Prevalence of Diabetes, Glycosuria and Related Variables Among a Cape Coloured Population *

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SUMMARY

A representative community of Cape Coloured people were surveyed in order to assess the prevalence of diabetes and related variables. The randomly selected sample consisted of 1 534 persons over the age of 10 years, of whom 63% were persuaded to undergo screening by blood-sugar level and testing for glycosuria 1 hour after a 50 g glucose load. The mean blood-sugar values obtained rose with age, were the same in each sex, and were a little higher among the Moslem sub-group. They were higher than those found in other racial groups. Blood-sugar levels did not correlate with body weight or parity.

The prevalence of known diabetes at all ages was 1·1% and of 'discovered diabetes' 6·1%. The total diabetes prevalence over the age of 15 was 8·7%; over the age of 55 it was 25%. There was little difference between the sexes. Diabetes was diagnosed in 7 children of 16 years of age or less, none of whom had symptoms. Symptoms were in fact extremely uncommon at all ages, even with gross hyperglycaemia and fasting glycosuria. In many diabetics, however, glycosuria was absent; urine testing alone proved an unreliable guide to the diagnosis. A family history of diabetes was found in 18% of the whole community and was no higher among the discovered diabetics, but was present in 4 of the 7 juvenile diabetics.

Obesity was uncommon among the men in general (7%), but frequent among the women (30%). The discovered diabetics were even fatter, and the young (under 40) diabetics were fatter than the over-40s, a result we have found in other races. We conclude that the Cape Coloured community are remarkably hyperglycaemic (for obscure reasons), and that this hyperglycaemia is rarely associated with symptoms, but importantly associated with vascular disease.

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We have investigated all racial groups in the Cape Town area in an attempt to determine the prevalence of diabetes and glycosuria and to correlate blood sugar levels with certain variables such as age, sex, weight, race, religion, diet, income, time of day and fecundity.[1-6] The Cape Coloured was the last ethnic group to be investigated.

The Cape Coloured community is a mixed group, which owes its origins to 4 basic elements: aboriginal Hottentot, slaves (Dutch East Indians and West Africans), White admixture (from the first European settlers 3 centuries ago), and a very small aboriginal Bushman content.[7] In recent years there has been another influence—the Bantu.

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Today these people are of varied economic and social standing in the community as a whole, and are represented in all walks of life, but the vast majority are in the lower socio-economic group.

METHODS AND SUBJECTS

Subjects

For this survey we selected a random 1-in-9 sample of families living in the Bokmakierie, Kewtown and Silvertown townships where there are sub-economic, economic and part-ownership housing-schemes. The families were interviewed by students at the Social Science Department of the University of Cape Town, supervised by trained social-workers. Details of age, sex, family relationship, language, religion (specifically Moslem or non-Moslem), obstetric history (where applicable), family history of diabetes, height, and weight were collected.

We arranged screening in central halls in an attempt to test all members over 10 years of age in the selected families. The total number of people selected was 1 534. From the outset, it was apparent they were extremely reluctant to come forward. Various dodges were employed to try to improve matters. For instance, we used a concentrated orange-flavouring with the glucose load to improve its taste, issued free tickets to the local cinema to everyone who attended, and eventually made house-to-house visits in an effort to screen as many people as possible, but even so we were largely unsuccessful.

Whatever the cause, or causes, of the reluctance to be tested, only 968 out of a possible 1 534 people were screened, giving a percentage yield of 63%. This was less than all the other ethnic groups surveyed: Indians 75·8%, Malays 88·5%, Bantu 85·5%, and Whites 72%. The major absence was in young people between 25 and 39 years of age.

With such an incomplete yield it is possible that our tested group is not truly representative but self-selected—perhaps on the basis of being more diabetes-conscious. Against this possibility, however, we found that only 19% of those screened knew of diabetes occurring in their family compared with 16% of those not screened—no real difference.

