

A Survey of Diabetes Mellitus in a Rural Population of India

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SUMMARY

A survey was carried out among an adult rural population of India to assess the prevalence of diabetes mellitus in undernourished population groups. The subjects subsisted on cereal-based diets inadequate in calories and most were underweight. The prevalence of diabetes, as assessed by the presence of glycosuria, was 2.4 per cent. No age differences were observed among men, whereas the prevalence was higher among women above fifty years of age.

Of the women between twenty to fifty years of age, 49.3 per cent were lactating at the time of the survey. Out of these, 66.5 per cent had lactosuria, the maximum prevalence being observed in the first two years of lactation. *DIABETES* 21:1192-96, December, 1972.

Several surveys have been carried out to determine the prevalence of diabetes mellitus in India. Most of these have involved urban populations attending clinics and hospitals.^{1,2} Special detection drives have also been undertaken; public announcements were made and the people were requested to attend the clinic.³⁻⁵ It was mainly the literate and educated sections of the urban society which utilized these services. Thus, in both types of survey, the population screened was a motivated and largely urban society. A majority of India's population live in rural areas and are illiterate. They subsist on diets inadequate in calories and deficient in several other nutrients. It is widely believed that undernutrition affords protection from diabetes,⁶ and the association between obesity and diabetes is well known. It was believed important, therefore, to determine the incidence of diabetes in a chronically undernourished population. This paper deals with the results of a survey undertaken to assess the prevalence of diabetes mellitus in a rural population close to the city of Hyderabad.

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MATERIALS AND METHODS

The survey was conducted in seventeen villages in the vicinity of the city of Hyderabad (Andhra Pradesh). Only adults above the age of twenty years were included in the survey. A total of 2,006 individuals, comprising 918 men and 1,088 women and constituting 30 per cent of the total adult population, were screened for diabetes. Of the surveyed population, 33 per cent were agricultural laborers doing heavy manual work, 27 per cent were small landowners doing moderately heavy work, and the remaining 40 per cent consisted of people engaged in various light or sedentary occupations.

The diets of the population were largely cereal-based, with rice and jowar (*Sorghum vulgare*) forming the main staple. Extensive dietary and nutritional surveys conducted earlier on this and similar rural populations by our Institute had shown that these diets were inadequate in several respects. The mean calorie intake was of the order of 2,400 per adult. The protein intake was around 50 gm., and the protein was largely derived from vegetable sources. Clinical manifestations of vitamin B complex deficiencies and anemia were frequent. In the pre-school children of the community, the prevalence of signs of hypovitaminosis A and protein-calorie malnutrition was also high. The anthropometric data for children provide a fairly accurate index of the nutritional status of a community; the fiftieth percentile for the heights and weights of the children of these communities corresponded to the fifth percentile of American children.⁷

The majority of the population was illiterate and unaware of the significance of diabetes. There was much reluctance and resistance on their part to participate in any blood tests. Detection of glycosuria was therefore used as a screening test. The villages were visited early in the morning by one of the authors and a social worker. Heights and weights were recorded by standardized procedures. A sample of urine was tested for glucose by Benedict's qualitative procedure. All positive samples were retested by the glucose-oxidase test. Urine samples of all pregnant and lactating women were also tested for the presence of lactose by the thin-layer chromatographic technic described by Jeffrey et al.,⁸ with use of the solvent system, methyl ethyl ketone-acetic acid-methanol (6:2:2).

On a second visit, the hyperglycemic response to glucose was studied in all those who were willing to cooperate. Efforts were made to include as many of the glycosurics as possible. Glucose, 50 gm., was administered orally and blood was obtained by finger prick one hour later. This test could be performed on ten glycosurics and fourteen nonglycosurics.

Blood sugar was estimated by Folin-Malmros's technic as modified by Park and Johnson.⁹ A value of 160 mg./100 ml. or more was judged to be abnormal.

RESULTS

Anthropometric measurements. The heights and weights of the population surveyed are presented in table 1. In the absence of data on anthropometric measurements for normal healthy Indian adults, it is difficult to quantify the weight deficit in the population presently surveyed. The Indian Council of Medical Research¹⁰ has assumed that the mean weights of normal Indian adult men and women are 55 kg. and 45 kg., respectively. The mean weights of both sexes observed in this community were far below these figures, the values being particularly low in men. It was observed that nearly 88 per cent of the men weighed less than 55 kg. while 79 per cent of the women weighed less than 45 kg.

The index, $\frac{\text{weight}}{(\text{height})^2} \times 100$ has been shown to be

correlated with body mass and to be independent of height both in adults¹¹ and in children.¹² The means of the indices in the different age groups ranged from 0.180 to 0.186 for men and 0.180 to 0.187 for women. Our results show that the index, in addition, is independent of sex. This index for the western population works out between 0.236 to 0.252. The values for the majority of the subjects surveyed here fell between 70 and 80 per cent of the values for western subjects. With the mean index for the western population set at 100 per cent, values of 70 to 90 per cent were considered to represent moderate underweight and values less than 70 per cent, severe underweight.

