

The prevalence of diabetes mellitus and impaired fasting glucose/glycaemia (IFG) in suburban Katmandu : Ethnic aspect of a community-based study of native Nepalese and Tibetan immigrants during the democratic movements in 1990

佐々木, 悠
九州大学健康科学センター

川崎, 晃一
九州大学健康科学センター

大柿, 哲朗
九州大学健康科学センター

小林, 繁
大阪大学大学院文学研究科

他

<https://doi.org/10.15017/3522>

出版情報 : 健康科学. 27, pp.41-48, 2005-03-25. Institute of Health Science, Kyushu University
バージョン :
権利関係 :

— ORIGINAL —

The prevalence of diabetes mellitus and impaired fasting glucose/glycaemia (IFG) in suburban Katmandu —Ethnic aspect of a community-based study of native Nepalese and Tibetan immigrants during the democratic movements in 1990—

Haruka SASAKI^{1)*}, Terukazu KAWASAKI¹⁾, Tetsuro OGAKI¹⁾,
Sigeru KOBAYASHI²⁾, Kazue ITOH³⁾, Yutaka YOSHIMIZU⁴⁾,
Sashi SHARMA⁵⁾ and Gopal P. ACHARYA⁵⁾

Abstract

To clarify the role of ethnicity and lifestyle in Type 2 diabetes, we reanalyzed the results of a study originally done in 1990 at the Jawalakhel Tibetan refugees camp and suburban Bhadrakali in Katmandu. A total of 539 Tibetan immigrants in Jawalakhel 20 years old or greater participated in this study, consisting of 236 males and 303 females, vs 121 males and 165 females who are native Nepalese (ethnic composition, Newar and Parbate Hindu) in Bhadrakali. Blood samples after overnight fasting were frozen for analysis in Japan. Not only the anthropometric status, total energy intake, and maximal oxygen uptake ($\dot{V}O_2$ max), but also the fasting insulin and fructosamine were recorded. A diagnosis of diabetes was determined based on the new criteria of ADA-1997. Remarkably lower rates of diabetes and impaired fasting glucose (IFG) were found in Jawalakhel and Bhadrakali in 1990 (diabetes and IFG; 1.9 % and 1.3 % vs 1.4 % and 2.5 %, respectively) than were found in a more recent survey done by Singh and Bhattarai (2003). Fructosamine was in the normal reference range for all subjects. The fasting insulin and homeostasis model assessment of insulin resistance (HOMA-IR) did not differ between the sexes, however, the HOMA-IR values were significantly higher in Jawalakhel than in Bhadrakali. The total energy intake was significantly higher in Bhadrakali than in Jawalakhel. However, the prevalence of obesity was significantly higher in Jawalakhel than in Bhadrakali despite similar $\dot{V}O_2$ max values in both communities. Our newly analyzed results provide baseline features for planning health care measures and establishing medical priorities for the modern citizens of Katmandu.

Key words: Diabetes mellitus, Impaired Fasting Glucose (IFG), Prevalence, Tibetan immigrants, Katmandu, Nepal

(Journal of Health Science, Kyushu University, 27: 41-48, 2005)

1) Institute of Health Science, Kyushu University, Fukuoka, Japan (Present: H.S., Division of Endocrine and Diabetic Medicine, Chikushi Hospital, Fukuoka University, Chikushino, Japan; T.K., Kyushu-Sangyo University, Fukuoka, Japan)

2) Graduate School of Letters (Cultural Geography), Osaka University, Osaka, Japan

3) Nakamura-Gakuen University, Fukuoka, Japan (Present: Aichi Gakusen University, Aichi, Japan)

4) Institute of Health and Sports Science, Kurume University, Kurume, Japan

5) Institute of Medicine, Tribhuvan University, Katmandu, Nepal

*Correspondence to : Haruka SASAKI, MD, PhD, Endocrine and Diabetic Medicine, Chikushi Hospital, Fukuoka, University, 377-1, Zokumyoin, Chikushino-Shi, Fukuoka, 818-0067, Japan
Tel: +81-92-9211011, Fax :+81-92-9280856 E-mail: sasaki@fukuoka-u.ac.jp

