A MODEL FOR DEFINING 'ABNORMAL' GLUCOSE TOLERANCE : INDIAN POPULATION STUDY

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Introduction

Diabetes mellitus is relatively a common disorder in India, as recent studies have reported age specific prevelance rates between 5 to 12 percent among urban and rural populations (1,2). However, one of the major problems in estimating the true prevalence in Indian population has always been-lack of uniformity in criteria for diagnosing diabetes. Although World Health Organisation (WHO) in 1980 (3) has endeavoured to define the diagnostic criteria of diabetes mellitus, it has also cautiously suggested that each nation should evolve such criteria independently among their own population groups.

In the present study, an attempt was made to analyse the distribution of glucose tolerance in a large population based data to seek a model for defining 'abnormal' blood glucose levels. This report is also intended to serve as a reference on Indian population characteristics, in designing sampling procedures for diabetes surveys for case-controls for prospective studies in diabetes.

Materials and Methods

In the national survey on diabetes sponsored by the Indian Council of Medical Research (ICMR) during 1972-76, a sample 34,412 persons above 15 years age was studied. This population was selected by stratified random sampling from six geographically different centres (Ahmedabad, Calcutta, Cuttack, Delhi, Poona and Trivandrum), with urban sample consisting of 56 and rural 40 percent of total population. Both sexes were equally distributed in urban or rural areas, and the age distribution of this samples conformed with the age structure of the Indian population (4). Each subject during this survey received 50 gms. of glucose orally and, at two-hours following oral glucose, capillary whole blood specimens were collected for estimation of glucose concentration.

After excluding incomplete data of 180 persons, a sample of 34,232 was retained for the present study. Computerisation and analysis were done at the Institute for the Research in Medical Statistics (IRMS) and the Department of Endocrinology, Metabolism and Diabetes. All India Institute of Medical Sciences, on personal computers by the authors (IMSL and PVR). Statistical analyses were done by the computer programmes developed at IRMS for this purpose.

Results

Table 1 shows the mean, standard error, mode, median and 97.5th percentile values of two-hour blood glucose measurements in each decade of life. It was observed that older persons above 40 years of age had higher blood glucose values, progressively rising with increasing age. Further, modal values were consistently between 81 and 83, medians between 77

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Table 1

Age Groups		Two-hour capillary blood glucose after 50g glucose				
Years	N	Mean	S.E.	Mode	Median	97.5P
15-19	5294	77.71	28.83	80.94	77.22	106.57
20-29	9278	79.03	25.22	81.77	79.39	107.58
30-39	7668	81.01	26.98	82.13	80.51	119.25
40-49	5678	85.07	40.68	82.43	81.78	141.12
50-59	3476	89.64	51.62	82.88	82.96	181.21
60-69	2022	96.60	65.51	82.64	85.71	216.25
70+	816	96.42	58.65	81.94	85.93	213.00
All	34232	82.80	37.07	81.97	80.48	129.89

All blood glucose values are in mg/dL
(N =total population; SE=standard error; P=Percentile)

and 86, and means 78 and 99 mg/dL in different age groups. Such narrow ranges for these values suggested that this large sample was normally distributed to a large extent, perhaps with deviations at extreme ends only.

In Table 2, mean+2SE (SE = standard error) and 97.5th percentile values of arithmatic and log blood glucose measurements are shown. Logarithmic transformation was done to improve the normality in frequency distribution of blood glucose values under analysis. The mean+2SE blood glucose, if similar to 97.5th percentile value of that age group--indicated that the blood glucose values in that category were normally distributed. In pooled data, the 97.5th percentile and (antilog of) mean+2SE of blood glucose on log scale were 129.89 and 127.47 mg/dL respectively, whereas mean+2SE of arithmatic values was grossly different (155.45 mg/dL) from the corresponding 97.5th percentile value. Following this

Table 2

Two-hour capillary blood glucose mg/dL

Age Group Years	97.5P	Arithmatic Mean + 2SE	Logarthmic Alog (Mean+ 2SE)
15-19	106.57	134.21	113.98**
20-29	107.58	128.46	113.79**
30-39	119.25	133.89	119.47**
40-49	141.12	164.81	134.09**
50-59	181.21	190.83*	148-93
60-69	216.25	225.01*	169.23
70+	213.06	211.45*	166.45
All	129.89	155.45*	127.47

(**) log converted or (*) original values found similar to 97.5th percentile blood glucose in respective age groups.

approach on testing for normality in different age groups, gaussian distribution of the logarithmic glucose values gave good fit in younger age groups (15-49 years), while distribution of arithmatic blood glucose values in the elderly age groups (above 50 years) followed gaussian pattern.