Structure of Survey Group

In Table I the age distribution of the *screened* population is compared with the general Cape Coloured population and the deficiency of young adults aged 20 - 39 in the

screened group is clear, though it is counterbalanced by an excess in the 10 - 19 and 45 - 69 age groups. The number and distribution of 'discovered diabetics' has therefore been corrected for age distribution in order to be applic-

TABLE I. AGE DISTRIBUTION OF SCREENED SAMPLE COMPARED TO ENTIRE COLOURED AND WHITE POPULATIONS OF SOUTH AFRICA OVER 10 YEARS OF AGE (1960 CENSUS), EXPRESSED AS PERCENTAGE OF TOTAL

	Survey population		% of whole country	
Age in years	No.	%	Coloureds	Whites
10 - 14	213	22·0	18·1	13·3
15 - 19	179	18·5	14·2	11·3
20 - 24	119	12·3	13·2	9·7
25 - 29	48	5·0	10·8	8·6
30 - 34	31	3·2	9·3	8·7
35 - 39	55	5·7	7·4	8·2
40 - 44	58	6·0	6·3	7·6
45 - 49	70	7·2	5·5	7·8
50 - 54	59	6·1	4·5	7·0
55 - 59	60	6·2	3·4	5·2
60 - 64	36	3·7	2·5	4·0
65 - 69	27	2·8	1·9	3·2
Over 70	13	1·3	2·9	5·3
Total	968	100·0	100·0	100·0

able to the whole Coloured community. Further age corrections, because of their different age-structure, are necessary before comparisons can be made with the White population (see last column in Table I). Among those screened, was a group of 166 Moslems, with Malay names, which contained a smaller proportion of persons over 55 (9%, compared with 14% for the whole community). Of the total number screened, 584 were female and 384 male, with similar age distribution for each sex.

'Weight' was calculated as a proportion of the standard weight for height as taken from Documenta Geigy tables, corrected for age. The term 'obese' was applied to those who were at least 15% above their standard weight.

'Known diabetes' at the time of the survey was confirmed from medical records or by blood-sugar estimations. The presence of diabetes was 'presumed' in any person whose screening figure was over 220 mg/100 ml or over 200 mg with glycosuria and who did not undergo further testing. (Two such positive subjects died before attending for a glucose-tolerance test (GTT).)

Methods

Screening was performed in the late afternoon or early evening after at least a 4-hour fast by urine testing and capillary-blood sampling one hour after a 50 g glucose load. Blood-sugar estimations were made using the Auto-Analyzer,* Hoffman method, and were performed by the same two technicians throughout. Our error on the particular machine used was ± 3%.

*Technicon Autoanalyzer (Pty) Ltd, Johannesburg.

All subjects whose screening blood-sugar level was over 159 mg/100 ml, or who showed glycosuria, were requested to undergo a full oral GTT at Medical School. Matched negative-screening controls were similarly tested. The final diagnosis of newly 'discovered diabetes' was made on the result of this test if *two or more* of the following were abnormal (venous plasma, Autoanalyzer, Hoffman method):

Fasting level ⩾ 120 mg/100 ml
Maximum level ⩾ 185 mg/100 ml
2-hour level ⩾ 140 mg/100 ml

'Lag storage curve' was applied to a GTT in which a peak level of over 185 mg/100 ml occurred at *30 minutes or before,* with other values normal. 'Borderline' was applied to a GTT with one of the above 3 levels abnormal (excluding 'lag curves'). Glycosuria was 'renal' if no blood-glucose value was over 159 mg/100 ml. Of the 968 persons who attended clinics, 310 screened 'positive' and 284 of these received full glucose-tolerance tests (Table II).

TABLE II. FLOW SHEET

Total survey population	1 534	
Known diabetic		16
Screened at clinic	968 (63%)	
Screened positive	310 *	
Presumed diabetic		3
Received GTT	284	
Diagnosed diabetic		56

* 288 with blood sugar >160 mg/100 ml, 22 with glycosuria only.

Of the 56 'available' discovered diabetics, 41 came for full physical examinations at hospital. They were seen by one of us (W.P.U.J.) and Dr Norman Marine, working in close collaboration. All had ECGs, chest X-rays and ophthalmoscopic examinations without mydriasis. Men who were suspected of any over-indulgence in alcohol also had X-rays of the abdomen and pancreatic function studies. The remaining 15 diabetics either refused to attend or preferred to go to their own doctors.

