PREVALENCE AND CAUSES OF GLYCOSURIA AMONG THE ETHNIC GROUPS IN SINGAPORE

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SYNOPSIS

During routine medical examinations of 5280 subjects (2736 males, 2544 females; Chinese 3386 (64·1%), Malays 1252(23·7%), Indians 508(9·6%) and other ethnic groups 134 (2·6%); age range 17 to 66 years) glycosuria was found in 97 cases (1·84%). The prevalence of glycosuria increased with increasing age; it was higher in Indians (3·92%) than in Chinese(1·65%)and Malays (1·52%). The causes of glycosuria were: renal glycosuria (38 cases; 39·2%), diabetes (31 cases; 31·9%), alimentary glycosuria (24 cases; 24·8%) and miscellaneous (4 cases; 4·1%).

The prevalence of renal glycosuria was 0·72%. Renal glycosuria occurred chiefly in the younger age groups; the highest prevalence was in the age group 20 to 29 years. Renal glycosuria was more frequent in males (0·88%) than females(0·56%); it was found with approximate frequency in Chinese (0·80%) and Malays (0·72%) and was less frequent in Indians (0·39%).

The prevalence of diabetes was 0·59%; it was highest in the age group 50 to 59 years. The prevalence of diabetes in Indians(2·76%)is almost nine times that in Chinese(0·30%)and six times that in Malays (0·48%). The difference in the prevalence of diabetes between Indians and Chinese is statistically significant ($p < 0·001$) and the difference between Indians and Malays is also significant ($p < 0·05$). Diabetes was more common in males (0·95%) than females (0·20%).

There were 24 cases of alimentary glycosuria; the prevalence of alimentary glycosuria was 0·45%. It was more common in males (0·66%) than females (0·24%). Alimentary glycosuria increased with age. Alimentary glycosuria was more common in Chinese (0·47%) than in Indians (0·30%) and Malays (0·24%).

The possible reasons for the high prevalence of diabetes in Indians are discussed; it is postulated that heredity and diet are important factors.

There is scanty knowledge on the prevalence and causes of glycosuria among the population in Singapore. We have described the prevalence and causes of glycosuria among young men of 17 years of age (Cheah, Tan and Wong, 1971). The higher prevalence of diabetes mellitus in Indians compared to the other ethnic groups has also been found during routine medical examination (Cheah, Tambyah and Mitra, 1972). This paper describes the prevalence and causes of glycosuria in a group of subjects undergoing a routine medical examination.

MATERIALS AND METHODS

All candidates for employment, confirmation of employment, extension of employment at retirement age and scholarships in governmental and quasi-governmental departments undergo a routine medical examination. Included in the examination is the detection of glycosuria in a postprandial specimen of urine using a glucose-oxidase strip (Clinistix, Ames Co.).

An oral glucose tolerance test was done in those with glycosuria. An oral load of 50 g. glucose was given after the fasting blood sugar was taken. The blood sugar was determined at ½ hourly intervals for 2 hours. The blood sugar was determined by the semimicro method of Asatoor and King (1954) using capillary blood. Urine was tested for the presence of sugar using Clinistix at the same interval.

The following criteria were used in the interpretation of the glucose tolerance test: (1) normal—fasting and 2 hour blood sugar of 120 mg.% or less, maximum blood sugar of 180 mg.% or less and absence of glycosuria; (2) diabetic—a 2 hour blood sugar of 140 mg.% or more (World Health Organisation expert committee No. 310, 1965); (3) renal glycosuria—normal blood sugar levels but presence of glycosuria (Lawrence, 1947); (4) alimentary glycosuria (lag-storage curve or oxyhyperglycaemia)—normal fasting and 2 hour

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blood sugar levels but the maximum blood sugar exceeds 180 mg.% and with the presence of glycosuria (McLean, 1922) and (5) miscellaneous—not normal but does not fit into the diabetic, renal glycosuria or alimentary glycosuria group.

RESULTS

Of the 5280 subjects examined, 2736 (51·8%) were males and 2544 (48·2%) were females. There were 3386 (64·1%) Chinese, 1252 (23·7%) Malays, 508 (9·6%) Indians and 134 (2·6%) other ethnic groups (mainly Eurasians). The age range of the subjects were 17 to 66 years. The age and sex distribution of the subjects examined are shown in Table I.