Introduction

Type 2 diabetes mellitus has been recognized to be a major global epidemic, with the prevalence of diabetes now rapidly increasing in many developed and/or developing Asian countries¹⁻⁷. No indexed study has been published to date showing an accurate prevalence of diabetes in developing countries such as Nepal. To clarify the relationship between ethnicity and lifestyle, we also reanalyzed the results of a study we did in March and September 1990 in the suburban region of Bhadrakali, Nepal (native Nepalese: ethnic composition, Newar and Parbate Hindu)⁸⁻¹⁰, and Jawalakhel, a Tibetan refugees camp established in 1960 by the International Committee of Red Cross^{11,12}, respectively. We also compared the data from the our studies with the data from Singh and Bhattarai¹³, who used the same new diagnostic criteria of ADA-1997¹⁴ and WHO-1998 without oral glucose tolerance test(O-GTT)¹⁵ and the same age distribution. Two typical suburban areas in Katmandu that have distinctive features were selected as survey sites in this study. Our study is community-based study, not a population-based survey. The participants of our study thus comprised a relatively homogeneous population. This is the first report on the prevalence of diabetes among Tibetan refugees in Nepal.

Materials and Methods

Subjects

The "Japan-Nepal Health Scientific Expedition" group in 1990 included members of the Institute of Medicine, Tribhuvan University and Japanese specialists⁶. Nepalese subjects were selected in two distinctly different representative areas: a suburban village, Bhadrakali in the Katmandu District and a Tibetan refugees camp, Jawalakhel in Patan City. Bhadrakali is located in a suburban area about 5-km northwest of the center of Katmandu, and it is easily accessible by public transportation, taxi and bike. As a result, many people from Bhadrakali earn their living in Katmandu. The population of individuals over 20 years of age was approximately 1,050 in 388 households at the time of the study. Most of the inhabitants were engaged in agriculture (83%) while

some others were also wage earners (9%). In contrast, the Tibetan immigrants all lived in a Tibetan refugee camp located in a suburban district of Katmandu in Nepal. The Tibetan refugees had migrated to Nepal from the Tibet Autonomous Region of China after the Dalai Lama was granted asylum in India in 1959^{11, 12}. Many Tibetans have thus relocated to Jawalakhel, which is situated in an urban area of Patan City (Lalitpur), neighboring Katmandu, and which is also easily accessible by public transportation and taxi. The total Tibetan population 20 years of age and over was approximately 813 at the time of the study. About 66.2 % of the Tibetan immigrants population, 236 males and 303 females participated in this study. Over half of the participants were Tibetan carpet weavers(58%) with the remainder comprising office workers(11%), merchants(10%) and others (21%).

Study design

The study protocol was approved by the Tribhuvan University Research Division and Ethnic Committees. The best ways to approach the subjects, to explain the survey and obtain their consent for participation were planned for about one month (March 1990 in Bhadrakali and September 1990 in Jawalakhel) beforehand with the help of local social organizations and the leaders of each community. If an individual agreed to be a study subject, then we gave that person a free physical examination including taking a complete history by well-trained Nepalese physicians. Pregnant women, residents younger than 20 years of age, those with an active infection and postprandial subjects were excluded from this analysis. Approximately 10 ml of venous blood was drawn from the subjects using an ethylenediamine tetraacetic acid (EDTA) tube (Nunc Cryo Tube No. 363401, 1.8ml, Denmark) and at both the ward-office in Bhadrakali and at the public local clinic in Jawalakhel. None of the subjects had been taking any medication.

Blood samples were centrifuged and kept frozen at -40°C until a biochemical analysis [total cholesterol, high density lipoprotein (HDL) cholesterol, triglyceride and others] was done within 7 days after being transported in dry ice by air to Japan. Some samples were measured at the Tribhuvan University Clinical Laboratory. Each participant received a copy of his/her

own biochemical results. The blood biochemistry analysis (by standard techniques using auto-analyzer (Olympus AV-500, Olympus Optical Co., Ltd., Tokyo) included fasting plasma glucose (FPG; glucose oxidase/peroxidase method), fasting immunoreactive insulin (F-IRI; Phadeseph Insulin RIA kit; Sweden) and fructosamine (FRA)¹⁷⁾ and all samples were obtained after a 10-h overnight fast. The blood pressure (OMURON HEM 401C, Tateishi; Electronic Co., Tokyo), anthropometric variables, body composition [body mass index; BMI (Body weight; kg/height in m²)], percentage of body fat [% Fat; estimation from skinfold thickness and body surface area by using the equation of Nagamine and Suzuki¹⁷⁾], and maximal oxygen uptake ($\dot{V}O_2$ max) measured in 516 subjects (85 men and 65 women in Bhadrakali and 186 men and 180 women in Jawalakhel, respectively) by Margaria's indirect method¹⁸⁾ were recorded (Table 4).