RESULTS

Blood Sugar at Screening, Body Weight and Other Correlations

The distribution curve of blood-glucose screening values moved to the right with age, but only over 34—the mode shifting from 110 to as much as 160 mg/100 ml (Fig. 1). The curves were approximately Gaussian with an increasing tail to the right with age, corresponding to an increase in the number of screening values over 200 mg/100 ml. The double hump on curve No. 3 is possibly just the effect of insufficient numbers. Three subjects screened at over 300 mg/100 ml, but more accurate figures were obtained at GTT (see below).

Mean blood-sugar levels in decades are shown in Fig. 2. On the whole the women had higher levels than men, but not significantly so, and the rise with age is again seen.

The mean blood-sugar values were higher among Moslems than non-Moslems at most ages (Fig. 3), and a

higher proportion of Moslems screened positive (32% as against 27·6%) despite the relatively small number of Moslems in the older age groups.

There was no significant correlation between blood-sugar level at screening and body weight. Over the age of 15, 30·5% of the women and 7% of the men were obese. There was no clear difference between Moslem and non-Moslem as regards weight. No correlation whatever appeared between blood-sugar level and parity in women over 40.

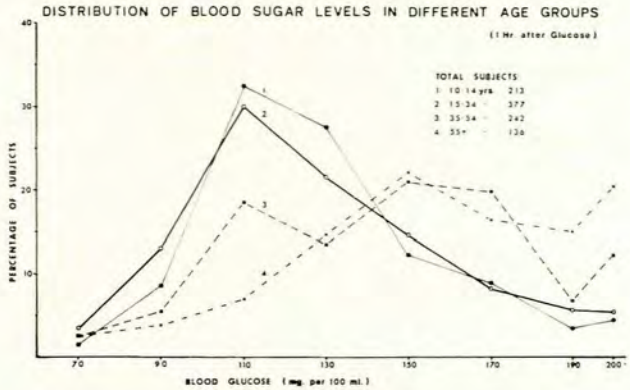

Fig. 1. See text.

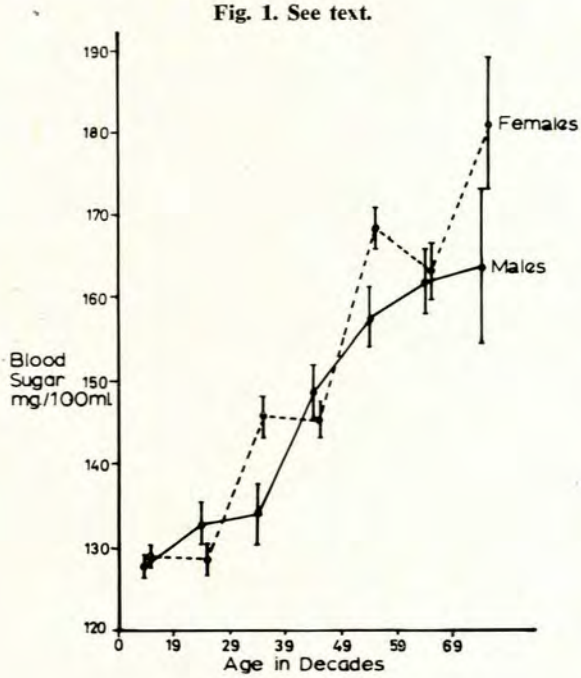

Fig. 2. See text.

Diabetes

The youngest 'previously known' diabetic in the survey was a girl of 25 years. The over-all prevalence of 'known diabetes' was 1·1%; in people over 55 it was 4·1% (Table III). The over-all prevalence of 'newly discovered' diabetics