Discussion

The study population of 34,232 persons analysed for this report, was one of the largest in world literature, and was the only national study representing the age structure of Indian population (4). However, as per the current WHO recommendation that a 75g of oral glucose challenge is essential for evaluating glucose tolerance, the blood glucose values analysed in the present study need not necessarily represent the diagnostic criteria to be followed for Indians. But an approach (model) to define such criteria in future studies can be adapted from the following analysis.

One of the earliest diagnostic criteria for diabetes by Fajans and Conn in 1959 (5) were the blood glucose levels greater than 2SE above mean, which were between 140 and 160 mg/dL at two-hours after 75 or 100 gms, of oral glucose. This recommendation was based on normality assumption of blood glucose values and an assumed diabetes prevalence rate of 2.5 percent. In the present data pooled for all ages, (antilog of) log mean+2SE blood glucose was 128 mg/dL, which was also similar to the cut-off point followed in Indian studies prior to WHO report of 1980. (viz. 130 mg/dL based on the European arbitrary recommendations (6) that two-hour blood glucose after 50g of oral glucose being between 120 and 150 mg/dL). Thus the general approach of following the levels of 2SE above mean, seem appropriate for Indian population data in defining glucose intolerance.

On analysing for age specific distribution of glucose values, the assumption of normality in population above 50 years of age was confirmed with arithmatic blood glucose values. In contrast, 97.5th percentile glucose values in younger age groups were corresponding only with mean+2SE of blood glucose on log scale. This implied that log conversion of blood glucose values observed at younger age was mandatory for fitting normal distribution. From the above findings, it is evident that mean+2SE criteria is not always applicable to all age groups and a better cut-off point is 97.5th percentile level, unless the normality assumption is met. Alternatively, an appropriate normal distribution can be fitted to the data (as in log conversion) and cut-off point determined corresponding to the assumed prevalence rate.

Summary

A model for defining abnormal blood glucose levels was described by analysing distribution pattern of glucose tolerance values of a large Indian population sample. It was observed that while log blood glucose levels in persons below 50 years of age were normally distributed, original glucose levels themselves were normally distributed among older populations. Further, log normal distribution was found more appropriate for the pooled data. The mean+2SE being the cut-off point for defining abnormal blood glucose, as recommended by Fajans and Conn, did not seem to be applicable to individual age groups. A better diagnostic criterion is 97.5th percentile level (corresponding to the assumed prevalence rate of 2.5

percent), unless the normality assumption is met, or alternatively an appropriate normal distribution can be fitted to the data.

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References

1. Mather HM, Verma NPS, Mehta SP, Madhu S, Keen H. The prevalence of known diabetes in Indians in New Delhi and London. Med. Assoc. Thailand 1987: 70 (suppl. 2) : 54-58.

2. Rao PV, Ushabala P, Seshaiah V, Ahuja MMS, Mather HM. The Eluru survey : prevalence of known diabetes in a rural South Indian Population. Diab. Res. Clin. Pract. 1989; (in press).

3. World Health Organisation Expert Committee on Diabetes Mellitus, Second Report. Technical Report Series 646. Geneva WHO, 1980.

4. Ahuja M M S. Epidemiological studies on diabetes mellitus in India. In : Ahuja MMS, ed. Epidemiology of diabetes in developing countries. New Delhi : Interprint, 1979 : 29-38.

5. Fajans SS, Conn JW. The early recognition of diabetes mellitus. Ann. Ny. Acad. Sci. 1959; 82; 208-218.

6. European Diabetes Epidemiology Study Group. Diabetologia 1970; 6 : 453-454.