Epidemiology of diabetes mellitus in relation to other cardiovascular risk factors in Lebanon

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وبائيات السكّري بالنسبة إلى عوامل الاختطار القلبية الوعائية الأخرى في لبنان

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خلاصة: أجريت دراسة على 2518 لبنانياً (1138 من الذكور و1380 من الإناث) ممن تبلغ أعمارهم 30 سنة أو أكثر، وتبين منها أن المعدل الإجمالي لكلٍّ من انتشار السكّري غير المعتمد على الإنسولين ونقص تحمّل الغلوكوز يبلغ 13.1% و6.0% على التوالي. وكان انتشار السكّري غير المعتمد على الإنسولين متماثلاً في الجنسين، بينما كان معدل نقص تحمل الغلوكوز أعلى قليلاً بين الإناث، وارتفع المعدلان ارتفاعاً مطرداً مع تقدم السن. وكان عامل الاختطار الرئيسي هو البدانة (55% بين الذكور و67% بين الإناث). وكان المشاركون المصابون بالسكّري ونقص تحمّل الغلوكوز أكثر استعداداً للإصابة بمرض قلبي، وكان المستوى الوسطي لضغط الدم ومستوى ثلاثي الغليسريدات لديهم مرتفعاً بعض الشيء.

ABSTRACT A study of 2518 Lebanese subjects (1138 males, 1380 females) aged 30 years and over revealed an overall prevalence of non-insulin-dependent diabetes mellitus and impaired glucose tolerance of 13.1% and 6.0% respectively. The prevalence of non-insulin-dependent diabetes mellitus was similar in both sexes, while impaired glucose tolerance was slightly higher among females; both increased steadily with age. The main risk factor was obesity (55% in males, 67% in females). Participants with diabetes and impaired glucose tolerance were more likely to have heart disease, and had slightly higher blood pressure and serum triglycerides.

L'épidémiologie du diabète sucré en relation avec d'autres facteurs de risque de maladies cardio-vasculaires au Liban

RESUME Une étude réalisée auprès de 2518 Libanais (1138 hommes, 1380 femmes) âgés de 30 ans et plus a révélé une prévalence globale du diabète non-insulino-dépendant et de l'abaissement de la tolérance au glucose s'élevant à 13,1% et 6% respectivement. La prévalence du diabète non-insulino-dépendant était la même pour les deux sexes, tandis que celle de l'abaissement de la tolérance au glucose était légèrement plus élevée chez les femmes; la prévalence augmente régulièrement avec l'âge pour les deux affections. Le facteur de risque principal était l'obésité (55% chez les hommes et 67% chez les femmes). Les sujets diabétiques et ceux qui ont un abaissement de la tolérance au glucose risquaient davantage de contracter une cardiopathie, et avaient une pression artérielle et un taux de triglycérides sérique moyens légèrement plus élevés.

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Introduction

In the past decade, a number of epidemiological studies have shown a relatively high prevalence of non-insulin-dependent diabetes mellitus (NIDDM) and impaired glucose tolerance (IGT) in several Middle Eastern countries [*1–6*]. In one study in Lebanon published in 1990 [*7*], in which the diagnosis was not based on the World Health Organization (WHO) criteria for the diagnosis of NIDDM and IGT [*8*] and which depended primarily on the study of inpatients and people undergoing routine laboratory examination, the estimated prevalence of NIDDM and IGT in adults was 7%–8% and 10%–11% respectively. An earlier study conducted in 1969, which was based on venous blood glucose measured two hours after a 50 g glucose load, revealed a prevalence of 3.3% in a university hospital population, with a definite increase with age and obesity [*9*].

The present study was part of a comprehensive survey aimed at estimating the prevalence of diabetes and other cardiovascular risk factors in the adult Lebanese population. We report on the prevalence of NIDDM and IGT, based on the WHO criteria, in three cluster samples of ambulatory adult Lebanese subjects, aged 30 years and above. The results are correlated with other variables including age, sex, socioeconomic status, family history, serum lipids, blood pressure, body mass index (BMI) and waist/hip ratio (WHR).

Subjects and methods

Study population

Three communities were selected for this cross-sectional study conducted during the period November 1994 to September 1995. In each community, men and women aged 30 years and above were included in the study.

