference in physical activity. Since obesity can develop gradually from an imbalance between energy ingested and energy expended, it is suggested that excessive fat intake caused an excess energy intake, which is likely to have played an important role in the observed prevalence of obesity.

Our data indicate that Vietnamese women have higher relative body fatness than Japanese women (Table 1, Fig. 1). The mean WHR was higher in Vietnamese than in Japanese women and a similar result was observed in a study comparing Vietnamese and Australian women.[13] Abdominal obesity in overweight and obese subjects was much higher in Vietnamese than in Japanese. This indicated that Vietnamese women have a higher risk of NIDDM than Japanese women. However, unlike the Fijian case, this speculation is not in accordance with current trends in the prevalence of diabetes in Vietnam. Further studies on genetic and environmental factors are necessary to characterize this anthropometrical characteristic in Vietnamese.

As for nutrient intake, the energy intake of Vietnamese was higher in terms of carbohydrates, but lower in fat than those of Fijians and Japanese. High energy consumption, as a percentage of fat intake, has been widely associated with insulin resistance and impaired glucose tolerance in western industrialized countries such as Fiji and Japan.[14]

The energy intake per kilogram of standard body weight for Vietnamese was similar to that of Fijians. However, the Vietnamese prevalence of obesity was low. This is because Vietnamese exhibited higher levels of physical activity and lower fat intake, both of which can prevent obesity. On the other hand, our findings suggest that Vietnamese women are at a high risk of fat deficiency. Energy intake derived from fat in our Vietnamese subjects was similar to that of the Japanese in the 1960s. At that time, Japan also experienced other disease problems like cerebral hemorrhage.[15,16] The dietary patterns of Japan, as well those of Vietnam, have changed rapidly with economic transition. Vietnamese may therefore control disease by following a change in dietary habits referring to the Japanese experience.

In conclusion, Fijians are at a high risk of diabetes mellitus, since the obesity and glycosuria rates of Fijians were higher than those of Japanese and Vietnamese. Energy and fat intakes were also highest in Fijians. The percentage of energy derived from fat was only 13% for Vietnamese women, while for Japanese and Fijian women, 30% of energy was from fat. It is hoped that the basic data obtained from this study will contribute to reducing the risk factors of Fijian, Japanese and Vietnamese women, thereby aiding the prevention of diabetes mellitus.

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