# High Prevalence of Diabetes in Young Adult Ethiopian Immigrants to Israel

MARGO P. COHEN, ERVIN STERN, YAEL RUSECKI, AND ADINA ZEIDLER

**We performed oral glucose tolerance tests in 158 Ethiopian immigrants to Israel. The subjects were <30 yr of age, had lived in Israel ≤4 yr, and originated from villages in the Gondar and Ambovar regions of Ethiopia. Most had been subjected to famine conditions in Ethiopia and/or extreme hardship in Sudan before or during immigration. All were lean. They revealed a profound change in dietary habits since their arrival in Israel, with consumption of large amounts of refined carbohydrate in place of spicy stews and injura (Ethiopian pita) that had constituted dietary staples in better times in Ethiopia. According to National Diabetes Data Group criteria, 14 (8.9%) of the subjects had diabetes, and another 14 (8.9%) had impaired glucose tolerance. In addition, 13 subjects had a dramatic increase in capillary blood glucose levels (>300 mg/dl) 1 h after ingestion of 75 g glucose, despite fasting and 2-h values well within the normal range, and they complained of associated symptoms during the 1st h of testing. Eleven of 137 men and 3 of 21 women had diabetes; 7 (5.1%) of the men and 7 (33%) of the women had impaired glucose tolerance. These results indicate a high prevalence of diabetes among young adult Ethiopian immigrants of relatively short residency in Israel, for which the factors responsible warrant further investigation. *Diabetes* 37:824–28, 1988**

The prevalence and incidence of diabetes has been reported to vary among populations and among age groups of the same population (1–3). For example, the prevalence of diabetes is ~25% in Blacks >65 yr of age in the United States (4–6). Although the disease is almost unknown in some rural Polynesians, it is highly prevalent in urbanized Polynesian and Micronesian populations (7–10) and also in American Pima Indians (11,12). Most population studies have shown a rising prevalence of diabetes with age (3,9,13–16). Because the population of Israel is heterogeneous in origin, the prevalence of diseases that are influenced by polymorphic gene frequencies, such as diabetes, may be expected to differ among segments of the Israeli population (17). Indeed, we and others have found that the prevalence of diabetes differs among segments of the Israeli population when subjects are classified according to country of origin (18–24). We recently had a unique opportunity to study another distinct population, i.e., Ethiopian Jews who immigrated to Israel, and report here the results of the first survey to examine the prevalence of diabetes among Ethiopian Jews.

The Ethiopian immigrant community in Israel, which now numbers ~16,000, is unusual from several perspectives, some of which we believe afford special opportunities to learn more about the underlying genetic predisposition and environmental influences that contribute to the pathogenesis of diabetes mellitus. Ethiopian Jews trace their origin to the time of the destruction of the First Temple (586 B.C.E.), which precipitated a major wave of dispersal of Jews and of the Jewish religion from ancient Palestine (25). Their oral history recounts migration through the Nile valley to ultimate settlement in Ethiopia, where they lived in villages constructed on a tribal system and were ethnically, geographically, and genetically isolated for centuries.* About half of the immigrants arrived in Israel during the national rescue effort ("Operation Moses") between November 1984 and early 1985, and another 800–1000 have arrived since March 1985. Between 6000 and 7000 Ethiopians immigrated to Israel between 1980 and late 1984, whereas before 1979, there were 268 Ethiopian Jews in Israel. The newer immigrants live mainly

From the Department of Adult Endocrinology, Section of Diabetes, Beilinson Medical Center, Petah Tiqva; Tel-Aviv University Sackler School of Medicine, Tel-Aviv; and the Department of Biochemistry and Human Nutrition, Hebrew University, Rehovot, and Department of Food Science and Biotechnology, Institute of Technology, Haifa, Israel.
Address correspondence and reprint requests to Margo P. Cohen, MD, University City Science Center, 3508 Market Street, Suite 420, Philadelphia, PA 19104.
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*Some historians believe that Ethiopian Jews are indigenous Africans of Agau (ancient Ethiopian) origin who adopted Jewish faith and practice. If conversion occurred, by who and when is obscure.

in absorption centers, and most of the long-term residents live in identifiable communities. In both circumstances, Ethiopian Jews attempt to adhere to the religious and cultural customs that marked their way of life in Ethiopia, but in many ways they have undergone part of the inevitable process of urbanization that often accompanies resettlement in a more advanced society. Among the many notable differences these immigrants perceive in comparing life in Israel to that in Ethiopia are those pertaining to their dietary habits.

