Prevalence of Type1 Diabetes among School Children and Adolescents in Sana'a City, Yemen

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Abstract

Background: *Childhood diabetes was rare and rapidly fatal at the start of the 20th century but the incidence began to increase steadily by the end of the century. This study aimed at screening for diabetes among school children and adolescents in Sana'a city, Yemen.*

Methods: *Of a total student population of 26410 from four educational district registers in Sana'a city, 2870 students were screened for diabetes by urine glucose testing. Diagnosis of diabetes was first suspected from urine testing, then confirmed by blood glucose testing.*

Results: *Glucosuria was detected in the urine samples of 10 out of 2870 students, giving an overall crude prevalence of 0.35% among school children and adolescents investigated. Diagnosis of type 1 diabetes was confirmed for all students with glucosuria by testing plasma glucose and Cpeptide levels of the index patients and a control group. As compared to control group, students with diabetes had significantly higher mean fasting and 2hpostprandial plasma glucose levels (P< 0.0001) but significantly lower mean fasting serum Cpeptide value (P< 0.0001). The agestandardized prevalence rate for age range 519 years (Census 1994 populationadjusted rate) is 0.36% (95% CI: 0.20.5%).*

Conclusion: *: Pediatric-onset Type 1 diabetes is relatively prevalent among school children and adolescents in Yemen, with a slightly higher frequency in those aged ≥ 15 years, but no significant sexdifference.*

Keywords: **Type 1 Diabetes, Screening, School Children, Yemen**

Background

At the start of the 20th century, childhood type 1diabetes (T1D) was rare and rapidly fatal. By its end, a steady rise in incidence had been reported from many different parts of the world (1). In 2019, the International Diabetes Federation (IDF) estimated that of the global child and adolescent 2.58 billion population aged less than 20 years, an estimated number of 1,110,000 have prevalent (existing) cases of T1D, corresponding to a prevalence rate of 0.043%, i.e. 43 existing cases per 100,00 global child and adolescent population (2). There are considerable regional and national differences in the number of children and adolescents with prevalent (existing) and incident (new) cases of T1D worldwide (2, 3). In the Eastern Mediterranean region, few population based studies on the prevalence of childhood T1D have been published (4). To the best of our knowledge, this is the first population based study on the prevalence of childhood diabetes in Yemen. The aim of this study was to determine the prevalence of T1D among school children and adolescents aged 519 years in the capital city Sana'a, Yemen.

Methods

Study Population and Sampling Technique:

This study was carried out during the first half of 1996. According to the 1994 Census (5), the estimated population of Sana'a city was 972,011 individuals with children aged less than 20 years constituting about 50% of the total resident population. Children aged 519 years were identified at the four educational district registers in Sana'a capital during the study period. A list of schools was prepared for each educational district register and a random sample selection of two schools in each district were chosen to represent both basic and secondary

educational levels. Again from a list of names of students in each school, a stratified random sampling technique by level of education was practiced in order to include at least 10% of the total number of students within each level as a representative sample. Of a total student population of 26,410 (17188 students in basic education, and 9222 students in secondary education) in the eight schools chosen from the four educational districts in the city, 2870 students (1885 males and 985 females), i.e. 10.9% were enrolled in the study. About two thirds of students examined (1888 students) came from basic educational level, and the remaining one third (982 students) from secondary educational level.

Laboratory Investigations

All students enrolled in the study were screened for diabetes by urine glucose testing as described elsewhere (6). Each student was instructed to urinate completely at bedtime and to refrain from consuming vitamin C or sugar containing food in the previous night. He also was given a dry clean plastic cup with a wide opening to collect a midstream urine specimen at his/her house immediately upon rising from sleep in the morning for testing fasting urine glucose. Students were also instructed to have a carbohydraterich breakfast on the same morning, and urine specimens were collected in their school two hours after breakfast. Urine glucose was determined by dip and read method using enzyme glucose oxidase reagent strips. Only strip band which is impregnated with test reagent was dipped in fresh uncentrifuged urine for a few second. The colour change of the test strip was compared against the colour chart in the dispenser and urine test was considered positive when urine glucose level is > 5.6 mmol/L (100 mg/dL) (6, 7). Urine acetone was tested using Ketostex strips.

All students who had fasting and/or 2hpostbreakfast glucosuria on initial screening were considered as cases and were subject to further investigation of their blood glucose and Cpeptide. For purpose of comparison, a similar number of age and sex matched students negative for glucosuria were investigated as a control group. Fasting venous blood samples (5 ml) were collected from the diabetic and control students, for determining fasting blood glucose, serum creatinine and Cpeptide levels in both groups. Second blood samples were collected at 2hours after breakfast from the same students for measuring postprandial blood glucose level. Serum glucose and Cpeptide levels were measured as mentioned elsewhere (8). Diagnosis of T1D in students positive for glucosuria was confirmed by laboratory finding of elevated plasma glucose levels, and low fasting serum Cpeptide (≤166 pmol/l) that was validated against concurrently obtained fasting blood glucose > 4.0 mmol/l and concurrently obtained normal kidney function.

