Association of High Body Mass Index with Low Age of Disease Onset among Arab Women with Type 2 Diabetes in a Primary Care Clinic

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Abstract

Background: Type 2 diabetes is usually associated with obesity, and both conditions are frequently detected in the Arab population in Israel. Recent studies have demonstrated that diabetes can be prevented by a change in lifestyle.

Objective: To assess the prevalence of diabetes in an Arab community, the contribution of obesity to diabetes development, and the therapeutic potential of a preventive program.

Methods: Data were obtained from the medical files of diagnosed diabetes patients attending a primary care clinic in an Arab village in northern Israel.

Results: Type 2 diabetes was diagnosed in 323 patients of whom 63% were women. The prevalence of diabetes below age 65 years was significantly higher among women than men. Diabetic women were younger than men at diagnosis (48.27 vs. 59.52 years respectively) and were found to have higher body mass index (34.35 vs. 30.04 respectively) at diagnosis. The age at diagnosis of diabetes was strongly correlated with BMI ($r = 0.97$, $P < 0.0001$).

Conclusions: Women of Arab origin are at higher risk of developing type 2 diabetes compared to men. Obesity in women seems to be associated with higher diabetes risk as well as earlier appearance of the disease. Therefore, they will have the disease for longer and, consequently, will be at higher risk for complications.

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Type 2 diabetes is the most common metabolic disease encountered in primary care. The number of diabetic patients in the year 2000 was estimated to be 160 million worldwide; this number is expected to double in 25 years [1]. No wonder, then, that healthcare providers consider diabetes an epidemic. Increase in the prevalence of diabetes, in addition to the aging population, are the two principal reasons for this dramatic increase in the number of diabetic patients.

Microvascular as well as macrovascular complications of type 2 diabetes continue to pose a considerable medical threat causing significant morbidity and mortality among diabetic patients [2]. Given the frequency and severity of diabetic complications and the epidemic dimensions of the disease, diabetes has become a significant public health burden in terms of morbidity and mortality as well as economic cost [3].

Obesity has a pivotal role in the development of type 2 diabetes [4]. It is widely accepted today that obesity is closely related to increased insulin resistance [5], consequently the demand for insulin in obese individuals is substantially augmented. When the beta cell cannot compensate for the increasing demand for insulin, impaired glucose tolerance occurs, which subsequently becomes overt diabetes [6,7]. The role of obesity in type 2 diabetes was illustrated by Hu et al. [8], who showed that the risk of diabetes was 90 times higher when the body mass index increased from 24 to 39. Thus, the dramatic increase in the prevalence of diabetes in recent years is attributed mainly to the increase in the rate of obesity [9]. Fortunately, this risk factor can be modified and reversed. Recent studies have demonstrated that in subjects with impaired glucose tolerance the progress to overt diabetes can be substantially reduced by a modest reduction in body weight (5–7%) [10,11]. Furthermore, type 2 diabetes was reversed in 60% of diabetic subjects with morbid obesity after substantial body weight loss (30 kg) [12].

To evaluate the contribution of obesity to the prevalence of type 2 diabetes in our population, and to estimate the potential proportion of diabetic subjects in whom disease could be prevented, we examined the epidemiologic characteristics of all diabetic patients in our primary care clinic. In the population studied we found a high prevalence of type 2 diabetes among middle-aged women, which could be attributed to a high incidence of obesity. This situation may be prevented by prior lifestyle modification.

Subjects and Methods

Study population

The subjects of this study were all type 2 diabetic patients who are insured in the Clalit Health Services and attend the Ibelin Clinic. Every Israeli citizen has free access to the public health system based on the Israeli National Health Plan. Primary care is provided by four health management organizations; the largest is Clalit, which serves about two-thirds of the population in the country. Each citizen registered in Clalit has a medical file that contains information on the patient's medical history, pharmacy dispenses, laboratory results, outpatient visits, and specialist consultations.

This study was conducted at Clalit's Ibelin Clinic in an Arab village in northern Israel. Of the village's 8,000 inhabitants 90% are insured in Clalit. The clinic provides primary health services to 7,434 members of whom 4,545 are above the age of 18; 2,321

BMI = body mass index

of them are female and 2,224 are male. There was no statistical significance between the age and gender distribution of the adult clinic population and the distribution of the whole Arab population in Israel.

All patients with type 2 diabetes were identified. We defined a patient as having type 2 diabetes if the diagnosis was registered in his/her medical problems list, if he/she was on anti-hyperglycemic medication or fasting blood glucose was above 126 in at least two measurements. In this population, 92.6% had at least two measurements of fasting blood glucose in their files and 97.8% had at least a single blood glucose measurement. Subjects with type 1 diabetes were excluded from the analysis.

Measurement of subject characteristics

We reviewed the medical files to ascertain height and weight at each individual's clinic visit, starting from the measurement at diagnosis. If that was not available, the measurement closest to the time of diagnosis was used. Seventy-eight percent of patients had documented weight measurement within one year of diagnosis. The average duration between diagnosis of diabetes and the first documented weight measurement was 1.92 ± 1.2 year. We also used the laboratory results database to ascertain hemoglobin A1c and lipid measurements.