The first community was Aisha Bakkar (AB), a residential area in Beirut representing an urban population sample of low socioeconomic status. The participants included the population who utilized the community health centre of a local charitable organization, Dar El-Enaya (Society for the Care of Mother and Child), for their routine medical encounters and those registered in Dar El-Enaya social work registry receiving social and financial support. The second community consisted of the academic and nonacademic employees of the American University of Beirut (AUB). They included academic staff, nurses, paramedical workers, clerks, employees and executives. All of them were urban Lebanese and represented a higher socioeconomic status than the first community. The third included residents of Hammana (HAM) and its six neighbouring villages. Hammana is a semirural town in the Lebanese mountains, 30 km east of Beirut.

Recruitment

A letter explaining the objectives of the study was distributed to the three communities. The target population of Aisha Bakkar were contacted through the social workers of Dar El-Enaya, who explained the content of the letter to each participant. No incentives for participation were promised but the importance of screening and being part of a national survey were emphasized. As regards the American University of Beirut, a complete list of all active employees in January 1995 was obtained from the personnel department and everyone aged 30 years or more was sent the letter in English and Arabic; they were then contacted by telephone to make an appointment for interview and examination. The list of the population of Hammana and the six ad-

jacent villages was obtained from the municipality and re-checked by the two community nurses at Hammana health centre who had recently conducted a house-to-house survey. Each person received a letter in Arabic and was invited to participate by reporting to the Hammana health centre during a specified period and time. The persons surveyed were primarily involved in agricultural work, small businesses or municipality work.

Data collection

All data were collected at the three sites by the same research team who were trained for the work. Each member of the team was assigned a specific job: one for administering the questionnaire, one for anthropometric and blood pressure measurements, one for withdrawing blood, giving oral glucose and taking capillary blood glucose measurements and one for organizing the flow of participants and coordinating the work. Data collection took place at Dar El-Enaya health centre, Hammana health centre and the outpatient medical department at the American University Hospital for the AB, HAM and AUB communities respectively.

Each participant presented after an overnight fast and was first interviewed using a structured questionnaire which provided information about demographic variables, education, occupation, presence and/or family history of NIDDM and cardiovascular diseases, smoking habits, use of medications and, for women, reproductive history. Thereafter, height, weight and waist to hip girths were measured. After the participant had rested for five minutes, blood pressure (BP) was measured twice in a supine position using a mercury sphygmomanometer. Subsequently, 10 ml of venous blood were drawn from each participant. The serum was separated on site and stored at 4 °C until transportation within two to three hours to the American University of Beirut Medical Centre laboratory for the measurement of fasting serum glucose, total cholesterol [*10*], triglycerides [*11*], high density lipoprotein (HDL) cholesterol [*12*] and low density liopoprotein (LDL) cholesterol [*13*].

All participants, except those previously known to be diabetic, were then asked to drink 75 g of anhydrous glucose dissolved in 200 ml of water. Two hours later, a capillary blood glucose measurement was made using haemoglucotest strips and the Reflolux-S glucometer (Boehringer, Mannheim).

According to WHO criteria [*8*], individuals who received the oral glucose tolerance test were classified as having NIDDM if the fasting serum glucose was > 7.8 mmol/l (140 mg/dl) and/or the two hour glucose value was > 11.1 mmol/l (200 mg/dl); or as having IGT if the fasting serum glucose was < 7.8 mmol/l (140 mg/dl) and the two hour glucose value was between 7.8 and 11.1 mmol/l (140–200 mg/dl). In addition, participants previously diagnosed as diabetic and who were receiving oral hypoglycaemic drugs were classified as diabetic. There were no participants whose history fulfilled the criteria of insulin-dependent diabetes mellitus.

Statistical analysis was done using *SPSS* (version 6).

Results

Table 1 shows the age and sex distribution of the study population from the three communities. Of the total 2518 participants, 2117 (84.0%) were in the age groups 30–64 years. Participants 65 years and older comprised 16% of the total but the proportion was less in the AUB sample (4.8%) than in AB (21.1%) or HAM (25.4%).