A total of 240 subjects (114 men and 126 women) in Bhadrakali and 533 (233 and 300) in Jawalakhel participated in the nutritional survey (Table 3). Nutritional intake was measured by a 24-h recall questionnaire¹⁰⁾. More than 30 foods representative of the local diet were collected in both areas, dried to a constant weight at -80°C in Tribhuvan University, and transported to Japan for analysis of their nutrient content. The details of these measurements have been published elsewhere⁸⁾⁻¹⁰⁾. At the time of the original study, no criteria for population-based mass screening of Type 2 diabetes had yet been established. Therefore, our data from 1990 were recently reanalyzed using the guidelines for impaired fasting glucose (IFG) and diabetes based on the current diagnostic criteria of the ADA¹⁴⁾ and WHO-1998 without O-GTT^{11),15)}. Participants with a fasting plasma glucose (FPG) concentration of less than 110mg/dl(<6.1 mmol/l) were classified as normoglycemic, those with FPG between 110 and 125 mg/dl(6.9 mmol/l) were considered to have IFG, and those with FPG greater than 126 mg/dl(7.0 mmol/l) were considered to have diabetes^{11),14),15)}. The values as an indicator of insulin resistance for subjects were calculated using the following formula:

$$\text{HOMA-IR} = [\text{F-IRI} (\mu\text{U/ml}) \times \text{FPG} (\text{mg/dl}) \div 405]^{19)}.$$

where HOMA-IR is the homeostasis model assessment of insulin resistance.

Statistical analysis

The statistical results are expressed as the mean \pm SD analysis of the data, including between-group comparisons using the Chi-square method, the unpaired Student's t-test, or the non-parametric test. A P value of < 0.05 was considered to be significant.

Results

As shown in Table 1, we analyzed a total of 286 inhabitants in the suburban Bhadrakali area and 539 in the Tibetan refugee camp, Jawalakhel were analyzed as shown in Table 1. The prevalence of diabetes mellitus and IFG for subjects aged 20 years or over was 1.4 % and 2.5 % respectively, in Bhadrakali village. In Jawalakhel, seven cases of diabetes (1.3 %) and six of IFG (1.1 %) were found. The mean values (SD) of serum biochemical variables (total cholesterol, protein), HOMA-IR and FRA for the subjects by sex and village were significantly different between Jawalakhel and Bhadrakali as shown in Table 2. The FRA values were in the normal reference range (205-285 $\mu\text{mol/l}$) in all subjects in both communities. An FPG level of over 140mg/dl was found in three elderly persons in Bhadrakali and four in Jawalakhel. According to these results, we previously reported an extremely low rate of diabetes mellitus in both communities Nepal in 1990 (in Japanese)⁸⁾. The total energy intake was significantly higher in Bhadrakali than in Jawalakhel (Table 3). Not only the protein intake and fat intake (especially animal protein) but also the crude fiber intake was significantly higher in Bhadrakali than in Jawalakhel. The quality and quantity, however, were exceedingly low in both communities compared to those currently recommended in Japan²⁰⁾ and the U.S.A.²¹⁾. The carbohydrate intakes were relatively lower in Jawalakhel than in Bhadrakali (Table 3). The mean biochemical values in all subjects were not significantly different from the mean values found in those who participated in the daily nutrient survey. Although the number of subjects was small because only relatively young people participated in the exercise test in Bhadrakali, the $\dot{V}O_2$ max was similar for both sexes and communities and there was a decreasing trend regarding age in both communities (Table 4). However, some subjects with moderate obesity (Bhadrakali, 3 males and 6 females; Jawalakhel, 27 males and 46 females, BMI ≥ 25 kg/m²

Table 1. The number and percentage of subjects with diabetes (DM) and impaired fasting glucose (IFG) by sex and age in Jawalakhel, Tibetan refugee camp, and in suburban Bhadrakali community studied in 1990

Site	Age, years	Male				Female				Total			
		DM	IFG	Obesity	Number	DM	IFG	Obesity	Number	DM	IFG	Obesity	Number
Jawalakhel													
20–39		0	0	8 (6.7)	120	0	0	16(10.7)	149	0	0	24 (8.9)	269
40–59		1(1.2)	2(2.4)	15(12.9)	85	2(1.7)	2(1.7)	26(22.6)	115	3	4(2.0)	41(20.5)	200
≥60		2(6.5)	2(6.5)	4(4.7)	31	2(5.1)	0	4(10.3)	39	4	2(2.9)	8(11.4)	70
Total		3(1.3)	4(1.7)	27(11.4)	236	4(1.3)	2(0.7)	46(15.2)	303	7(1.3)	6(1.1)	73(13.5)	539
Bhadrakal													
20–39		0	1(1.5)	1(1.7)	66	0	2(2.9)	2(2.9)	69	0	3(2.2)	3(2.2)	135
40–59		0	1(3.1)	1(3.1)	32	0	0	3(5.0)	60	0	1(1.0)	4(4.3)	92
≥60		3(13.0)	1(4.3)	1(4.3)	23	1(2.7)	2(5.6)	1(2.8)	36	4(6.8)	3(5.1)	2(3.4)	59
Total		3(2.4)	3(2.5)	3(2.5)	121	1(0.6)	4(2.4)	6(3.6)	165	4(1.4)	7(2.5)	9(3.1)	286

