Epidemiology of Childhood Type I Diabetes in Sudan, 1987–1990

ABDELAZIZ ELAMIN, MD
MOHAMED I.A. OMER, MD
KAMEL ZEIN, MD
TORSTEN TUVEMO, PHD

OBJECTIVE — To determine the incidence of type I diabetes in children 0–14 yr of age in Khartoum, Sudan.

RESEARCH DESIGN AND METHODS — Prospective registration of newly diagnosed patients in a hospital-based registry with independent validation of completeness of case ascertainment. Eligible patients were Sudanese children <15 yr of age, who developed type I diabetes during the period 1 January 1987 through 31 December 1990, and who were living in Khartoum city at the time of diagnosis. The denominator is the stable childhood population of Khartoum city, as estimated by the National Bureau of Statistics.

RESULTS — In 4 yr, 239 cases were notified in the primary source and 268 in the secondary source. Some 196 patients were registered in both sources. Using the capture-recapture method to correct for underascertainment, the estimated total number of cases was 327, and the overall degree of ascertainment was 95%. The incidence of type I diabetes in children 0–14 yr of age increased from $5.9/10^5$ in 1987 to $10.1/10^5$ in 1990 ($P < 0.001$). Girls exhibited slightly higher incidence rates than boys in the 10–14-yr age-group throughout the 4 yr, but the differences were not statistically significant. The age distribution at onset was bimodal with a clear peak at age 12 yr in girls and age 14 yr in boys and another smaller peak at age 7 yr in both sexes. The number of new cases was markedly higher in the cooler months of the year, with a peak in January and a nadir in June ($P < 0.01$). This trend was consistent over the period of observation.

CONCLUSIONS — Childhood diabetes is increasing in Sudan. Our incidence figures are higher than those reported from other Arab countries and is similar to reports from France and Italy.

FROM THE DEPARTMENT OF PEDIATRICS, UNIVERSITY HOSPITAL, KHARTOUM, SUDAN; AND THE DEPARTMENT OF PEDIATRICS, UNIVERSITY HOSPITAL, UPPSALA, SWEDEN.

ADDRESS CORRESPONDENCE AND REPRINT REQUESTS TO DR. TORSTEN TUVEMO, MD, PHD, DEPARTMENT OF PEDIATRICS, UNIVERSITY HOSPITAL, 751–85 UPPSALA, SWEDEN.

RECEIVED FOR PUBLICATION 8 JANUARY 1992 AND ACCEPTED IN REVISED FORM 23 JULY 1992.

TYPE I DIABETES, INSULIN-DEPENDENT DIABETES MELLITUS; CI, CONFIDENCE INTERVALS.

The epidemiology of type 1 diabetes in childhood has been documented for various populations around the world (1–4). However, on the African continent this sort of information is still scarce. It has been thought that the incidence of type I diabetes is low in Africa (5), but a brief study from Algeria in 1989 challenged this speculation (6). Herein, we report the findings of a prospective study on the incidence of childhood type I diabetes, as observed during the 4-yr period from January 1987 to December 1990 in Khartoum, Sudan.

RESEARCH DESIGN AND METHODS

Sudan is the largest state in Africa, with an area of 2.51 million square kilometers and 25 million people. Khartoum, the capital, is a large city that is bisected by the two branches of the Nile River into three towns. Ethnically, the majority of inhabitants of Khartoum have a homogeneous admixture of Arab and African heritage. The stable population of Khartoum was ~2.5 million in 1991 (7). The number of children 0–14 yr of age during the period 1987–1990 is estimated by the National Bureau of Statistics (Table 1).

Collection of data

As a part of an ongoing registry for young patients with type I diabetes, which was established in January 1987, a prospective registration of newly diagnosed diabetic children has been performed in all hospitals with pediatric wards in Khartoum. To be included in the registry, the diabetic child must be a Sudanese living in the Khartoum metropolitan area at the time of diagnosis. Data were collected according to standardized global guidelines (8). The name of the patient, age and sex, date at onset of diabetes, and presence of type I in siblings, parents, and close relatives were recorded. Date of diagnosis was defined as the day when the first insulin injection was given.