## SUBJECTS AND METHODS

We conducted our study between March and June 1987 by visiting absorption center study camps for young adult Ethiopian immigrants. Special arrangements, including multiple explanations of the design and purpose of our study to absorption center personnel and to the immigrants themselves, were required for each visit in view of sensitive political, religious, and cultural issues. Once these concerns were addressed, completion rates at the sites that we visited were 100%, with participation of all residents at those sites who were 18–30 yr of age and had resided in Israel for ≤4 yr. Screening was completed in 158 subjects, of whom 137 were men and 21 were women.

The subjects were not prepared with a formal diet and had been on unrestricted diets of their choice. Sample dietary histories taken from several subjects at each site and confirmed by the resident absorption center counselor indicated that the average daily intake of carbohydrate was >150 g. Notably, we learned that breakfast and supper included 3–5 slices of bread and tea or coffee with 4–6 heaping teaspoons of sugar and that lunch (which is the main meal in Israel) usually included ≥200 g of rice or noodles liberally flavored with spices of red and green peppers and hot paprika. The subjects ate little meat or fowl even though they were offered it in at least one meal per day.

All subjects were requested to report in a fasting state to the testing room between 0800 and 0900 h. Each subject was allocated a number, and personal identity thereafter remained confidential. However, the camp nurse or doctor was subsequently notified of those subjects in whom a diagnosis of diabetes was made. Each subject was interviewed, often with the aid of a camp social worker or translator, to obtain the following information: age, date of emigration, duration and conditions of journey, date of arrival in Israel, area of origin, known history of diabetes, family history of diabetes, other diseases, weight on arrival in Israel, and current weight and height. Capillary blood samples were obtained before and 1 and 2 h after 75 g glucose in 150 ml warm water was taken orally under the supervision of an investigator. Blood glucose measurements were determined from capillary blood with a refractometric method (Ames Glucometer, Elkhart, IN) and were performed by one of the investigators. The equipment was calibrated with appropriate standards and controls before each screening session and retested for accuracy against known standards at least once during each session.

The criteria used for the definition of diabetes were based on values proposed by the World Health Organization and the National Diabetes Data Group (26–28) and took into account the screening methods employed, i.e., use of capillary whole blood (29). These criteria were: fasting blood glucose >120 mg/dl plus a 1-h value >220 mg/dl and/or a 2-h value >220 mg/dl. Subjects with fasting capillary glucose levels <120 mg/dl but with a 1-h value >220 mg/dl and a 2-h value between 160 and 220 mg/dl were assigned to the category of impaired glucose tolerance.

TABLE 1
Prevalence of diabetes and impaired glucose tolerance in survey population

| | Diabetes | Impaired glucose tolerance |
|---|---|---|
| *n* (%) | 14 (8.9*) | 14 (8.9*) |
| Capillary blood glucose (mg/dl) | | |
| Fasting | 160 ± 23 | 111 ± 7 |
| 1 h | 306 ± 26 | 230 ± 29 |
| 2 h | 196 ± 22 | 188 ± 8 |

Data are from a survey population of 158 subjects. Capillary blood glucose values are means ± SE.
*Prevalence rates calculated for 95% confidence intervals were 8.9 ± 4.4.

TABLE 2
Prevalence of diabetes in survey population according to gender

| | Men | Women |
|---|---|---|
| Diabetic group | | |
| *n* | 11 | 3 |
| Percent | | |
| Of all in survey | 7.0 | 1.9 |
| Of corresponding sex | 8.0 | 14.3 |
| Years of age (range) | 24.0 (18–30) | 20.7 (20–21) |
| Impaired carbohydrate tolerance | | |
| *n* | 7 | 7 |
| Percent | | |
| Of all in survey | 4.4 | 4.4 |
| Of corresponding gender | 5.1 | 33.3 |
| Years of age (range) | 22.3 (20–25) | 22.6 (19–25) |

## RESULTS

The results of the survey with respect to the diagnosis of diabetes or impaired glucose tolerance are summarized in Table 1. Of the 158 subjects, 14 (8.9%) met the criteria for a diagnosis of diabetes, and 14 (8.9%) were classified as having impaired glucose tolerance. None of the subjects had been aware of carbohydrate intolerance or diabetes.