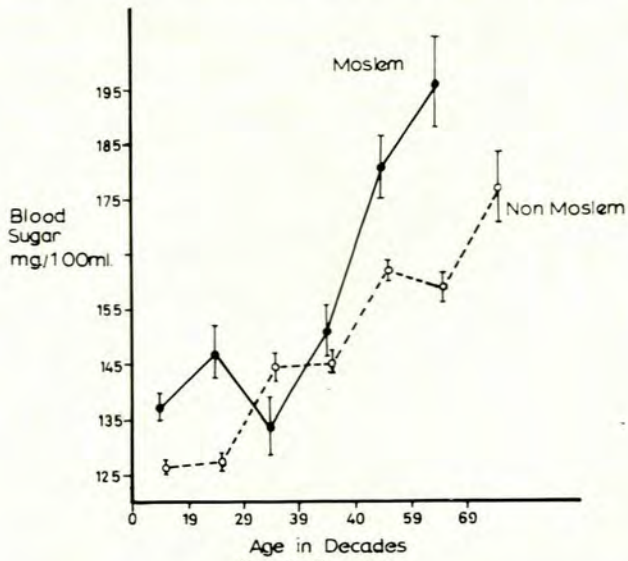

Fig. 3. See text.

TABLE III. ALREADY KNOWN AND TOTAL (KNOWN PLUS DISCOVERED) DIABETICS OVER AGE 15

	Known diabetics					
	Male		Female		Total diabetics	
Age group	No.	%	No.	%	Both sexes	Both sexes
15 - 34	0	0	1	0·2	0·1	1·8
35 - 54	4	1·2	3	0·7	0·9	9·1
55+	1·1	1·2	7	6·4	4·1	24·7
All ages	5	0·9	11	1·5	1·3	8·7

TABLE IV. COLOURED SURVEY — DISCOVERED DIABETICS

	Male (384)		Female (584)		Both sexes		Moslems only (166)	
Age group	No.	%	No.	%	No.	%	No.	%
10 - 14	2	2·4	1	0·8	3	1·4	0	0
15 - 34	7	4·4	1	0·3	8	1·7	1	1·3
35 - 54	5	5·9	15	9·5	20	8·2	3	6·8
55+	9	16·1	19	23·8	28	20·6	5	33·3
All ages	23	6·0	36	6·2	59	6·1	9	7·2*

* Age-corrected.

was 6·1%; over 55 it was 20·6% (Table IV). Diabetes, both known and discovered, was slightly more common in women.

TABLE V. OBESITY

	Total screened population		Discovered diabetics		
Age	Male	Female	Male	Female	Both sexes
Over 40	**7·5%**	**32%**	$^{7}/_{28}$	$^{13}/_{29}$	**24%**
Under 40	**6·5%**	**25%**	$^{3}/_{8}$	$^{5}/_{6}$	**57%**
All ages	**6·7%**	**28%**	**33%**	**51%**	

Considering only those people over the age of 15 (for comparison with other surveys), the total diabetes prevalence was 8·7% (Table III); 7·9% for males and 9·1% for women; over the age of 55 it was 25%. Age correction for the Coloured population in general made virtually no difference to these figures; age correction to the White population (see Table I) increased the over-15 prevalence figure to 10·6%.

Among the Moslems there were no known diabetics, but 5·4% were 'discovered diabetics'—7·2% when age-corrected (Table IV).

Obesity was present in 33% of males and 51% of female discovered diabetics (Table V). Under 40, 57% of discovered diabetics were obese, as against 24% obese over 40 years of age.

Only one discovered diabetic screened positive with glycosuria but negative on blood sugar (i.e. below 160 mg/100 ml). As many as 35 of the 56 proven diabetics had no glycosuria at screening despite blood-sugar levels over 160 mg/100 ml. Glycosuria occurred at one or both tests in all but 16, and the fasting blood-sugar level was over 120 mg/100 ml in all but 7. Only 10 gave a positive family history for diabetes.

The highest recorded blood-sugar level was 524 mg/100 ml in a 72-year-old asymptomatic female; 3 other discovered diabetics had values over 400 and 3 more were 'over 300' with the exact figure not determined.

One husband-and-wife diabetic pair was discovered; in a second family the husband was discovered to be diabetic at the survey and the wife became diabetic *after* a negative screening test. A mother and 2 sons were discovered diabetics in a third family, and a brother and sister in a fourth.