Ascertainment

As a secondary independent source for validation of case ascertainment, the rec-

Table 1—*Observed and estimated number of cases, ascertainment, and standardized incidence rate of type I diabetes in 0–14 yr-old children in Khartoum, Sudan 1987–1990*

Year	Denominator (total number of children in Khartoum)*	Observed cases by source			Estimated cases (CI)	Ascertainment (%)	Incidence rate/100,000/yr (CI)
		Primary	Secondary	Both			
1987	1,010,000	42	50	35	60 (56–64)	95.0	5.9 (4.4–7.4)
1988	1,025,000	56	61	43	79 (73–85)	93.7	7.7 (6.0–9.4)
1989	1,035,000	65	73	57	83 (80–86)	97.6	8.0 (6.3–9.7)
1990	1,045,000	76	84	61	105 (99–111)	94.3	10.1 (8.1–12.2)
Total	1,030,000	239	268	196	327 (317–337)	95.1	31.8 (28.4–35.2)†

*Estimated by National Bureau of Statistics.
†Cumulative incidence.

ords of the Juvenile Diabetes Foundation in Khartoum were used. To correct for incomplete registration and to calculate the degree of ascertainment, the capture-recapture method described by Cochi et al. (9) was used. With this method, it was possible to correct for underascertainment, and estimate the real number of children who developed type I diabetes in Khartoum during the study period.

Statistical analysis

The estimated real number of cases was used to calculate incidence rates and to compare girls and boys. Standardization of incidence rates was done by the direct method, using the 1983 census population as standard. The 95% CIs on incidence rates were calculated with the Haenzel et al. (10) Poisson distribution described by Lilienfeld and Lilienfeld (11). The effect of age and sex on incidence rates were tested by χ^2 statistics. To determine statistically significant seasonal trends, a method based on the Kolmogorov-Smirnov test was used (12).

RESULTS

Incidence rates

We identified 239 patients through hospital registration, and 268 patients were recorded in the secondary source. Of these patients, 196 were registered in both sources. Using the capture-recapture method, the overall degree of ascertainment was 95%, and the estimated real number of cases was 327. The observed and estimated numbers of cases and the standardized annual incidence rates and their CIs are shown in Table 1. The rise in incidence was steady, from $5.9/10^5$ in 1987 to $10.1/10^5$ in 1990. We observed more diabetic girls than boys, but the incidence rates of type I diabetes among girls were similar to those of boys in the age-groups 0–4 yr and 5–9 yr and were slightly higher in the age-group 10–14 yr; however, the difference was not statistically significant. Because no difference was noted in diabetes incidence between girls and boys and because of the small number of cases in each age-group, the data for both sexes were combined in the table.

Age at diabetes onset

The incidence of type I diabetes increased with age in this population. As expected, the highest rate in both sexes was in the 10–14-yr age-group. The mean age at diagnosis was 9.3 yr for boys and 9.1 yr for girls. The age distribution curve in both sexes showed a bimodality with a peak incidence around age 12 yr in girls and age 14 yr in boys and a smaller one at age 7 yr in both sexes (Fig. 1). A dramatic fall in incidence occurred at 14 yr of age in girls.

Seasonal variation

Figure 2 charts the month of diagnosis of diabetes in our population. Generally, more cases were diagnosed during the cooler months (November to February), with a peak in January and a low number of cases during summer (May-July) with the nadir in June. The difference was statistically significant ($P < 0.01$).

CONCLUSIONS— Until very recently, the epidemiology of childhood type I diabetes in Africa was almost unknown. In 1989, we documented the prevalence of type I diabetes in school children in Khartoum (13); and in 1991, we reported the preliminary results of 1-yr incidence study (14). This study is one of the first in Africa to determine the incidence of type I diabetes in children over a period of time using a validated epidemiological technique. However, it should be remembered that no one study is truly representative of African population because of the great ethnic diversity within that continent. Our results are probably representative of African children with mixed genetic heritage.

The incidence rate reported in this study is surprisingly high and contradicts previous speculation on rarity of type I diabetes in Africa (5). However, even when compared with global incidence rates, our figure for 1990 ranks higher than those reported from Kuwait,