Glycosuria was found in 97 cases (1·84%) out of the 5280 subjects examined. The prevalence of glycosuria was higher in males (2·52%) than in females (1·10%). The prevalence of glycosuria increased with age (Table I and Fig. 1). Indians have the highest prevalence of glycosuria (3·94%) compared to Chinese (1·65%) and Malays (1·52%; Table II). Glycosuria occurred with approximate frequency in the main dialect groups among the Chinese: 1·93% in Hokkien, 1·73% in Cantonese and 1·28% in Teochew.

The causes of glycosuria in this study are shown in Table III; renal glycosuria was the commonest (39·2%) followed by diabetes (31·9%) and alimentary glycosuria (24·8%).

The prevalence of renal glycosuria according to sex and age groups is shown in Table IV. The prevalence of renal glycosuria was higher in males (0·88%) than in females (0·56%). Renal glycosuria occurred mainly in the younger age groups: of 4134 subjects in the age group 17 to 29 years screened, 34 (0·82%) were found to have renal glycosuria while of 1146 subjects in the age group 30 to 66 years screened, 4 (0·35%) were found to have renal glycosuria. In the age group 20 to 59 years, the highest prevalence of renal glycosuria was found in the age group 20 to 29 years (Table IV). Renal glycosuria was found with approximate frequency in Chinese (0·80%) and Malays (0·72%); it was less frequent in Indians (0·39%; Table V).

Diabetes mellitus was the second most common cause of glycosuria in this survey (Table III). The distribution of the diabetics according to sex and age group is shown in Table VI. The prevalence of diabetes in males (0·95%) was more than four times that in females (0·20%). The prevalence of diabetes increased with age and is most frequent in the age group 50 to 59 years (Table VI and Fig. 1).

The prevalence of diabetes in the various ethnic groups is shown in Table VII. The prevalence of diabetes in Indians (2·76%) is almost nine times that in Chinese (0·30%) and six times that in Malays (0·48%). The difference in the prevalence of diabetes between Indians and Chinese is statistically highly significant ($p<0·001$); the difference between Indians and Malays is also significant ($p<0·05$). Table VIII shows the prevalence of diabetes among the ethnic groups in the age group 30 to 66 years. The prevalence of diabetes in Indians in this age group (6·36%) is about six times that in Chinese (0·96%) and five times that in Malays (1·39%). The difference in the prevalence of diabetes in this age group between Indians and Chinese is highly significant ($p<0·001$) and the difference between Indians and Malays is also significant ($p<0·05$).

Of the 31 diabetics, 4 (12·9%) were previously known diabetics while 27 (87·1%) were newly discovered cases. Three (9·7%) have a family (parents, brothers and sisters) history of diabetes. Fifteen cases (48·4%) were of normal weight (normal weight is defined as $\pm$ 10% of ideal weight), 9 (29·0%) were overweight and 7 (22·6%) were underweight. Of the 14 Indian diabetics, 5 (35·5%) were overweight while of the 10 Chinese diabetics, 2 (20·0%) were overweight.

There were 24 cases (24·8%) of alimentary glycosuria in this study (Table III). The distribution of alimentary glycosuria according to sex and age groups is shown in Table IX. Alimentary glycosuria was commoner in males (0·66%) than females (0·24%). The prevalence of alimentary glycosuria increased with age (Table IX and Fig. 2). Alimentary glycosuria was more common in Chinese (0·47%) than in Indians (0·30%) and Malays (0·24%; Table X).

Four cases (4·1%) were classified under miscellaneous causes (Table III); in 2 cases the glucose tolerance curve resembled that of renal glycosuria but the 2 hour blood sugar was more than 120 mg.% but less than 140 mg.% and in the other 2 cases the glucose tolerance curve resembled that of alimentary glycosuria but the 2 hour blood sugar was higher than 120 mg.% but lower than 140 mg.%.