Young diabetics. Seven discovered diabetics were under 20 years of age. (Details are shown in Table VI.) It is noteworthy that only one was overweight, none were ketotic or even symptomatic, and only 2 had sugar in their urine after 2 glucose loads, despite blood-sugar levels in excess of 200 mg/100 ml. A positive family history was more common than with the older diabetics.

Glycosuria

Results of testing for glycosuria at screening are shown in Table VII. The frequency of glycosuria in both sexes rose with age and was slightly higher in men than women. The full GTT showed only 7 subjects with renal glycosuria, and a further 8 in whom glycosuria was associated with a 'lag' curve.

TABLE VII. GLYCOSURIA AT SCREENING (PERCENTAGES)

Age group	Renal, etc. *	Hyperglycaemic†	Total glycosuria
10 - 14	**0·9**	**0·5**	**1·4**
15 - 34	**1·7**	**4·6**	**6·3**
35 - 55	**6·2**	**10·3**	**16·5**
55+	**6·0**	**12·5**	**18·5**
All ages	**2·8**	**6·7**	**9·5**

* Calculated as % with glycosuria in those with blood sugar below 160 mg per 100 ml.

† Blood sugar over 159 mg per 100 ml.

The appearance of glycosuria was inconsistent. Despite the same glucose load at screen and at GTT, 21 of the 56 known diabetics showed glycosuria at one test and not at the other.

Glycosuria, as related to the final diagnosis, is shown in Table VIII in the 284 subjects who screened positive and had a subsequent full GTT. Diabetes accounted for about half the total glycosuria, and was more likely to be present in older people. Males and females were roughly equal in number, males yielding nearly all the 'lag' curves and females the renal glycosuria.

TABLE VI. YOUNG DIABETICS

						Screen blood	Glucose tolerance test			
No.	Age	Sex	Weight*	Family history	Symptoms	sugar (mg/100 ml)	Fasting	1 h	2 h	Glycosuria
518	**11**	**M**	**− 9**	**0**	**0**	**188**	**165**	**200**	**144**	**0**
458†	**13**	**F**	**−20**	**mother**	**0**	**228**	**124**	**205**	**130**	**0**
636	**14**	**M**	**−25**	**uncle**	**+**	**164**	**100**	**219**	**140**	**+**
683	**15**	**M**	**− 5**	**grandmother**	**0**	**232**	**—**	**—**	**—**	
459†	**16**	**M**	**−13**	**mother**	**0**	**178**	**131**	**202**	**152**	**0**
175	**16**	**M**	**−21**	**0**	**0**	**171**	**128**	**226**	**185**	**0**
041	**16**	**M**	**+30**	**0**	**0**	**162**	**141**	**205**	**109**	**+**

* % under or over standard weight for sex and age.

† Brother and sister.

TABLE VIII. GLYCOSURIA, FINAL DIAGNOSIS ON GTT IN 284 SUBJECTS WHO SCREENED POSITIVE

	Renal*			Lag curve†			Borderline**			Diabetic			Unclassified	Total		
Age group	M	F	M&F	M	F	M&F	M	F	M&F	M	F	M&F	M&F	M	F	M&F
10 - 14	0	0	0	0	1	1	0	0	0	2	0	2	0	2	1	3
15 - 34	0	6	6	1	0	1	3	4	7	2	1	3	0	6	11	17
35 - 54	1	0	1	3	0	3	6	3	9	5	10	15	2	16	14	30
55+	0	0	0	3	0	3	2	0	2	2	8	10	1	8	8	16
All ages	1	6	7	7	1	8	11	7	18	11	19	30	3	32	34	66

* No blood glucose value over 159 mg/100 ml.
† One or more values above 185 mg/100 ml at 30 minutes or earlier with fasting and later values normal.
** Peak value above 185 mg/100 ml later than 30 minutes, but fasting and 2-hour values normal.

Comparison of Morning and Afternoon Blood-Sugar Levels

Screening was performed in late afternoon; GTTs in the morning. Among the discovered diabetics, the mean morning 1-hour post-glucose level was nearly 30 mg/100 ml higher than the evening level. On the other hand, the mean morning and evening levels were much the same among those classified as 'borderline' and among the normal controls. Among those who screened positive but had normal GTTs, the mean morning level was more than 30 mg *lower*. All 297 subjects considered together had a lower morning mean (162 as against 181). Statistical evaluation cannot be performed because the screen tests were made on capillary blood and the GTTs on venous plasma.