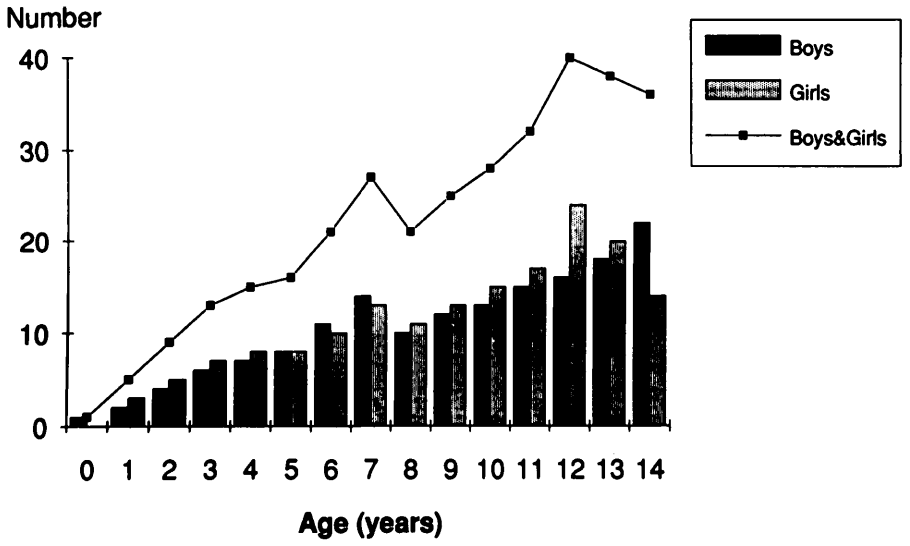

Figure 1—*Age at diagnosis of type I diabetes in 327 children in Khartoum, Sudan (1987–1990).*

Saudi Arabia, and Poland (15–17), and is similar to the figures reported from France and Italy (2,4). Furthermore, the incidence of type I diabetes seems to increase rapidly in our childhood population. A 76% increment occurred within 4 yr. It is possible that the number of cases was underestimated in 1987 because it was the first year of the registry. However, a comparison of the incidence in 1988 is with that of 1990 still shows a 31% increment. Although increments in the incidence of type I diabetes have been reported from several countries worldwide (18–22), few registries reported such a marked increase in incidence of diabetes over such a short time (17). Moreover, we believe that some of our diabetic children still may have been missed by both sources of ascertainment—either because they were seen in private clinics or because they died before diagnosis (we suspect). African children presenting with diabetic coma usually are investigated and treated empirically for cerebral malaria or meningitis, and often die before diagnosis of diabetes is made (23).

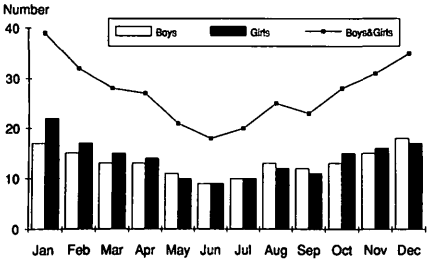

Figure 2—*Month of diagnosis of type I diabetes in 327 children in Khartoum, Sudan (1987–1990).*

Previous studies on white children have suggested a bimodal distribution of the age at diagnosis of type I diabetes, with the highest incidence in the prepubertal age (24,25). In this study, such a bimodality was seen with a peak at age 12 yr in girls and age 14 yr in boys and a minor peak at age 7 yr in both sexes. The early peak coincides with the age at start of school in Sudan. Similar observations have been reported in Britain and Sweden (26,27). Another interesting finding is the sex difference in diabetes incidence shown in this study. Although it fell short of statistical significance, the trend was consistent with our previous study, and similar findings have been documented for black Americans and Kuwaiti, Saudi, and Palestine Arabs in Israel (15,28,29). It appears that for most populations where the incidence rate is <10/100,000, a slight female predominance is observed.

One of the most striking epidemiological characteristics of type I diabetes is seasonal variation in its onset. Our findings are similar to those of numerous studies in which the highest number of cases occurred during the cooler months of the year, in both sides of the hemisphere (30,31). The trend is more or less similar all over the globe, despite the great differences in the temperature gradients across the year. In Khartoum, the daytime temperature ranges between 47°C in May-June to 20°C in January-February. The lowest temperature is just a summer day temperature in northern Europe. The great seasonal variation seen in our study is amazing and cannot be explained by cold stress, as suggested by MacDonald et al. (32). Erhlich et al. (33) noted that low and high monthly peaks occur in certain years (but not in others) in the same population. This is not the case in our population, which showed a consistent seasonal trend, particularly in the last 3 yr. Analysis of cumulative incidence data over longer periods of time is essential for documentation of persistent seasonal variation and for differentiating epidemic patterns from temporal trends. The seasonal patterns and the short-term variation in the incidence of childhood type I diabetes highlight the role of environment in the pathogenesis of the disease. As stressed by the Diabetes Epidemiology Research International Group, epidemiological studies on diabetes mellitus in various populations should be based on comparable methods and should include evaluation of environmental and genetic factors (34). The investigation on genetic markers in Sudanese children is underway.

Acknowledgments— This study was supported by grants from the Maud & Birger Gustavsson Stiftelser, Stockholm, Sweden.

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