There were 137 men and 21 women in the survey group. Prevalence of diabetes and carbohydrate intolerance according to gender are summarized in Table 2. Three of the diabetic subjects and 7 of those with impaired glucose tolerance were women. Thus, as might be expected given that there were six times as many men as women in the survey population, the total number of men with abnormal carbohydrate tolerance exceeded that of women.* Nevertheless, and although it is recognized that the sample size was small, the prevalence of diabetes and impaired carbohydrate tol-

*Overall, there are two to three times more young men than young women in the Ethiopian immigrant population, and the mean age of young female immigrants is lower (<19 yr). This fact, coupled with the fact that five of the six randomly selected camps that we visited had male residents predominantly, biased our survey in favor of men.

TABLE 3
Capillary blood glucose values in subjects with abnormal peak response

| Gender | Age (yr) | Blood glucose (mg/dl) | | |
|---|---|---|---|---|
| | | Fasting | 1 h | 2 h |
| M | 24 | 73 | 306 | 149 |
| M | 28 | 69 | >400 | 151 |
| M | 28 | 90 | >400 | 67 |
| M | 29 | 101 | >400 | 115 |
| M | 23 | 92 | >400 | 104 |
| M | 24 | 66 | >400 | 151 |
| M | 25 | 116 | 371 | 120 |
| M | 23 | 50 | >400 | 93 |
| M | 23 | 52 | >400 | 134 |
| M | 25 | 54 | >400 | 71 |
| M | 22 | 72 | >400 | 100 |
| M | 27 | 81 | 320 | 130 |
| F | 22 | 73 | 333 | 141 |
| Mean ± SE | | 76 ± 5 | 390 ± 12 | 117 ± 8 |

erance in women (14.3 and 33.3%, respectively) exceeded that in men (8.0 and 5.1%, respectively). All subjects in the survey population were between 18 and 30 yr of age; ages in the diabetic group ranged from 18 to 30 yr and in the group with impaired carbohydrate tolerance, from 19 to 25 yr (Table 2). All subjects were lean, with a value for body mass index <27, calculated according to the formula weight (kg)/height $(m)^2$ (30,31). All had arrived in Israel after 1983.

There were 13 subjects (12 men, 1 woman) in the survey population who clearly exhibited abnormalities with glucose tolerance testing but who failed to meet criteria by conventional standards for a diagnosis of diabetes or classification of impaired glucose tolerance. The characteristic feature in this group was a 1-h value >300 mg/dl (in 9 subjects the 1-h postglucose level was >400 mg/dl) associated with symptoms of weakness, dizziness, nausea, fatigue, or general sense of lack of well-being. However, most symptoms subsided by the 2nd h after ingestion of glucose, when the capillary blood glucose level in each of these subjects was <150 mg/dl (Table 3).

## DISCUSSION

The overall diabetes prevalence of 8.9% in this group of 158 young adult Ethiopian Jews who recently immigrated to Israel is higher than that found in other urban societies; it is also higher than the prevalence estimated from most previous epidemiologic surveys of the Israeli population in general or of specific ethnic groups in this country. For example, the original survey by Cohen (22) of 15,000 Jews in Israel, in which subjects with blood glucose levels >170 mg/dl at 1 h and >120 mg/dl at 2 h after an oral glucose challenge were considered diabetic, reported an overall prevalence of 2.5% in Ashkenazim and 1.0% in non-Ashkenazim. A subsequent study, with venous blood glucose values of >190 mg/dl at 1 h and >140 mg/dl at 2 h after oral glucose (1 g/kg body wt), reported that the overall prevalence of diabetes in the surveyed Israeli population was 11.2%, with respective prevalences of 8.7% among Ashkenazic Jews born in Israel or Western countries and 12.6% among Yemeni Jews who had immigrated 18–25 yr earlier (32). However, all of the subjects in that study were >30 yr of age. Donchin et al. (21) defined diabetes according to serum glucose values of ≥2 points in the glucose tolerance test, or ≥130 mg/dl fasting together with either a random value ≥235 or a postglucose peak ≥270 mg/dl, and probable diabetes as 1.5 points on the glucose tolerance test, or fasting serum glucose ≥130 mg/dl together with either a random value between 190 and 234 mg/dl or a postglucose peak between 235 and 269 mg/dl. With these criteria, the prevalence rate of definite plus probable diabetes was 5.8% in men and 4.6% in women, which increased markedly with age and followed an order according to region of birth of North Africa > Israel > Asia > Europe. Using criteria similar to those of Donchin, we found an overall diabetes prevalence of 4.1% among 4660 Israeli adults between ages 30–65 yr, with prevalence lowest among Afro-Asian–born subjects, intermediate in American-European born, and highest in Israeli born (18). Prevalence rates were 0.7 and 1.2%, respectively, in subjects <39 yr of age and in the Afro-Asian–born group.