TABLE IX. ONE-HOUR POST-GLUCOSE BLOOD LEVELS (MEANS IN MG/100 ML)

	No.	At screening* (p.m.)	At GTT† (a.m.)
Discovered diabetics	56	209	237
Borderline	53	185	180
Screen +, normal GTT	151	181	136
Normal controls	37	131	140
'Lag' curves	17	186	151
All subjects	314	181	161

* Capillary blood after at least 4-hour fast.
† Venous plasma.

DISCUSSION

Clinical impressions and imperfect statistics from diabetes clinics have long suggested that there is more diabetes among the Cape Coloured community than among the Cape White population.[5] The present work substantiates this belief, although most of the difference was 'hidden'—indicated by high screening blood-sugar levels and 'newly discovered' diabetes at survey.

Blood Glucose Levels

We were astonished at the high blood-sugar levels 1 hour after glucose that we obtained at screening—with a mean of 128 mg/100 ml in the youngest decade rising to 174 in the oldest and with almost one-third of all tested people screening positive (i.e. with blood-sugar levels over 159 mg). Similarly, the over-all frequency of glycosuria (9·5%) was higher than that found in other races.

As expected, the mean blood-sugar levels rose with age and the whole distribution of blood levels shifted to the right, though only over 35 (Fig. 1). Fig. 1 also indicates the rather remarkable frequency of values over 200 mg/100 ml in the older age groups. Again, as expected from the experience of previous studies, we could find no correlation between blood sugar and body weight or parity, and in this survey there was no consistent or significant difference between the sexes.

It has recently been shown that a GTT done in the afternoon tends to give higher figures than one done in the morning,[9] and we have confirmed this ourselves. This difference is less, or absent, among morning hyperglycaemics,[8] and so would not be expected in our 'discovered diabetics'. It was odd, however, to find considerably *higher* morning 1-hour values in the diabetics, and not to find any difference between morning and afternoon values in the normal controls. The 'positive' subjects, who had afternoon hyperglycaemia on their initial screening, would be expected to show lower mean figures on re-testing simply on a mathematical basis. We can therefore again conclude that late afternoon or early evening screening (after at least a 4-hour fast) is a valid procedure.[2,6]

Diabetes

We have previously defended our definition of diabetes,[3] but would repeat that our criteria are fairly stringent—many authorities would consider diabetes to be present with lesser abnormalities.[2] We believe all will agree we do not over-diagnose. Nevertheless, we cannot be certain all our 'discovered diabetics' are truly diabetic in a disease-sense—and would be content if the phrase 'discovered hyperglycaemic' were used instead. It should be noted that for our diagnosis a subject must be hyperglycaemic on at least 3 occasions—at screening and twice during the full GTT. To some extent this rules out those people with large swings in blood sugar who may only be hyperglycaemic on occasion.[6]

The prevalence of diabetes among Cape Coloureds known at the time of the survey was 1·1%—very similar to that in most White communities—including the White people of Cape Town, and also the Cape Town Bantu.[4,5] 'Discovered diabetes', however, was very much more frequent among Coloureds than among Whites or Bantu—the

over-all figure of 6·1% being even higher than that found among Cape Indians (4·5%) and Cape Malays (4·4%). Nevertheless, there was less total diabetes among the Coloured community than among the Indians: over the age of 15 the total prevalence, age-corrected to compare with the White population, was 10·6% for Coloureds and 19·1% for the Indians (against only 3·7% for Whites).

The cause of this great frequency of hyperglycaemia is not clear. It is not due to chronic pancreatitis nor related to excessive in-breeding. As a whole, the Coloured community is not more adipose than the White and, despite the large preponderance of obese females, the frequency of diabetes is very little different in the two sexes. The total calorie, sugar and fat intakes are known to be lower than the corresponding levels among the White population.[10] Racially-considered, the problem is worse confounded: in Hottentots and Bushmen diabetes is unknown; it is less common among the other progenitors of the Coloured people (European, Malay and Bantu); yet mix them all together and a diabetes prevalence of 7·2% in those over the age of 10 is found.