Statistical Analysis

Data were collected in tabular forms. Coding of data was done manually, whereas tabulation and other operations were carried out by computer. Data were analysed using tow statistical software packages, EpiInfo, version 6.02 (9) and Confidence Interval Analysis (CIA) version 1.0 (10). The crude prevalence rate of diabetes was calculated as percentage and 95% confidence interval (95% CI). The agestandardized prevalence and 95% CI of diabetes for age range 519 years of the population of Yemen were calculated using the world population as the standard (11, 12). According to this method, the prevalence rates were standardized for age in a truncated age range of 519 years using 4year age groups and the Yemen standard population for the year 1994 Census (5).

Continuous variables were expressed as means (SD)] and a 2tailed ttest was used for calculating statistical significance. In addition, 95% CI was calculated in order to indicate precision of sample estimate and variability of characteristics being studied. Median and interquartile range (IQR) was also measured to show central tendency and to measure skewed distribution. Categorical variables were expressed as numbers and percentages (%). The level of significance was taken at just < 0.05.

Results

All students enrolled in the study were screened by testing their urine for glucose in the fasting state and at 2hour after a high carbohydrate breakfast. Glucosuria was detected in the urine samples among 10 out of 2870 students being screened, giving an overall crude prevalence of 0.35% among school children and adolescents investigated, with a slightly higher rate in females than in males (0.41% vs. 0.32%).

A total number of 10 students had glucosuria on initial screening, four of them were found on ascertainment to have previously diagnosed diabetes with variable duration. Cases of diabetes were considered valid if diagnosis was made by a physician and currently receiving insulin treatment. All students with screen detected or previously diagnosed diabetes were subject to further measurement of their urine ketone, and their blood glucose, serum creatinine and plasma Cpeptide. The median (IQR) age at diagnosis of diabetes was 14 (5.3) years and a peak age of 15 years. Biomarkers for T1D among these students included high mean (± SD) values of fasting plasma glucose (10.5 ± 1.9 mmol/l) and postprandial plasma glucose concentration (14.8 ± 2.6 mmol/l) but low mean fasting serum Cpeptide level (110 ± 23 pmol/l). On contrary, the control group showed significantly lower mean (± SD) values of fasting plasma glucose (4.6 ± 0.4 mmol/l) and postprandial plasma glucose concentrations (5.5 ± 0.3 mmol/l), $p < 0.0001$ for each; but significantly higher mean fasting serum Cpeptide level (483 ± 100 pmol/l), $p < 0.0001$.

Table (1) - Number of cases, crude prevalence rates, and age-standardized prevalence rates of diabetes by age at diagnosis and sex among school children and adolescents in Sana'a city- Yemen:

Age Groups (Years)	Males			Females			Total		
	No. Examined	Diabetes		No. Examined	Diabetes		No Examined	Diabetes	
		n	% (95% CI)		n	% (95% CI)		n	% (95% CI)
05-09	311	2.0	0.64% (0.1-2.3)	172	0.0	(0.0%)	483	2.0	0.41% (0.06-1.5)
10-14	653	1.0	0.15% (0.01-0.9)	461	2.0	0.43% (0.06-1.6)	1114	3.0	0.27% (0.06-0.8)
15-19	921	3.0	0.33% (0.07-1.0)	352	2.0	0.57% (0.07-2.0)	1273	5.0	0.39% (0.13-0.9)
05-14	964	3.0	0.31% (0.07-0.9)	633	2.0	0.32% (0.04-1.0)	1597	5.0	0.31% (0.1-0.7)
05-19	1885	6.0	0.32% (0.12-0.7)	985	4.0	0.41% (0.12-1.0)	2870	10	0.35% (0.2-0.6)

Table (1) illustrates the crude and agestandardized prevalence rates of T1D among the school children and adolescents by age at diagnosis and sex. Among those students at basic educational level, 5 students (3 males and 2 females) developed diabetes between the age of 514 years, corresponding to an overall crude prevalence rate of 0.31% (0.31% in males and 0.32% in females). Similarly, among students at secondary educational level, other 5 students (3 males and 2 females) developed diabetes between the age of 1519 years, corresponding to an overall crude prevalence rate of 0.39% (0.33% in males and 0.57% in females). Although the crude prevalence of diabetes was apparently higher in students aged ≥ 15 years at diagnosis as compared to those aged < 15 years (0.39% vs.0.31%), but the difference was not statistically significant (Fisher exact, p= 0.76).The overall crude prevalence of T1D among the whole student population screened is 0.35% (95% CI: 0.20.6%), with a slightly higher frequency in females (0.41%, 95% CI: 0.121.0%) than in males (0.32%, 95% CI: 0.120.7%), (Fisher exact, p=0.74). The estimated agestandardized prevalence rate and 95% CI of T1D for a truncated age range 519 years of the population of Yemen was 0.36% (95% CI: 0.20.5%) with a substantially higher frequency in males (0.39%, 95% CI: 0.20.7%) than in females (0.3%, 95% CI:0.140.53%). In other words, the overall estimated ageadjusted prevalence rate of T1D in children and adolescents in Yemen appear to be 360 cases per 100,000 children aged 519 years (390 cases per 100,000 in males, and 300 cases per 100,000 in females).