BMI, calculated as kg/m^2, was based on the first weight measurement after diagnosis and any recorded height since diabetes was diagnosed. Nearly 97% of individuals had this information available in their medical file.

Statistical analysis

We conducted all statistical analysis using an Excel software package. Chi-square test was used to evaluate significance when comparing proportions, and Student's *t*-test for comparing mean differences. $P < 0.05$ was considered statistically significant.

Results

There were 323 subjects with type 2 diabetes. The prevalence in this community was 7.1%, with 200 (8.6%) of the 323 diabetic subjects being female and 123 (5.5%) male; the male:female ratio was therefore 1:1.56, i.e., the rate of diabetes was 56% higher among female than male subjects.

Figure 1 presents the age distribution of both female and male diabetic subjects. As expected, the prevalence of diabetes was age-dependent. It increases substantially with age. However, while there was a higher prevalence rate of diabetes in female than male subjects among all groups, the difference was statistically significant only between the ages of 45 and 65 ($P = 0.003$), when the prevalence was significantly higher among women. Because there was a significantly higher prevalence of diabetes among young women, we examined the age of disease onset. The average age was 52.18 ± 16.12 years. However, the age of diabetes onset was gender-dependent, with women being younger than men (ages 48 ± 15.16 years vs. 59.51 ± 14.72 years, respectively, $P < 0.0001$). Thus, not only was there an increased prevalence in the disease among women but they also developed diabetes at a younger age.

Obesity is a major risk factor in the development of type 2 diabetes. To assess the contribution of obesity to the excessive prevalence of diabetes among women, we compared the distribution of BMI in both men and women. Table 1 demonstrates that women with diabetes are more obese than men: 77.5% of women were obese (compared to 42% of men) and only 12.5% of women were lean (compared to 30% of men).

To assess the contribution of obesity to the early development of diabetes among women, we examined the correlation between BMI and the age of disease onset. Figure 2 shows that the age of diabetes onset was strongly correlated with BMI ($r = -0.97$, $P =$

Table 1. Distribution of diabetic subjects (in percentage) according to gender and BMI

	Male	Female	*P*
Lean (BMI <27)	30	12.5	0.0113
Overweight (BMI 27–30)	28	10	0.0073
Obese (BMI >30)	42	77.5	0.0089

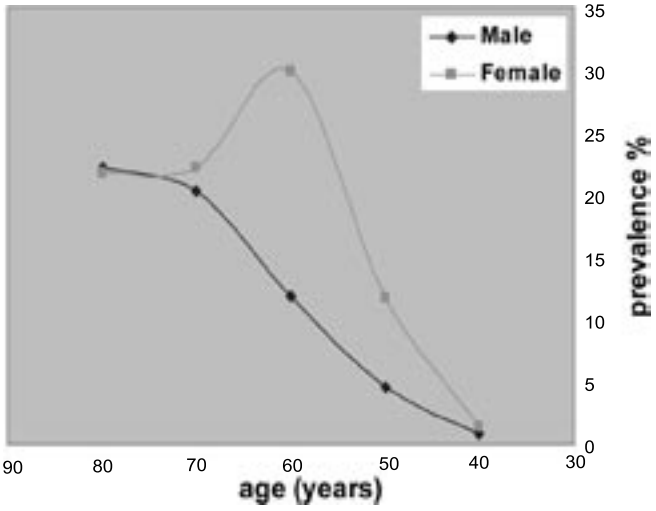

Figure 1. Prevalence of diabetes according to age and gender

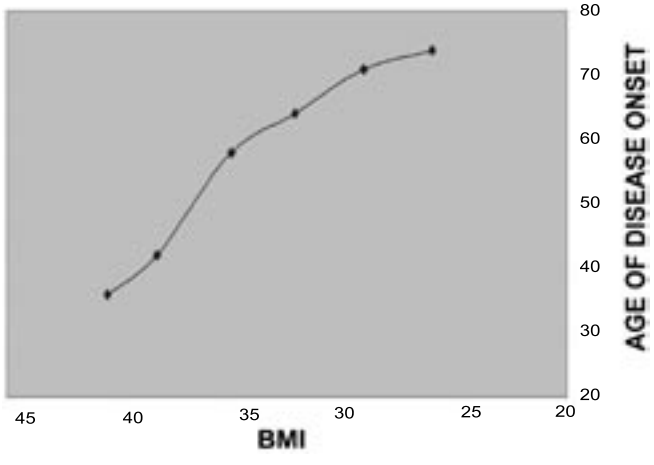

Figure 2. Relation between BMI and age at diabetes onset

Table 2. Distribution of age of disease onset according to BMI and gender

BMI	Male	Female
<27	73.6 ± 4.29	71.36 ± 3.2
27–30	67.3 ± 3.3	68.3 ± 3.9
30–35	62.13 ± 9.0	60.25 ± 5.3
34–38	54.2 ± 8.2	52.73 ± 6.72
>38	43.1 ± 7.07	41.06 ± 3.83

0.0002), suggesting that obesity plays a pivotal role in determining the age of diabetes onset. This correlation was gender-independent, and was observed among men and women [Table 2]. When the average BMI at the time of diagnosis was compared between men and women, women had significantly higher BMI than men (34.35 ± 4.82 and 30.04 ± 5.053 respectively, $P < 0.0001$).