Although there was no correlation between screening blood-glucose level and body weight, we found, as usual, that obesity was clearly related to diabetes (Table V) and more particularly so in young diabetics under the age of 40 years. As previously observed,[11] the inference is that *overweight may be a more powerful diabetogenic influence in young than in older people.*

Knowledge of a *family history of diabetes was found no more often among discovered diabetics than among the total population* (18%). This might suggest that hereditary influences played little part in the high prevalence of diabetes among the Coloured community—but the aggregation of diabetes in some families was striking.

We were surprised to find as many as 7 diabetics aged 16 or less, all mild in type, and all but 1 asymptomatic (Table VI). Of these, 4 had a close relative with diabetes, suggesting that inheritance played more part in their diabetes than in the adult diabetics. We have likewise found adolescent mild diabetes in Malay and Indian communities but none in White or Bantu.

Only 3—remarkably few—of the 59 discovered diabetics had symptoms of definite diabetic nature: these were usually absent even when the post-glucose blood-sugar values were over 300 mg/100 ml or when fasting levels were over 200 mg/100 ml or with heavy fasting glycosuria.

Evidence of ischaemic heart disease* was found in 11 of the 41 discovered diabetics who were examined, and hypertension* in 12: rather similar frequencies to those among White diabetics,[11] and almost certainly higher than among the Coloured population in general. Fairly gross, typical, bilateral diabetic retinopathy was found in only one patient —a clear indication that she had 'diabetic disease'. The incidental finding of evidence of old (presumed), apical tuberculous infection in 14 subjects is worth remarking. No case of pancreatitis was discovered.

Glycosuria

In this particular survey we would have missed only one discovered diabetic had the urine not been tested at screening—the other 58 were all hyperglycaemic. On the other hand, had *glycosuria alone* been looked for at at screening, *35 would have been missed,* which indicates clearly the utter inadequacy of urine testing as a sole screening procedure, even after a glucose load. As in other racial groups, the frequency of glycosuria rose with age and was more likely to indicate diabetes in the elderly. Again, the presence of glycosuria was frequently inconsistent, even after the same glucose load.

Usually glycosuria is more common among males than females,[1] but in this survey there was no clear difference between the sexes, except that, as we found previously, glycosuria due to the 'lag curve' was much more common in men.[1] Yet renal glycosuria was more common in women.

Possible Moslem Influence

In previous studies the Cape Malays (Moslems) were found to have higher blood-glucose levels than Indians or Bantu when tested 1 hour after an oral glucose load.[5] They also had a high prevalence of discovered diabetes. Historically, the Malay people have contributed towards the formation of the Cape Coloured community, so we wondered whether the high frequency of diabetes in the present study might be partly due to Malay influence. In fact there were no known Moslem diabetics in this study, and the frequency of discovered diabetes was little different from that in the non-Moslem community, although on the whole, the screening blood-sugar levels were rather higher (Fig. 3).

We conclude that the Malay admixture alone cannot explain the hyperglycaemia among the Coloured community.

CONCLUSION

The Cape Coloured people appear to have a degree of hyperglycaemia far above that of the Cape White community and above any of their progenitors, being virtually the same as that found among Cape Indians. On the other hand, their 'known diabetes' rate was much the same as among White people, and this is presumably because of: (*a*) lack of diabetes-awareness, with a low 'family history rate' even in diabetics themselves, and (*b*) lack of symptoms of polyuria, thirst, pruritus vulvae and weight loss even in subjects with fasting blood-sugar levels above 200 mg/100 ml.

Two important conclusions can be drawn: (*i*) that neither symptoms nor glycosuria can be relied upon to herald the presence of even biochemically severe diabetes, and (*ii*) that this asymptomatic hyperglycaemia is important in relation to the accompanying excessive incidence of vascular disease in the Cape Coloureds (this was also found in the Bedford survey).[12]

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*For definitions and interpretations see Reference 11.

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