Percentage in parentheses. Obesity : Body Mass Index $\geq 25(\text{kg/m}^2)$

Table 2. The body mass index and index of insulin resistance (HOMA-IR) and blood biochemical variables of the subjects by sex and the community

	Male		Female	
	Jawalakhel	Bhadrakali	Jawalakhel	Bhadrakali
BMI (kg/m^2)	$21.3 \pm 3.1^{\#}$	19.5 ± 2.3	$22.0 \pm 3.5^{\#}$	19.6 ± 2.5
Ranges of BMI	15.7—33.5	14.6—25.7	15.4—35.1	15.3—25.6
FPG (mg/dl)	87 ± 14	85 ± 16	86 ± 12	84 ± 12
F-IRI ($\mu\text{U/ml}$)	7.1 ± 4.0	6.2 ± 6.1	8.0 ± 4.0	5.9 ± 5.6
HOMA-IR	$1.6 \pm 1.0^{\#}$	1.1 ± 0.9	$1.8 \pm 1.2^{\#}$	1.2 ± 1.4
Fructosamine ($\mu\text{M/l}$)	$210 \pm 20^{\#}$	223 ± 23	$214 \pm 18^{**}$	219 ± 23
Total protein (g/dl)	$7.7 \pm 0.4^{\#}$	7.9 ± 0.5	$7.8 \pm 0.4^*$	7.9 ± 0.6
Albumin (g/dl)	$4.4 \pm 0.2^{\#}$	4.5 ± 0.3	4.4 ± 0.2	4.4 ± 0.3
Total cholesterol (mg/dl)	$158 \pm 33^{\#}$	148 ± 37	$163 \pm 34^{\#}$	153 ± 34
HDL-cholesterol (mg/dl)	$43.7 \pm 9.8^{\#}$	39.0 ± 11.1	48 ± 11	42.7 ± 9.7
Triglyceride (mg/dl)	$111 \pm 48^{\#}$	148 ± 90	$98 \pm 40^{\#}$	125 ± 62

Mean \pm SD, Obesity : Body Mass Index $\geq 25(\text{kg/m}^2)$,

HOMA-IR : homeostasis model assessment of insulin resistance

Number of participants in parentheses.

* $p < 0.05$, ** $p < 0.01$, # $p < 0.001$ (vs. values of Bhadrakali by a non-parametric test)

Table 3. Daily nutrient intakes and composition of the subjects by sex and community

	Male		Female	
	Jawalakhel	Bhadrakali	Jawalakhel	Bhadrakali
Energy intake (kcal/day)	$2480 \pm 909(233)^{**}$	$2815 \pm 939(114)$	$2182 \pm 715(300)^{**}$	$2608 \pm 885(126)$
Protein (%)	$12.3 \pm 2.0^{\#}$	10.8 ± 1.7	$11.9 \pm 1.8^{\#}$	11.1 ± 1.8
Fat (%)	$20.0 \pm 8.1^{\#}$	11.4 ± 4.4	$22.9 \pm 9.9^{\#}$	11.2 ± 4.8
Animal protein ratio (%)	26.4 ± 11.6	9.9 ± 7.4	25.2 ± 10.7	9.3 ± 6.7
Carbohydrate (%)	$67.7 \pm 12.2^{\#}$	77.8 ± 5.6	$65.2 \pm 11.7^{\#}$	77.7 ± 5.7
Crude Fiber (g/day)	$6.9 \pm 3.7^{\#}$	12.4 ± 5.8	$6.4 \pm 3.0^{\#}$	11.9 ± 4.8

Mean \pm SD, Number of participants in parentheses.