DISCUSSION

The prevalence of glycosuria in this study is 1·84%; this compares with a prevalence rate of 3 to 5% in the general population in Western series (Oakley, Pyke and Taylor, 1968). The prevalence of glycosuria increases with age (Table I and Fig. 1); the reason for this is that the renal threshold for glucose falls with increasing age (Fine, 1965;

TABLE I

PREVALENCE OF GLYCOSURIA ACCORDING TO SEX AND AGE GROUP DISTRIBUTION

Age Group	MALES			FEMALES			MALES AND FEMALES		
	No. Screened	No. with Glycosuria	% with Glycosuria	No. Screened	No. with Glycosuria	% with Glycosuria	No. Screened	No. with Glycosuria	% with Glycosuria
17 - 19	750	4	0·53	1051	13	1·24	1801	17	0·94
20 - 29	1112	29	2·61	1221	13	1·06	2333	42	1·80
30 - 39	444	10	2·23	196	2	1·02	640	12	1·88
40 - 49	251	10	3·98	52	0	0·00	303	10	3·30
50 - 59	124	10	8·06	24	0	0·00	148	10	6·76
60 - 66	55	6	10·90	0	0	0·00	55	6	10·91
All ages	2736	69	2·52	2544	28	1·10	5280	97	1·84

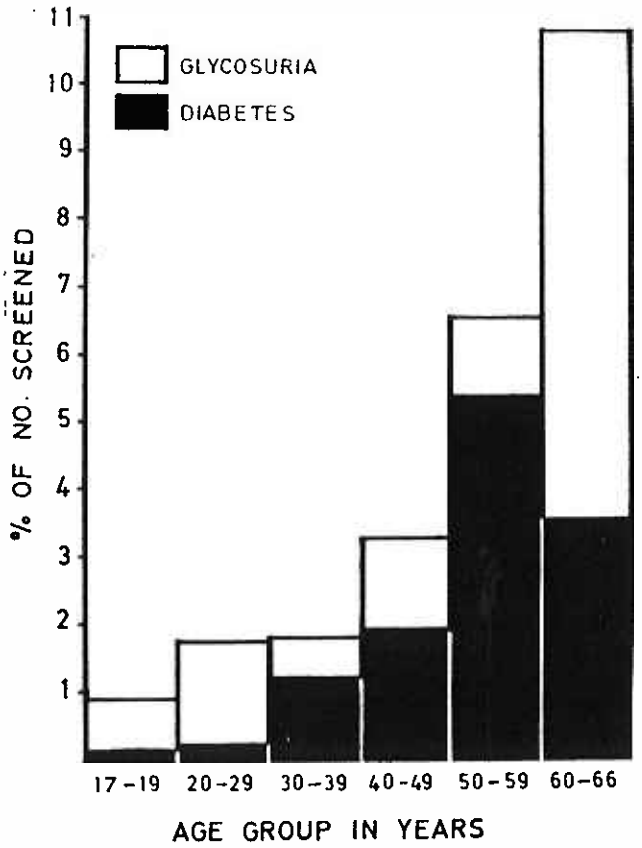

Fig. 1. Prevalence of glycosuria and diabetes mellitus according to age groups.

TABLE II

PREVALENCE OF GLYCOSURIA AMONG THE ETHNIC GROUPS

Ethnic Group	No. Screened	No. with Glycosuria	% with Glycosuria
Chinese	3386	56	1·65
Malays	1252	19	1·52
Indians	508	20	3·94
Others	134	2	1·49
All ethnic groups	5280	97	1·84

TABLE III

CAUSES OF GLYCOSURIA IN PRESENT STUDY

Cause of Glycosuria	No.	%
Renal glycosuria	38	39·2
Diabetes	31	31·9
Alimentary glycosuria	24	24·8
Miscellaneous	4	4·1
All causes	97	100·0

TABLE V

PREVALENCE OF RENAL GLYCOSURIA IN THE ETHNIC GROUPS

Ethnic Group	No. Screened	No. with Renal Glycosuria	% with Renal Glycosuria
Chinese	3386	27	0·80
Malays	1252	9	0·72
Indians	508	2	0·39
Others	134	0	0·00
All ethnic groups	5280	38	0·72