In contrast to the above, all of the subjects surveyed in this study were ≤30 yr of age. Furthermore, they are a distinct population that differs entirely in genetic and geographic origin from other ethnic Jewish subgroups and cannot be considered Ashkenazic, Sephardic, or Oriental (25). The overall prevalence of diabetes plus impaired glucose tolerance of 17.7% (11.75 to 23.65% for 95% confidence interval) in young adult Ethiopian immigrants is thus extremely high compared with that in all other segments of the Israeli population, especially when compared with that among young adults in such segments or in the Israeli population in general. The incidence and prevalence of type I (insulin-dependent) diabetes in Israel, for which data were available only for Ashkenazic and non-Ashkenazic groups, are reported to be among the lowest in the world (33,34).

Until information such as HLA antigen frequencies and islet cell autoimmunity is available, it is not possible to categorically state whether these subjects have early type I diabetes or type II (non-insulin-dependent) diabetes or whether they represent an atypical form of diabetes occurring in young lean adults. With respect to the former possibility, it is noted that subtle abnormalities in insulin secretion or moderate carbohydrate intolerance may precede symptomatic hyperglycemia by years (35–37). With respect to the latter possibility, it is noted that several syndromes of early-onset atypical diabetes have been described. These include maturity-onset diabetes of youth, type J diabetes, tropical pancreatic diabetes, and the recently reported maturity-onset diabetes of youth in Black Americans (26,38–43). Such atypical or "third diabetes syndromes" may predominate in certain parts of the world, particularly in underdeveloped countries (44). Given that our subjects are of subtropical, non-White origin, that they experienced chronic undernutrition for variable periods before and during immigration, and that they have chosen to consume relatively little protein in Israel, a type J or tropical pancreatic diabetes seems likely. Malnutrition and low protein intake both have been cited as contributory to the pathogenesis of atypical diabetes, although this finding is controversial (45–47).

The explanation for the abnormalities observed 1 h after glucose ingestion in 13 of the subjects is obscure. Although inadequate carbohydrate intake in the days before testing

is possible, this seems unlikely in view of the dietary histories that we obtained. Furthermore, the postglucose glycemic excursion seems inordinately high to ascribe to inadequate carbohydrate preparation. We intend to follow these subjects with repeat testing to determine whether overt diabetes develops and whether this abnormal response constitutes loss of phasic insulin secretion and is an early sign of evolving diabetes. If so, the diabetes prevalence rate in this group of young subjects would reach 26%.

The question of whether the prevalence of diabetes is similar among Ethiopians of a comparable age group residing in Ethiopia is pertinent. Information addressing this question is scant, and in fact, one recent article stated that "the incidence of diabetes in Ethiopia is unknown" (48). Nevertheless, it is noted in that report, which describes 121 hospitalizations of 116 diabetic patients in 3453 admissions to a general hospital during a 6-mo period, that 78% of the patients were >40 yr of age and that duration of diabetes was <10 yr in 80% of the 116 patients. A survey of 16,000 people in the Gondar area reported that the overall prevalence of diabetes was 0.6% and reached only 2.4% in subjects >40 yr of age (49). This information, and the calculated 95% confidence intervals for prevalence of diabetes (4.5%, 13.3%) and of diabetes plus impaired glucose tolerance (11.75%, 23.65%) in our surveyed population suggests that the prevalence of diabetes among 18- to 30-yr-old Ethiopian Jews immigrant to Israel is significantly greater than that in a comparably aged Ethiopian population residing in Ethiopia.

In summary, this study is the first to describe diabetes in a group of young adult Ethiopian Jews who immigrated to Israel. The high diabetes prevalence, coupled with clinical, geographic, and genetic considerations, suggests unusual and/or atypical pathogenetic factors that warrant further investigation.

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