* $p < 0.05$, ** $p < 0.01$, # $p < 0.001$ (vs. values of Bhadrakali by a non-parametric test)

Table 4. Percentage of body fat (% Fat) and physical activity shown as the maximal oxygen uptake ($\dot{V}O_2$ max) of the subjects by sex and community

Sex Sites Years old	Male				Female			
	Jawalakhel		Bhadrakali		Jawalakhel		Bhadrakali	
	% Fat	VO2 max	% Fat	VO2 max	% Fat	VO2 max	% Fat	VO2 max
20-29 y.o	13.3 \pm 4.1(65)*	46.2 \pm 8.0(64)**	11.8 \pm 3.0(42)	42.1 \pm 6.2(38)	22.7 \pm 5.9(86) [#]	35.6 \pm 5.9(74)	15.8 \pm 4.4(42)	36.4 \pm 5.0(32)
30-39 y.o	15.4 \pm 5.5 (55)**	39.9 \pm 8.2(47)	12.4 \pm 3.6(24)	39.4 \pm 5.6(21)	24.3 \pm 7.5(63) [#]	34.6 \pm 5.0(72)	16.3 \pm 5.4(29)	33.1 \pm 4.7(5)
40-49 y.o	16.5 \pm 6.8 (28)	34.1 \pm 25.5(24)	12.5 \pm 3.5(11)	37.5 \pm 5.7(7)	23.6 \pm 7.2(67) [#]	32.3 \pm 4.5(41)	14.8 \pm 4.7(21)	33.9 \pm 5.2(6)
50-59 y.o	15.5 \pm 5.8 (57)**	32.2 \pm 5.2(38)	11.1 \pm 3.1(22)	34.3 \pm 5.1(11)	25.1 \pm 7.6(48) [#]	30.7 \pm 3.4(13)	15.0 \pm 5.2(20)	30.8 \pm 5.5(65)
≥ 60 y.o	15.8 \pm 5.0 (31) [#]	31.2 \pm 5.3(13)	11.3 \pm 2.4(22)	32.3 \pm 1.7(8)	18.8 \pm 7.0(39)**	29.8 \pm 2.1(2)	13.0 \pm 4.4(14)	n.d
Total	15.3 \pm 5.4(236)	39.3 \pm 9.1(186)	11.8 \pm 3.1(120)	39.2 \pm 6.5(85)	29.9 \pm 7.0(303) [#]	34.2 \pm 5.4(180)	14.8 \pm 4.8(140)	34.6 \pm 5.9(22)

Mean \pm SD, % Fat : Percentage of body fat, $\dot{V}O_2$ max : Maximal oxygen uptake (ml/kg/min),

Number of participants in parentheses, n.d : not determined

* p<0.05, ** p<0.01, [#]p<0.001 (vs. values of Bhadrakali by a non-parametric test)

based on the 2002 criteria of the Japan Society for the Study of Obesity ²²⁾ were found, as shown in Table 1. The prevalence of obesity was significantly different, namely it was much higher in Jawalakhel (13.5%) than in Bhadrakali (3.1 %), especially in middle-aged and elderly persons in Jawalakhel (Table 1). The percentage of body fat (%Fat) was also significantly higher in Jawalakhel than in Bhadrakali in all age groups (Table 4).

Discussion

We read with great interest the short communication by Singh and Bhattarai¹³⁾ on the high prevalence of diabetes impaired glucose/glycaemia (IFG) (urban, diabetes and IFG: 14.9 % and 9.4 %; rural, diabetes and IFG: 4.1 % and 1.9 %, respectively) in the first heterogeneous population-based rural and urban Nepal survey using the new diagnostic criteria of ADA¹⁴⁾ and WHO-1998, which do not require an O-GTT¹⁵⁾. Recently, Karki and colleagues²³⁾, ²⁴⁾ also reported a high prevalence of Type 2 diabetes (6.3%; 1.6% previous and 4.7% new) in the urban areas of eastern Nepal in a hospital-based study of a heterogeneous Nepalese population using the modified WHO-1985 criteria. Some of the subjects were tested with O-GTT and also had their glycated hemoglobin measured²⁴⁾. After reading these statistics, we decided to reanalyze an area of Katmandu that had been surveyed in 1990, at the Jawalakhel Tibetan refugee camp, and in a suburban area of Bhadrakali, which were considered to be representative of the different ethnic origins groups currently seen in Nepal⁸⁾.

Our newly analyzed findings showed a relatively low prevalence of diabetes (1.4 %) and IFG (2.5 %) in Bhadrakali and 1.3 % and 1.1 % in Jawalakhel, even though the suburban area of Katmandu was included. Although the locations of the current survey by Singh and Bhattarai¹³⁾ were different, Bhadrakali probably demonstrates a similar in cultural lifestyle, diet, and nutritional status to that of Barbar Mahal, Balaju, and other similar areas of Katmandu that had been previously studied by them¹³⁾. However, Jawalakhel had a somewhat different cultural lifestyle, diet, and nutritional status in comparison to these areas. The daily diet of Tibetan immigrants consisted mainly of noodles, Tibetan bread, sanba and Tibetan tea. Tibetan tea is made from rock salt, butter, and tea, and it is rich in both saturated and mono-unsaturated fatty acid (data not shown). Tibetan tea may be one of the important nutritional foods for Tibetan immigrants.