Prevalence of glycosuria. The villagers were not in the habit of taking tea or eating anything early in the morning. Therefore, all urine samples were fasting specimens; this was confirmed in the course of the survey. Of the 2,006 persons screened, 509 had urine positive to Benedict's test. Among these, 290 were found to be positive to lactose; of the remaining subjects only forty-nine were found to be true glycosurics (i.e., their urines were positive to glucose-oxidase reaction). Among the latter, only one was a known diabetic.

As many as 170 (8.5 per cent) had reducing substances other than these two sugars.

The prevalence of true glycosuria in individuals between twenty to fifty years of age was 2.5 per cent in men and 1.2 per cent in women. In subjects over fifty years of age, the prevalence was 4.0 per cent in men and 5.4 per cent in women. There were no significant differences in the prevalence rate observed among men and women. However, the prevalence in women over fifty years of age was significantly higher than that observed in younger women ($P < 0.01$). Among the men, on the other hand, the difference between the two age groups was not significant. The prevalence rate in the total population surveyed was 2.4 per cent: 2.9 per cent in men and 2.0 per cent in women (table 2).

Although no striking correlation could be observed between glycosuria and body weight, it would appear that in the above-fifty age group the prevalence was high in those whose weights were more than 90 per cent of the standard employed (table 3). However, the small numbers in this group do not permit a definite conclusion.

Blood sugar levels. Levels of blood sugar one hour after a 50-gm. oral glucose load, ranged from 180 to 270 mg./100 ml. in ten glycosurics and from 83.5 to 139.5 mg./100 ml. in fourteen nonglycosurics in whom the test was performed. Thus all the glycosurics tested were found to be diabetic, by the criterion adopted.

Prevalence of lactosuria. Of the 1,088 women studied in the survey, 885 were below the age of fifty years. Among these, forty, nearly 4.5 per cent, were pregnant and 436, 49.3 per cent, were lactating at the time of the survey; the latter group included twelve of the pregnant women (table 4). Of the 436 lactating mothers, 290 were observed to have lactosuria. By age, 55.6 per cent of the lactating mothers twenty to thirty years old and 72.4 per cent of those over thirty years had lactosuria. The maximum prevalence of lactosuria was observed when the period of lactation did not extend beyond two years ($P < 0.01$). Furthermore, women over the age of thirty years had a significantly higher prevalence of lactosuria ($P < 0.01$) than those twenty to thirty years old (table 5).

TABLE 1
Anthropometric measurements of the population surveyed

Age group in years	Number surveyed	Height cm.	Weight kg.	$\frac{\text{Weight}}{(\text{Height})^2} \times 100$
Men				
20-30	217	161.7 ± 0.42*	48.7 ± 0.38	0.186 ± 0.0012
30-40	265	161.9 ± 0.37	48.5 ± 0.36	0.185 ± 0.0011
40-50	189	161.4 ± 0.48	47.7 ± 0.43	0.183 ± 0.0014
50-60	144	159.8 ± 0.53	46.0 ± 0.48	0.180 ± 0.0016
≧ 60	103	159.0 ± 0.58	44.2 ± 0.69	0.175 ± 0.0023
Women				
20-30	282	149.4 ± 0.58	41.8 ± 0.31	0.187 ± 0.0012
30-40	422	149.8 ± 0.24	41.9 ± 0.25	0.187 ± 0.0010
40-50	181	149.2 ± 0.46	41.4 ± 0.47	0.185 ± 0.0018
50-60	138	147.8 ± 0.47	39.4 ± 0.54	0.180 ± 0.0020
≧ 60	65	146.5 ± 0.79	39.0 ± 0.90	0.181 ± 0.0028

* Mean ± S.E.M.

TABLE 2
Percentage prevalence of glycosuria

Age in years	Number of individuals with glycosuria			Percentage prevalence of glycosuria		
	Men	Women	Total	Men	Women	Total
20-50	17	11	28	2.5	1.2	1.8
≥50	10	11	21	4.0	5.4*	4.7
Total	27	22	49	2.9	2.0	2.4

*P<0.001

DISCUSSION

In the survey reported here an attempt has been made to find out the prevalence of diabetes mellitus in a poor rural population close to the city of Hyderabad. Surveys conducted hitherto in this country have been mostly on urban and semi-urban population groups. The incidence in these surveys was found to range from 1.5 per cent to 2.5 per cent.^{2,3,13} These estimates were derived from detection drives carried out in the urban area. The population screened was comprised mostly of literate or semiliterate, fairly well-nourished individuals and cannot, therefore, be considered as representative of the major part of the country's population.