Table 1 Age and sex distribution of the study population

Age (years)	Males								Females								All							
	AB (*n* = 186)		AUB (*n* = 650)		HAM (*n* = 302)		Subtotal (*n* = 1138)		AB (*n* = 472)		AUB (*n* = 371)		HAM (*n* = 537)		Subtotal (*n* = 1380)		AB (*n* = 658)		AUB (*n* = 1021)		HAM (*n* = 839)		Total (*n* = 2518)	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
30–39	27	15	218	34	47	16	292	26	66	14	149	40	93	17	308	22	93	14	367	36	140	17	600	24
40–49	40	22	170	26	75	25	285	25	100	21	111	30	138	26	349	25	140	21	281	28	213	25	634	25
50–59	48	26	157	24	56	19	261	23	149	32	79	21	128	24	356	26	197	30	236	23	184	22	617	25
60–64	23	12	68	10	30	10	121	11	66	14	20	5	59	11	145	11	89	14	88	9	89	11	266	11
≥ 65	48	26	37	6	94	31	179	16	91	19	12	3	119	22	222	16	139	21	49	5	213	25	401	16
Mean ± *s* (years)																								
30–64	48.7±9.6		45.4±9.9		47.8±9.6		46.4±9.8		49.8±9.3		43.5±8.9		47.9±9.6		47.2±9.6		49.5±9.4		44.7±9.5		47.9±9.6		46.8±9.7	
≥ 65	69.9±3.7		66.4±1.7		71.9±5.6		70.2±5.0		70.0±4.4		66.9±1.9		70.8±5.0		70.3±4.7		70.0±4.2		66.5±1.7		71.3±5.3		70.3±4.9	

AB = Aisha Bakkar *AUB = American University of Beirut* *HAM = Hammana* *s = standard deviation*

The prevalence of NIDDM and IGT in the three study samples is shown in Table 2. In both males and females there was the expected age-related rise in the prevalence of NIDDM and IGT and no significant differences were observed in these prevalence rates between males and females in all age groups, except for the age group above 65 years, in which the prevalence of IGT was significantly higher in females. In both males and females, the overall prevalence rates were 13.1% for NIDDM and 6.0% for IGT, but the prevalence rates were relatively very low (< 1%) in the age group below 40 years.

As shown in Table 3, the prevalence of NIDDM and IGT was significantly lower in the AUB (higher socioeconomic urban) sample than in the AB (lower socioeconomic urban) sample and the HAM (semi-rural) sample. These differences are accounted for, at least in part, by the lower mean age, lower family history of diabetes and the lower mean BMI in the AUB sample. The results of the HAM sample fell between AB and AUB, showing also a statistically significant lower prevalence of NIDDM ($P < 0.05$) than the AB sample. Again these differences are accounted for by the relatively younger mean age and relatively lower family history of NIDDM and mean BMI. In all three samples, participants aged 65 years and above showed a higher prevalence of both NIDDM and IGT than in the younger age groups.

The coexistence of other cardiovascular risk factors in normal participants and those with NIDDM and IGT aged 30–64 years is shown in Table 4. There was a significantly higher percentage of abnormal (increased) BMI and WHR in both male and female participants with either NIDDM or IGT when compared with normal subjects. The prevalence of obesity as measured by BMI was significantly higher in

Table 2 **Prevalence of non-insulin-dependent diabetes mellitus and impaired glucose tolerance by sex in the combined population samples in Lebanon**

Age (years)	Number examined	NIDDM						IGT	
		Previously diagnosed		Newly diagnosed		Total diabetics			
		No.	%	No.	%	No.	%	No.	%
Male									
30–39	292	3	1.0	0	0	3	1.0	3	1.0
40–49	285	18	6.3	7	2.5	25	8.8	16	5.6
50–59	261	29	11.1	13	5.0	42	16.1	20	7.7
60–64	121	21	17.4	7	5.8	28	23.1	10	8.3
≥ 65	179	42	23.5	9	5.0	51	28.5	15	8.4
30–64	959	71	7.4	27	2.8	98	10.2	49	5.1
Subtotal	1138	113	9.9	36	3.2	149	13.1	64	5.6
Female									
30–39	308	1	0.3	0	0	1	0.3	3	1.0
40–49	349	14	4.0	5	1.4	19	5.4	17	4.9
50–59	356	48	13.5	12	3.4	60	16.9	22	6.2
60–64	145	27	18.6	8	5.5	35	24.1	11	7.6
≥ 65	222	56	25.2	11	5.0	67	30.2	35	15.8
30–64	1158	90	7.8	25	2.2	115	9.9	53	4.6
Subtotal	1380	146	10.6	36	2.6	182	13.2	88	66.4
All									
30–39	600	4	0.7	0	0	4	0.7	6	1.0
40–49	634	32	5.0	12	1.9	44	6.9	33	5.2
50–59	617	77	12.5	25	4.1	102	16.5	42	6.8
60–64	266	48	18.0	15	5.6	63	23.7	21	7.9
≥ 65	401	98	24.4	20	5.0	118	29.4	50	12.5
30–64	2117	161	7.6	52	2.5	213	10.1	102	4.8
Total	2518	259	10.3	72	2.9	331	13.1	152	6.0