TABLE IV

PREVALENCE OF RENAL GLYCOSURIA ACCORDING TO SEX AND AGE GROUPS

Age Group	MALES			FEMALES			MALES AND FEMALES		
	No. Screened	No. with Renal Glycosuria	% with Renal Glycosuria	No. Screened	No. with Renal Glycosuria	% with Renal Glycosuria	No. Screened	No. with Renal Glycosuria	% with Renal Glycosuria
17 - 19	750	3	0·40	1051	8	0·60	1801	11	0·65
20 - 29	1112	17	1·53	1221	6	0·49	2333	23	0·99
30 - 39	444	2	0·45	196	0	0·00	640	2	0·31
40 - 49	251	1	0·40	52	0	0·00	303	1	0·33
50 - 59	124	0	0·00	24	0	0·00	148	0	0·00
60 - 66	55	1	1·81	0	0	0·00	55	1	1·81
All ages	2736	24	0·88	2544	14	0·56	5280	38	0·72

TABLE VI

DISTRIBUTION OF DIABETES ACCORDING TO SEX AND AGE GROUPS

Age Group	MALES			FEMALES			MALES AND FEMALES		
	No. Screened	No. with Diabetes	% with Diabetes	No. Screened	No. with Diabetes	% with Diabetes	No. Screened	No. with Diabetes	% with Diabetes
17 - 19	750	0	0·00	1051	2	0·19	1801	2	0·11
20 - 29	1112	3	0·27	1221	1	0·08	2333	4	0·22
30 - 39	444	6	1·35	196	2	1·02	640	8	1·25
40 - 49	251	6	2·39	52	0	0·00	303	6	1·98
50 - 59	124	8	6·45	24	0	0·00	148	8	5·40
60 - 66	55	3	5·45	0	0	0·00	55	3	3·64
All age Groups	2736	26	0·95	2544	5	0·20	5280	31	0·59

TABLE VII

PREVALENCE OF DIABETES IN THE VARIOUS ETHNIC GROUPS IN THE AGE GROUP 17 TO 66 YEARS

Ethnic Group	No. Screened	No. with Diabetes	% with Diabetes
Chinese	3386	10	0·30
Malays	1253	6	0·48
Indians	508	14	2·76
Others	104	1	0·75
All ethnic groups	5280	31	0·59

TABLE VIII

PREVALENCE OF DIABETES AMONG THE ETHNIC GROUPS IN THE AGE GROUP 30 TO 66 YEARS

Ethnic Groups	No. Screened	No. with Diabetes	% with Diabetes
Chinese	627	6	0·96
Malays	288	4	1·39
Indians	220	14	6·36
Others	32	1	3·12
All ethnic groups	1167	25	2·14

TABLE IX

PREVALENCE OF ALIMENTARY GLYCOSURIA ACCORDING TO SEX AND AGE GROUPS

Age Groups	MALES			FEMALES			MALES AND FEMALES		
	No. Screened	No. with Alimentary Glycosuria	% with Alimentary Glycosuria	No. Screened	No. with Alimentary Glycosuria	% with Alimentary Glycosuria	No. Screened	No. with Alimentary Glycosuria	% with Alimentary Glycosuria
17 - 19	750	1	0·13	1051	3	0·29	1801	4	0·22
20 - 29	1112	8	0·72	1221	3	0·25	2333	11	0·47
30 - 39	444	2	0·45	196	0	0·00	640	2	0·31
40 - 49	251	3	1·19	52	0	0·00	303	3	0·99
50 - 59	124	2	1·83	24	0	0·00	148	2	1·35
60 - 66	55	2	3·64	0	0	0·00	55	2	3·64
All ages	2736	18	0·66	2544	6	0·24	5280	24	0·45