In contrast, the usual daily diet of Bhadrakali villagers consisted mainly of bhaat, dido, and tarukali. Achar and dal were also seen in their diet. The staple foodstuffs in Bhadrakali were corn and wheat. Drinking tea with sugar was also common in Bhadrakali, whereas there was no habit of drinking Tibetan tea. The level of habitual activity is considered to be the most important factor influencing $\dot{V}O_2$ max. In both sexes, the mean $\dot{V}O_2$ max of the Tibetan immigrants was very similar to the levels seen in level the suburban group of native Nepalese in Bhadrakali. Half of the men and two thirds of the women worked as weavers at a factory for Tibetan carpet products. As the results, most of

the participants in Jawalakhel had basically a sedentary lifestyle and were relatively inactive physically.

It is not easy to evaluate why the total cholesterol concentration and protein as well as triglyceride levels differed between the communities, and no available data have yet been reported in Nepal. The HOMA-IR levels in Jawalakhel were significantly higher than in Bhadrakali but they did not correlate with the BMI in both Communities (data not shown). This type of impaired glucose regulation is not always related to the BMI. Our data suggest that the degree of obesity may therefore not play an essential role in the development of diabetes²⁵⁾. The relationship between obesity and insulin resistance may occur at lower levels of fatness in south Asians than in Europeans and/or Caucasians^{5), 25)}. Various lifestyle factors in Jawalakhel are probably also responsible for the low incidence of diabetes, in spite of an extremely high prevalence of obesity in comparison to that in Bhadrakali.

More, sophisticated methods are needed to determine the BMI, and more studies should be undertaken to explore the risk factors related to the prevalence of diabetes in different communities of the same country. Although ethnic-related differences in lifestyle factors may be partially related to a predisposition to develop diabetes, ethnic/racial variations have been reported to play a more determinant role²⁷⁾⁻²⁹⁾.

Recent heterogeneous hospital-based surveys also carried out by others³⁰⁾⁻³²⁾ have shown a surprising and dramatic increase in the number of diabetes cases in Nepal. Epidemiological studies regarding the role that ethnic and/or racial differences play in the prevalence of diabetes and obesity in both racially different populations in common environments, and in recent immigrant populations, have also provided important insight into the possible role that ethnicity and environmental variations play in the etiology of these disorders^{5), 27), 28)}. At the time of our study, no criteria for population-based mass screening of Type 2 diabetes had yet been established. There is considerable discordance between IFG and impaired glucose tolerance (IGT) and a lower sensitivity of IFG for predicting the development of diabetes^{25), 33)} or cardiovascular disease³⁴⁾. A higher prevalence of IGT than IFG has also been reported for all age-groups in an Asian cohort study²⁶⁾. As a result, it is possible that our findings underestimated the prevalence of undiagnosed diabetes in Nepal. However, it was very difficult to perform O-GTT even in Katmandu

at the time of that study.

The recent rapid increase of diabetes in Nepal¹³⁾, in comparison to our previous surveys in both communities in Nepal and in an ethnically different Tibetan population in Jawalakhel, appears to have been influenced more by socioeconomic development and/or dietary changes more than by ethnic differences. In fact, since the establishment of democracy in Nepal, urbanization, modernization, demographics and socioeconomic status have all dramatically changed in both urban and suburban Katmandu³⁵⁾⁻³⁸⁾. During the last 10 years, namely during the first decade of democracy, the lifestyle has dramatically changed from a traditional one to a modern one in both communities. Although it is not easy to compare the two surveys in question, a three to ten times higher prevalence toward diabetes was observed in Singh and Bhattarai's survey¹³⁾, even though the age distribution was the same.

Further follow-up research, particularly analyses of ethnic differences, will be necessary to clarify the relative role of the various factors contributing to the rising rate of diabetes and IFG in Nepal. The increase in diabetes and obesity, not only in the urban areas of Katmandu, but also among Tibetan immigrants, may be soon be a greater public health problem than infectious and/or inflammatory diseases. Our newly revised data therefore provide baseline features for the planning of local and national multi-agency measures and for the establishment of medical priorities in modern day Nepal.