both male and female participants with NIDDM ($P < 0.04$; $P < 0.001$) and those with IGT ($P < 0.009$; $P < 0.001$) when compared with normal. A similar highly significant difference was also observed when comparing obesity as measured by WHR. The degree of obesity (mean BMI) and its type (mean WHR) were more obvious in females with NIDDM and IGT than males.

In comparison with normal males and females, participants with NIDDM were characterized by a significant elevation of mean total serum cholesterol, triglycerides and LDL-cholesterol and a significant decrease in HDL-cholesterol. However, these differences were less obvious in males in whom, unlike females, the percentage of participants with NIDDM with a serum LDL-cholesterol > 150 mg/dl or with a serum HDL-cholesterol < 35 mg/dl were not significantly different from normal (Table 4).The results in participants with

Table 3 **Prevalence (%) of non-insulin-dependent diabetes mellitus and impaired glucose tolerance and related parameters in different socioeconomic and age (years) groups**

Diabetes	**Low urban (AB)** (n = 658)		**High urban (AUB)** (n = 1021)		**Semi-rural (HAM)** (n = 839)		**Total** (n = 2518)	
	30–64 (519)	≥ 65 (139)	30–64 (972)	≥ 65 (49)	30–64 (626)	≥ 65 (213)	30–64 (2117)	≥ 65 (401)
Previously diagnosed	13.9	30.2	3.0[a]	14.3[a]	9.6[b]	23.0	7.6	24.4
Newly diagnosed	3.3	2.2	1.9[b]	8.2	2.7	6.1	2.5	5.0
Total diabetics	17.2	32.4	4.9[a]	22.5[b]	12.3[b]	29.1	10.1	29.4
Impaired glucose tolerance	6.9	18.7	3.0[a]	2.0[a]	5.9	10.8[b]	4.8	12.5
Family history of NIDDM	50.7	37.4	36.0[a]	22.4	36.4[a]	27.2[b]	39.7	30.2
Mean age±s (years)	49.5±9.4	70.0±4.2	44.7±9.5[a]	66.5±1.7[a]	47.8±9.6[a]	71.3±5.3[a]	46.8±9.7	70.3±4.8
Mean BMI±s (kg/m²)	29.9±5.5	30.2±5.6	26.8±4.1[a]	28.2±5.0	28.2±4.7[a]	28.7±4.5[a]	27.9±4.8	29.2±5.0
Mean WHR±s	0.88±0.08	0.92±0.07	0.87±0.09[a]	0.92±0.06[b]	0.85±0.07[a]	0.89±0.07[a]	0.87±0.08	0.90±0.07

[a]$P < 0.01$ for comparisons of AUB with AB or HAM with AB [b]$P < 0.05$ BMI = body mass index WHR = waist hip ratio
s = standard deviation AB = Aisha Bakkar AUB = American University in Beirut HAM = Hammana

IGT showed the same trend, with all the above-mentioned serum lipid abnormalities being more obvious in females than in males (Table 4).

Modest but significant increases in systolic and diastolic blood pressure and a higher prevalence of heart disease were seen in both male and female participants with NIDDM or IGT. The presence of a positive family history of diabetes was significantly higher in both male and female Lebanese participants with NIDDM, in agreement with the study of Abou-Daoud [*9*] (Table 4). However, although the family history of diabetes was also higher in male participants with IGT, it was not statistically significant in females (Table 4). On the other hand, although the prevalence of consanguineous parents was generally high in the whole study population (22.9%–28.8%), it was not significantly higher amongst participants with NIDDM or IGT compared with normal participants.

The prevalence of current and past smoking amongst males was consistently higher than in female participants. The percentages of current smokers were almost the same amongst normal males and those with NIDDM or IGT; however there were more past smokers amongst male participants with NIDDM than normal participants. In females, the only observed difference was a lower frequency of current smokers amongst participants with IGT than in normal participants.