Discussion

In this community, type 2 diabetes is a very common disease, with at least 7.0% of the adult population having the disease. Our study included 90% of the village population, and around 98% of them had at least a single fasting glucose measurement. Thus we can assume that the prevalence of diabetes in this study represents the prevalence of the disease in the entire village population.

The prevalence reported in this study is lower than that reported in other Arab communities in Israel [13], but it is comparable to the levels reported from western countries [14,15]. However, the 7% prevalence rate reported from Australia [14] and the United States [15] includes both diagnosed and undiagnosed subjects, while our studies included only those who were diagnosed. Since diabetes was diagnosed by fasting glucose only and not by an oral glucose tolerance test, and since the population was not surveyed to detect undiagnosed patients, we assume that a significant proportion of diabetes patients are still undiagnosed. For example, in the Australian study, where they used the OGTT to search the population, the rate of undiagnosed diabetes subjects reached as high as 50% of the total prevalence of the disease [14]. Therefore, we can assume that the real prevalence of type 2 diabetes in our community is higher than 7%. In a previously reported nationwide survey in Israel [16], which was based on examining fasting glucose only, the rate of undiagnosed type 2 diabetes was about 15% of the total prevalence rate. According to these figures we can estimate that the total diabetes prevalence is about 8%.

An important finding in our study was that diabetic women are more obese than men. The average BMI was significantly higher for women compared to men. Indeed, the percentage of obese subjects was significantly higher among women than men (77.5% and 42% respectively). On the other hand, only 12.5% of women were lean compared to 30% of men. Central obesity has a key role in diabetes, but unfortunately, measuring waist circumference is not a routine practice in Clalit Health Services, so this information was not available in the medical files. Our findings emphasize the need to introduce this parameter into routine clinical practice in the primary healthcare setting.

Because of the important role played by obesity in the pathogenesis of type 2 diabetes, the high rate of obesity observed among women may explain the excessive rate of diabetes among them. Moreover, consistent with other studies [17], the age of appearance of diabetes is directly related to the degree of obesity regardless of gender. The higher BMI observed among women at the age of disease diagnosis may explain the young age of women at diagnosis. Consequently, the prevalence of diabetes among women is especially high in the age group 45–65 years. Therefore, obesity was shown to have a dual effect in women in our community: it is responsible not only for the high rate of diabetes but also for the disease's development at a young age. This observation has important clinical significance, since disease duration is an important risk factor for diabetes complications, and microvascular complications in particular. Younger age of disease onset will result in longer duration of diabetes and higher risk for complications. Since obesity is a modifiable factor, if women in this community were to participate in a primary prevention program, such a program would not only reduce the incidence of diabetes, but subjects who still develop diabetes will be older and at lower risk for developing complications.

Type 2 diabetes is considered to show no major gender bias, however the similarity of our results to those from Europe and the U.S. in the first half of the last century is remarkable [18]. A similar high prevalence rate of diabetes among women of Arab origin was also reported from another Arab community in southern Israel [13]. We have no explanation for this higher prevalence of obesity and subsequently higher rate of type 2 diabetes and younger age of disease onset among women in this particular age group. Social factors probably played an important part in this, such as the high parity among women that is still common in the studied community, and the sedentary lifestyle of women as a consequence of housekeeping compared to men's work in jobs involving heavy physical labor.

We can assume that if we identify the obese women before they develop diabetes and introduce them to a diabetes prevention program [11], we could reduce the prevalence of diabetes among them, at least to the same level as men. Thus, at least 74 cases of diabetes (of 323 in our clinic) could have been prevented. Indeed, if patients with BMI >27 would have participated in such a prevention program (the Diabetes Prevention Program included subjects with BMI >24) then an additional 32 women and 51 men could be normalized. Hence, prevention of diabetes in this sample could potentially be between 74 and 157 individuals, representing about 50% of all diabetic patients in the clinic.

Diabetes is a common chronic disease with a high morbidity and mortality rate, and because of the economic burden it places on the healthcare system, a primary prevention program for diabetes among high risk individuals would be highly cost-effective in this community. Since individuals at high risk for diabetes are also at risk for other diseases such as hypertension and coronary heart disease, we believe that such a program would help prevent those diseases as well.

OGTT = oral glucose tolerance test

Conclusion

The high prevalence of obesity among diabetic women of Arab origin has two effects: it increases the prevalence of diabetes and causes longer duration of the disease, and exposes the patient to higher risk for developing complications. Therefore, an intervention study is urgently needed in this community, among women in particular, in order to reduce the prevalence of the disease and its complications.

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