In the present study of an undernourished rural population, the over-all prevalence of glycosuria was observed to be 2.4 per cent. It was also observed that all glycosurics whose blood could be tested were diabetic as judged by their hyperglycemic response. No diabetics were detected among the nonglycosurics. Though this may seem surprising, it may be attributed to the very small number of blood sugar estimations that could be performed. In the only other survey of similar nature, reported earlier, Ganguly et al.¹⁴ have observed a prevalence of 1.9 per cent in the total population. The prevalence in the population above twenty years of age

was, however, 2.9 per cent, which is not very different from the prevalence observed in our survey. These figures are similar to those reported from the urban area. The latest estimate of the prevalence in the U.S.A. is reported to be 1.8 per cent.¹⁵ In the Bedford Survey conducted in the U.K.,¹⁶ a 1.4 per cent incidence was observed. The prevalence in the rural population studied by us appears to be not very different from those reported in these two countries.

The over-all prevalence of glycosuria was the same in both sexes. Though the prevalence increased with age, the differences were significant only in women. In the U.S.A. the prevalence in individuals below forty-five years of age has been observed to be about 1 per cent and that in those above this age, more than 5.0 per cent.¹⁵ The percentage prevalence data obtained in the present study are very close to those figures.

The present study shows that even in an undernourished population, diabetes may be prevalent. This is in contrast to the commonly observed association of diabetes and obesity in affluent countries. Tripathy and Kar¹⁷ had observed earlier a large incidence of marked underweight among diabetics admitted to a hospital in India. On the other hand, Datta et al.¹⁸ attributed the low incidence of diabetes, 0.7 per cent, observed by

TABLE 3
Association of glycosuria with weight in relation to height*

Age group in years	Number surveyed	≥ 90%		70-90%		< 70%	
		Number of glycosurics	Number surveyed	Number of glycosurics	Number surveyed	Number of glycosurics	
Men							
20-50	34	0	470	15	167	2	
≥ 50	11	2	115	3	121	5	
Women							
20-50	69	3	596	4	220	4	
≥ 50	14	2	95	3	94	6	

* The mean $\frac{W}{H^2} \times 100$ for western population is set at 100 per cent (details given in text).

TABLE 4
Percentage prevalence of lactation and lactosuria

Age in years	Number of women surveyed	Number of women lactating	Per cent women lactating	Number of lactating women with lactosuria	Per cent lactating women with lactosuria
20-30	282	153	54.2†	85	55.6
30-50	603	283	46.9	205	72.4*
Total	885	436	49.3	290	66.5

*P<0.05

†P<0.001

them, to undernutrition. However, the criteria used by both groups of workers to assess underweight is not known. It has been suggested that obesity may be the predominant determinant for manifestation of diabetes.¹⁹ On the other hand, it appears that genetic or environmental factors, like undernutrition, may be equally important. Moreover, undernutrition does not appear to substantially protect a population from the risk of diabetes.

In the developing countries, survey for diabetes by screening for glycosuria remains a method of necessity, though not one of choice. When the technics employed for detection of glucose include other reducing substances (this holds good in the case of blood sugar estimations also), it is essential that lactose be excluded. The present survey revealed some interesting data regarding the prevalence of lactosuria in a rural community. About 50 per cent of the women in the reproductive period (twenty to fifty years) were lactating at the time of the survey and more than half of them had lactosuria. This points out the magnitude of error that may creep in, in assessing the prevalence of glycosuria if the incidence of lactosuria and lactosemia are not taken into account. In the rural and semi-urban communities of India, weaning is postponed to a late age and nearly 50 per cent of the infants are breast fed up to eighteen months of age.²⁰ In the present survey it was observed that nearly 56 per cent of the women were breast feeding their infants for more than twelve months, and nearly half of them were breast feeding

for periods of more than two years. The prevalence of lactosuria was maximum during the first two years of lactation. Irrespective of the period of lactation, the prevalence of lactosuria was higher in women above thirty years than in younger women. The former group are more likely to have had a greater number of pregnancies and more periods of lactation than the latter. It is not uncommon to find women breast feeding a baby even during a subsequent pregnancy. In this study 37 per cent of the pregnant women were found to be lactating. Whether age per se or the near perpetual state of lactation has any effect on prevalence of lactosuria needs to be studied. However, analysis of our data shows that parity may not be related to the incidence of lactosuria. It is widely accepted that lactosuria is common among lactating mothers,²¹ but there appear to be no data on the incidence of lactosuria in various countries. It is hence difficult to determine whether this high incidence of lactosuria is a universal phenomenon or whether it is conditioned by maternal malnutrition. This high rate of lactosuria might have well accounted for the higher incidence of glycosuria observed by Rao et al.⁴ and of diabetes observed by the K. E. M. Hospital²² group of Bombay, in women. It is suggested that while employing methods for detection of glycosuria or for blood sugar determinations this high prevalence of lactosuria be taken into account.

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TABLE 5

Association between duration of lactation and percentage prevalence of lactosuria

Age in yrs	Up to 12 mos.	12 to 24 mos.	More than 24 mos.
20-30	66.2	61.9	53.3
30-50	77.3	80.2	59.8
Total	72.8	74.2	58.1

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