Discussion and conclusions

The target population of our study was about 3000 Lebanese aged 30 years and more distributed evenly among the three communities of Aisha Bakkar, the American University of Beirut and Hammana. One thousand in each community were ex-

Table 4 **Prevalence (%) of major risk factors among participants with non-insulin-dependent diabetes mellitus, impaired glucose tolerance and normal subjects aged 30–64 years old**

	Males					Females				
Risk factors	**NIDDM** 98 (10.1)	**IGT** 49 (5.1)	**N** 812 (84.7)	***P*** NIDDM vs N	***P*** IGT vs N	**NIDDM** 115 (9.9)	**IGT** 53 (46)	**N** 990 (85.5)	***P*** NIDDM vs N	***P*** IGT vs N
BMI: M > 27 kg/m²; F > 25 kg/m²	68.4	73.5	52.6	0.003	0.004	87.8	81.1	64.1	< 0.01	0.01
Mean ± *s*	29±3.7	29±3.6	28±3.8	0.004	0.009	31±5	31±6	28±5.4	< 0.001	0.001
WHR: M ≥ 1; F ≥ 0.9	20.4	16.3	6.3	< 0.001	0.01	32.2	13.2	10	< 0.001	NS
Mean ± *s*	0.96±0.05	0.94±0.06	0.92±0.06	< 0.001	0.03	0.88±0.05	0.84±0.05	0.82±0.07	< 0.001	0.001
Serum total cholesterol ≥ 240 mg/dl	31.6	16.3	16.1	< 0.001	NS	42.6	41.5	19.9	< 0.001	< 0.001
Mean ± *s*	222±57	205±31	201±46	0.001	NS	231±47	226±40	204±46	< 0.001	< 0.001
Serum triglycerides ≥ 160 mg/dl	69.4	59.2	43.7	< 0.001	0.03	63.5	50.9	27.5	< 0.01	< 0.001
Mean ± *s*	246±153	214±121	175±125	< 0.001	0.31	220±111	193±99	134±75	< 0.001	< 0.001
Serum LDL ≥ 150 mg/dl	32.7	10.2	26.5	NS	0.01	44.3	45.3	28.3	< 0.001	0.008
Mean ± *s*	138±48	124±27	130±36	0.09	NS	146±41	143±37	131±40	< 0.001	0.02
Serum HDL ≥ 35 mg/dl	53.1	44.9	46.4	NS	NS	27	22.6	12.8	< 0.001	0.04
Mean ± *s*	35±9	38±10	37±10	0.03	NS	42±12	44±11	48±12	< 0.001	0.04
Serum total cholesterol/ HDL ratio ≥ 5.0	76.5	75.5	65.1	NS	0.047	69.6	56.6	32.1	< 0.001	0.02
Systolic BP ≥ 165 mmHg	10.2	10.2	1.5	< 0.001	< 0.001	11.3	13.2	3.3	< 0.001	< 0.001
Diastolic BP ≥ 95 mmHg	10.2	12.2	5.7	< 0.001	0.006	11.3	17.0	6.3	< 0.001	< 0.001
History of heart disease	21.4	20.4	7.9	< 0.001	0.006	18.3	15.1	7.5	< 0.001	0.049
Family history of NIDDM	53.1	46.9	33.1	< 0.001	0.047	62.6	43.4	40.6	< 0.001	NS
Consanguinity	28.4	22.9	24.1	NS	NS	23.6	28.8	25.7	NS	NS
Past smoker	30.6	20.4	19.5	0.01	NS	8.7	11.3	9.8	NS	NS
Current smoker	34.7	42.9	37.1	NS	NS	26.1	13.2	27.4	NS	0.02

NIDDM = non-insulin-dependent diabetes mellitus *IGT = impaired glucose tolerance* *N = normal* *BMI = body mass index*
WHR = waist hip ratio *LDL = low density lipoprotein* *HDL = high density lipoprotein* *BP = blood pressure* *s = standard deviation*

pected to participate. A total of 2615 actually participated, i.e a response rate of 87.2%. Of these, 97 were excluded because of missing variables and thus 2518 people were included in the study (84% coverage). This method of inviting participants in defined communities has been used in many studies.