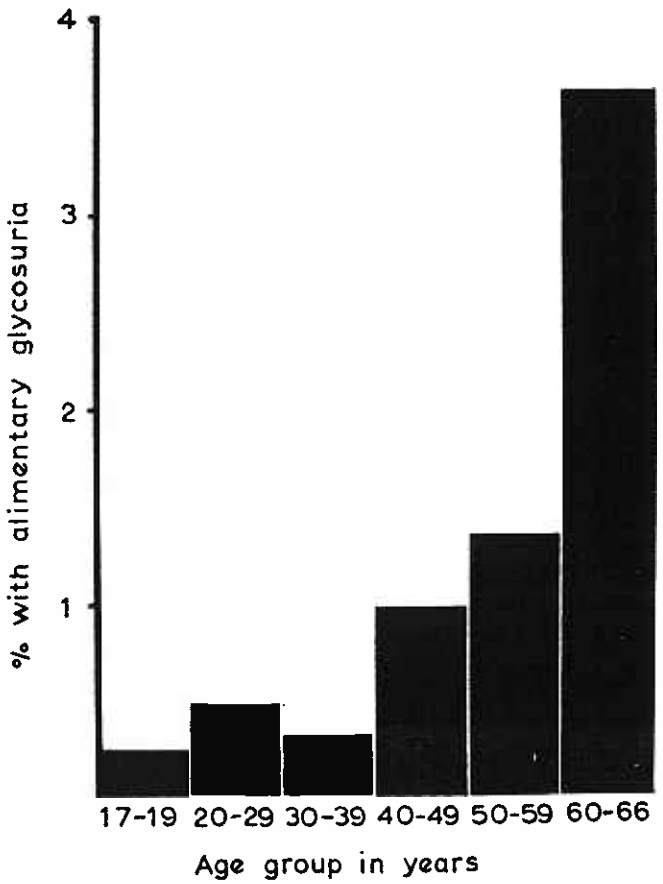

Fig. 2. Prevalence of alimentary glycosuria according to age groups.

TABLE X

PREVALENCE OF ALIMENTARY GLYCOSURIA AMONG THE ETHNIC GROUPS

Ethnic Group	No. Screened	No. with Alimentary Glycosuria	% with Alimentary Glycosuria
Chinese	3386	16	0·47
Malays	1252	3	0·24
Indians	508	4	0·30
Others	134	1	0·75
All ethnic groups	5280	24	0·45

Butterfield, 1967). In Singapore, the prevalence of glycosuria in young men (17 years of age) is 0·40% (Cheah, Tan and Wong, 1971).

Renal glycosuria is the commonest cause of glycosuria in this study: it accounted for 38 (39·2%) out of 97 cases of glycosuria (Table III). This is due to the fact that renal glycosuria occurs mainly in the young (Malins, 1968) and in this study 4134 subjects (78·3%) are in the age group 17 to 29 years and 1146 (21·7%) are in the age group 30 to 66 years. Some cases of renal glycosuria are familial. It is a harmless condition and does not progress to diabetes mellitus (Joslin *et al*, 1959, Malins, 1968).

There are 31 cases (31·9%) of diabetes out of the 97 cases of glycosuria (Table III). The highest prevalence of diabetes is in the age group 50 to 59 years (Table VI); this was also found in hospital cases by Ho (1959) and Lim and Khoo (1971). In the West diabetes is also most frequent in the 5th and 6th decades of life (Malins, 1968; Pyke, 1968). In this survey, the prevalence of diabetes in males (0·95%) is higher than in females (0·20%; Table VI). This preponderance of males was also found in hospital series (Ho, 1959; Lim and Khoo, 1971) in Singapore and in a series from Japan (Wada *et al*, 1964).

This study shows that diabetes is far more common in Indians than other ethnic groups in Singapore (Tables VII and VIII); this confirmed clinical impression based on hospital data (Ho, 1959; Lim and Khoo, 1971). In Malaya, it is also a clinical impression that diabetes is commonest in Indians (Tulloch, 1962) but this was not confirmed in a survey by West and Kalbfleisch (1966). The possible reasons for the high prevalence of diabetes in Indians as compared to the other ethnic groups have been discussed in detail elsewhere (Cheah, Tambyah and Mitra, 1972).

There are 24 cases of alimentary glycosuria (lag-storage, oxyphyerglycaemia) in this survey and the prevalence of alimentary glycosuria is 0·45% (Table IX). Like diabetes, the prevalence of alimentary glycosuria increases with increasing age (Fig. 2). A follow-up after 5 years of cases with alimentary glycosuria in the Birmingham survey showed that the incidence of diabetes was 17 times that which would be expected in the population (Malins, 1968). There is thus evidence to classify alimentary glycosuria as potential or chemical diabetes (Rosenbloom, Drash and Guthrie, 1972).

The significance of the 4 cases classified as miscellaneous remains uncertain; their possible significance have has discussed previously (Cheah, Tan and Wong, 1971).

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