Acknowledgments

This work was supported in part by Grants in Aid for Scientific Research from the Ministry of Education, Science and Culture, Japan (Nos.62041068&63043655). The authors thank all collaborators in this study, especially, Mr. Kurishina and Mrs. Chikako Tamang for help in recruiting volunteers in Jawalakhel and Bhadrakali villages. We also gratefully acknowledge the assistance of Dr. M. D. Bhattarai, Bir Hospital in Katmandu (Nepal Diabetes Association) for their critical discussions regarding our previous study.

References

- 1) Zimmet P, Alberti KGMM, Shaw S: Global and societal implications of the diabetes epidemic. *Nature*, 414: 782-787, 2001.
- 2) King H, Aubert ER, Herman WH: Global burden of diabetes, 1995-2025. *Diabetes Care*, 21: 1414-1431, 1998.
- 3) Wild S, Roglic G, Grees GA, Sicree R, King RH: Global prevalence of diabetes. Estimates for the 2000 and projection for 2030. *Diabetes Care*, 27:1047-1053, 2004.
- 4) The DECODA Study Group: Age and sex-specific prevalence of diabetes and impaired glucose regulation in 11 Asian cohorts. *Diabetes Care*, 26:1770-1780, 2003.
- 5) Chowdhury TA, Grace C, Kopelman PG: Preventing diabetes in south Asians, Too little action and too late. *BMJ*, 327: 1059-1060, 2003.
- 6) Cockram CS: The epidemiology of diabetes mellitus in Asia-Pacific region. *Hong Kong Med J* 6: 43-52, 2000.
- 7) Fugishima F, Kiyohara Y, Kato I, Ohmura T, Iwamoto H, Nakayama K, Ohmori S, Yoshitake T: Diabetes and cardiovascular disease in a prospective population survey in Japan. The Hisayama Study. *Diabetes*, 45 (Suppl.3): S14-16, 1996.
- 8) Report of Comparative Epidemiological Studies on the Genesis of Hypertension in Nepal. Second and Third Health Scientific Expedition., in T. Kawasaki T (ed), Institute of Health Science, Fukuoka Japan: Kyushu University, 1991, pp. 41-107. (in Japanese)
- 9) Kawasaki T, Itoh K, Uezono K, Ogaki T, Yoshimizu Y, Kobayashi S, Osaka M, Ogata M, Dhungel S, Sharma S, Acharya GP: Investigation of high salt intake in a Nepalese population with low blood pressure. *J Hum Hypertens*, 7: 131-140, 1993.
- 10) Itoh K, Kawasaki T, Ogaki T, Uezono K, Yoshimizu Y, Kobayashi S, Osaka T, Wakana C, Nakayama J, Onaka J, Acharya GP, Ogata M. Relationship between total cholesterol level and nutritional and physical status in Nepalese rural people. *J Nutr Sci Vitaminol*, 39: 127-139, 1993.
- 11) Jah HB: Settlement and rehabilitation, and Socio-economic life of the refugees, Tibetan in Nepal, Dalhli: Book Fath India, 1992, pp. 31-33 and pp. 56-79.
- 12) Goldstein MC: Ethnogenesis and resource competition among Tibetan Refugees in South India: A new face to the Indo-Tibetan Interface. in Fisher JF(ed), *Himalayan Anthropology: The Indo-Tibetan Interface*, Chicago: The Hague: Mouton, 1978, pp. 395-420.
- 13) Singh DL, Bhattarai MD: High prevalence of diabetes and impaired fasting glycaemia in urban Nepal. *Diabetic Med*, 20: 170-171, 2003.
- 14) Expert committee on the diagnosis and classification of diabetes mellitus: Report of the expert committee on the diagnosis and classification of diabetes mellitus. *Diabetes Care*, 20(Suppl 1): 1183-1197, 1997.
- 15) Alberti KGMM, Zimmet PZ, for the WHO Consultation: Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: diagnosis and classification of diabetes mellitus. Provisional report of WHO consultation. *Diabetic Med*, 15: 539-553, 1998.
- 16) Johnson RN, Metcalf PA, Baker JR: Fructosamine: a new approach to the estimation of serum glycation. An index of diabetes control. *Clinica Chemica Acta*, 127: 87-95, 1982.
- 17) Nagamine S, Suzuki S: Anthropometry and body composition of Japanese young and men and women. *Human Biol*, 36: 8-15, 1964.
- 18) Margaria R, Aghemo P, Rovelli E: Indirect determination of maximal O₂ consumption in man. *J Appl Physiol*, 20:1070-1073, 1965.
- 19) Matthews DR, Hosker JP, Rudenski AS, Naylor RA, Treacher DF, Turner RC: Homeostasis model assessment: insulin resistance and β -cell function from fasting plasma glucose and insulin in man. *Diabetologia*, 28: 412-419, 1985.
- 20) Food Exchange Lists, Dietary guidance for Persons with Diabetes. in Japan Diabetes Society(ed), Japan Association of diabetes Care and Education, Bunkodo Co Ltd. Tokyo; 2003.
- 21) Costacou T, Mayer-Davis ET: Nutrition and prevention of Type 2 diabetes. *Ann Rev Nutr*, 23: 147-170, 2003.