Of the 2518 participants, 1021 (40.5%) were from AUB, 839 (33%) from HAM and 658 (26%) from AB. Although we have no information on actual glucose or lipid levels of the non-participants, the distributions of the gender and different age groups among the participants (Table 1) were approximately similar to national distribution tables.

The prevalence of NIDDM and IGT in Lebanese subjects of both sexes aged 30 years and above, and especially after the age of 40 years, was higher than initially anticipated. However, the results are similar to those reported recently from other Arab countries [*1–6, 14*], especially from Oman, Saudi Arabia and Egypt, and from other non-Arab countries like Italy [*15*] and Jamaica [*16*]. The factors leading to the relatively high prevalence are probably similar to those concluded from the other studies, especially the impact of increasingly sedentary lifestyles and a higher prevalence of obesity. The increasing prevalence of obesity may also explain, at least in part, the increasing prevalence of NIDDM with age as found in this study.

There are no recent official census data from Lebanon. However, out of an estimated total population of 3 million, only 35% are over the age of 30 years. Accordingly, the overall national prevalence of NIDDM would be approximately 4.5%.

The prevalence of NIDDM in the present study was relatively higher than that of IGT, a pattern similar to what was reported in recent studies from Egypt, Italy and Jamaica [*14–16*] but different from the results reported from Saudi Arabia and Oman in which an almost equal prevalence of NIDDM and IGT were found [*2,3,5*].

As in many previous epidemiological studies of NIDDM, age and obesity appear to be the main risk factors associated with the increased prevalence of NIDDM and IGT. Obesity, in addition to a possibly higher positive family history of NIDDM, may explain the higher prevalence rates of NIDDM associated with a lower socioeconomic status, a finding which has also been noted in a recent study from Egypt [*14*]. However, unlike Egypt, in Lebanon the higher prevalence of NIDDM and IGT was not restricted to the urban female population but was also true of the semirural male and female population. The reason for this difference lies in the fact that in Lebanon, both the low socioeconomic groups, whether urban or semirural, were characterized by a higher prevalence of obesity; in Egypt, obesity was less common in the rural population [*15*].

Amongst the cardiovascular risk factors associated with NIDDM and IGT, increased BMI and especially abdominal obesity (as reflected in high WHR) were consistently present, in agreement with previous studies. The contribution of a positive family history is in agreement with the previous study from Lebanon [*9*]. However, a positive family history of diabetes was not statistically significant for IGT in females, reflecting the more important contribution of nongenetic factors, like obesity, which was more prominent in females. Although consanguinity continues to be as prevalent in Lebanon as it was reported in the 1969 study [*9*], its failure to influence the prevalence of NIDDM or IGT is not surprising as the inheritance of NIDDM is not monogenic.

A modest but significantly increased blood pressure in people with NIDDM and

IGT has been previously reported [*15*].Together with the tendency to dyslipidaemia, it reflects the tendency of several cardiovascular risk factors to cluster together in what has been labelled as syndrome X [*17*]. More studies are needed to examine the possible existence of insulin resistance as the common denominator in Lebanese people with the constellation of NIDDM or IGT, hypertension, abdominal obesity and dyslipidaemia.

The serum lipid abnormalities noted in Lebanese participants with NIDDM and IGT are similar to those noted in other countries in which the most consistent abnormality was modest hypertriglyceridaemia [*18*], while the more modest increase in total or LDL-cholesterol and fall in HDL-cholesterol was more obvious in females [*15,19*]. This finding is consistent with the clinical observation that the impact of NIDDM on cardiovascular diseases is particularly strong in females with NIDDM.

Although the prevalence of smoking amongst the Lebanese has apparently decreased in comparison with the figures quoted in the 1969 study [*9*], it continues to be high, especially amongst males. However, it was not apparently any higher amongst participants with NIDDM. The finding of a slightly higher percentage of past smokers among male participants with NIDDM might indicate a tendency in this subgroup to stop smoking perhaps as a result of a higher level of health awareness.

The results of this study indicate that, as in many developing countries, NIDDM in adults is becoming a major public health problem [*20*]. Major efforts by health policy-makers in these countries are needed to enhance public education and health care programmes that aim at early recognition and improved control of NIDDM [*22*]. The clustering of other cardiovascular risk factors with NIDDM and IGT deserves attention, especially in terms of their common denominators, namely sedentary lifestyle and excessive consumption of calorie-rich and high fat food.

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