Discussion

Glucosuria is nearly always caused by elevated blood glucose levels, and is rarely caused by an intrinsic renal problem. In 1974, the school health law in Japan was revised to mandate urine glucose screening of all primary and junior high school students for glucosuria in order to detect children with diabetes (14). Since then, several studies have been published on urine glucose screening for early detection of type 1 and type 2 diabetes in school children in Japan (6, 13, 14, 15) and Korea (16).

The prevalence rates of T1D diabetes provide information about the size of the patient population that is determined by the preceding incidence of the disease (4). The reported prevalence rate of T1D diabetes among children aged 519 years at diagnosis in Yemen might reflect the incidence rate of the disease prior to 1996 when this study was conducted. We have previously found among a diabetic clinic population in Sana'a, as in many parts of the world, that the prevalence of T1D was about 10.5% of the total number of diabetic population investigated with a mean age at diagnosis of 16 years (17). In general, T1D is best described concerning incidence, particularly in childhood, and this is why only a very few populationbased studies of the prevalence of T1D have been reported in the Middle East region (4).

In the present study, the estimated overall crude prevalence rate of T1D among school children and adolescents was found to be 0.35%. The agestandardized population adjusted prevalence rate (Census 1994) was 0.36%, i.e. 360 cases per 100,000 child and adolescent Yemeni population aged 519 years. Compared with other countries in the Middle East, prevalence rates in Yemen are higher than those reported from Libya (36.2 in 1981, 59.5 in 1990 per 100,000 child and adolescent population aged 019 years)(18), Kuwait (269.9 per 100,000 child and adolescent population aged 618 years)(19), Saudi Arabia (109.5 per 100,000 child and adolescent population aged 019 years)(20), Oman (150 per 1000,000 children aged 015)(21) and Turkey (67 per 1000,000 child and adolescent population aged 618 years)(22). Our finding of relatively higher prevalence might be explained by the small number of cases of diabetes diagnosed by urine glucose screening in this study, thus the relatively wide 95% CI (200to500) and the apparently higher prevalence rates as compared to other countries in the region.

The age specific prevalence rate data of T1D in this study has shown a higher rate in those aged ≥ 15 years than in those aged < 15 years (0.39% vs. 0.31%). This finding is controversial with

what was estimated by Amos et al on T1D in Yemen where the rate was said to be slightly higher in children aged < 15 year than in those aged ≥ 15 years (23). In Turkey (22), the highest prevalence of T1D was for age ≥ 14 years and the lowest for age 611 years. In Kuwait (19), the highest prevalence was for age 1013 years and the lowest was for age 69 years. In Saudi Arabia (20), the highest prevalence was for age 13 16 years and the lowest for age 56 years.

The limitation of this study is the small yield of children with diabetes out of the total number of students screened, in spite of the standardized method of sampling and screening. This is the first study on the prevalence of childhood diabetes and it was performed in 1996 when there was no data on the epidemiology of T1D in Yemen. Aiming at accurately measuring the incidence and prevalence rates of T1D in Yemen, we are currently conducting a registry based cohort study of about 500 children and adolescents with T1D that is on the way for publication in the near future.

In conclusion, this study shows that T1D seems to be prevalent among school children and adolescents in Yemen, with a higher frequency in those aged 15 years and over but with no significant sexdifference. We recommend conducting an incidence study on pediatric onset T1D in Yemen, in order to best describe the annual incident (new onset) cases of the disease during a specified time of follow-up among children and adolescents in the country.

Declarations

Ethics Approval and Consent to Participate

This fieldwork was approved by the Ethical Committee at the Faculty of Medicine and Health Sciences, Sana'a University. It was supported by the Ministry of Education in Yemen, and by every headmaster and teacher in each school after discussing the objectives and methodology with them. The work was conducted in closed collaboration of three parties: the Central Laboratory, Ministry of Public Health; Faculty of Medicine and Health Sciences, Sana'a University; and Central Research Laboratories, Faculty of Science, Sana'a University. Verbal consent was obtained from parents of students in each school involved in the study and all parents gave their consent to allow their children to participate in the study.

Consent for Publication

Not applicable

Availability of Data

All data analyzed in this study were obtained from a part of the MSc thesis presented by Dr. Ebtesam alZabedi to Alexandria University, Egypt in collaboration with Sana'a University. The data and materials of the study are available at the Faculty of Medicine and Health sciences, Sana'a University.

Competing Interest

The authors declare that there is no conflict of interest that could appear to have influenced the submitted work.

Authors' contribution

EMZ and AAG: Conceived and designed the study; EMZ: Conducted the field work of the study; AAG and EMZ: Comprehensive clinical assessment and analysis of data; AAG and EMZ: Contributed to the writing of the manuscript; AAG and EMZ: Agreed with manuscript results and conclusions; AAG: Made critical appraisal and approved the first version of the manuscript; EMZ and AAG: reviewed and approved the final manuscript.

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