- 22) The Examination Committee of Criteria for 'Obesity Disease' in Japan: Japan Society for study of Obesity: New criteria for ' Obesity Disease' in Japan, *Circ J*, 66: 987-992, 2002.
- 23) Karki P, Baral N, M. Lamsal M, S. Rijal S, B.C.Koner BC, S. Dhungel S, S. Koirala S: Prevalence of non-insulin dependent diabetes mellitus in urban area of eastern Nepal: A hospital based study. *Southeast J Trop Med Public Health*, 31: 163-166, 2000.
- 24) Baral N, Konoer BC, Kark P, Ramaprasad C, Lamsal M, Koirala S: Evaluation of new WHO diagnostic criteria for diabetes on the prevalence of abnormal glucose tolerance in a heterogeneous Nepali population: The implication of measuring glycated hemoglobin. *Singapore Med J*, 41:264-267, 2000.
- 25) The DECODA Study Group on behalf of the European Diabetes Epidemiology Group in the international Diabetes Epidemiology Group: Age, body mass index and type 2 diabetes: associations modified by ethnicity. *Diabetologia*, 46: 1063-1070, 2003.
- 26) Qiao Q, Lindstrom J, Valle TT, Tuomilehto J: Progression to clinically diagnosed and treated diabetes from impaired glucose tolerance and impaired fasting glycaemia. *Diabetic Med*, 20:1027-1033, 2003.
- 27) Zimmet P: Kelly West Lecture 1991: Challenges in diabetes epidemiology: from west to rest. *Diabetes Care*, 15: 232-251, 1991.
- 28) Abate N, Chandalia M: The impact of ethnicity on type 2 diabetes. *J Diabetes Complications*, 17: 39-58, 2003.
- 29) Knowler WC, Pettitt DJ, Saad MF, Charles MA, Nelson RG, Howard BV, Bogardus C, Bennett PH: Obesity in Pima Indians: its magnitude and relationship with diabetes. *Am J Clin Nutr*, 53: S1543-1551, 1991.
- 30) Singh SL, Bhattarai MD, Maskey A: Dermographic profile of diabetic patients admitted in the medical ward of Bir hospital, Nepal, 1990 to 1994, *International Diabetes Digest*, 6: 87-88, 1995.
- 31) Bhattarai MD: Diabetes in Nepal, Diabetes in Middle East Eastern Mediterranean & South East Asia (DIMEMSEA), Second Conference, March 2-4, 2000, Dhaka Bangladesh.
- 32) Acharya GP. Diabetes mellitus at Teaching Hospital. 20th All Nepal Medical Conference of the Nepal Medical Association. February 28 to March 3, 2001, Birendra International Convention Centre, Kathmandu, Nepal.
- 33) Nakagami T, Qiao Q, Tuomilehto T, Balkav B, Carstensen B, Tajima N, Iwamoto Y, Broch-Jansen K and The DECODA Study Group: The fasting plasma glucose cut-point predicting a diabetic 2-h OGTT glucose level depends on the phenotype. *Diabetes Res Clin Pract*, 55: 35-48, 2002.
- 34) Tominaga M, Eguchi E, Manaka H, Igarashi K, Kato T, Sekikawa A: Impaired glucose tolerance is a risk factor for cardiovascular disease, but not impaired fasting glucose: Funagata Diabetes Study. *Diabetes Care*, 22: 920-924, 1999.
- 35) District development profile of Nepal, A development database for Nepal, in *Informal Sector Research and Study Center* (ed), Kathmandu: 2001, pp. 250-265.
- 36) Kathmandu Metropolitan City (2003), "City Development Strategy Report" City Planning Commission Office, Kathmandu Metropolitan City, URL: <http://www.kathmanducity.org/cds/cdsreport/cdsreport.htm> (accessed June 29, 2004)
- 37) Nepal Development Digest, Kathmandu District, in Rima N, Sharma H, Rimal S (ed), Dilli Bazar, Kathmandu: Natinal Research Associate Kathmandu, 1996.
- 38) Statistical Year Book of Nepal 2003, His Majesty's Government National Planning Commission Secretariat, Ramshh Path, Thapathali, Kathmandu: Centre Bureau of Statistics, 2003.