

# PREVALENCE OF GLYCOSURIA AND DIABETES AMONG INDIANS AND BANTU\*

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With a report by Cosnett in 1957,<sup>1</sup> attention was drawn to various aspects of diabetes in Indians in Natal. This worker studied the clinical records of 10,000 Indian in-patients at a Durban hospital, and stated that, by comparison with hospital admissions in England and Wales,

diabetes was more common in Indians. In 1959 Cosnett reviewed the clinical aspects of Indian diabetics.<sup>2</sup>

In 1960, Wood<sup>3</sup> carried out a glycosuria survey encompassing a 10% sample of a sub-economic housing scheme in Springfield, Durban. Her conclusions were that the prevalence of diabetes for Indians above the

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ages of 20 years and 30 years was 5.5% and 8.8% respectively.

Campbell<sup>6</sup> emphasized Cosnett's findings and in a series of publications<sup>6-11</sup> drew attention to many facets of the disease in Indians in Natal. Some of the points made were, firstly, that there existed an inordinately high prevalence of diabetes in Indians in Natal; secondly, that the vascular component of the disease was especially pernicious and malignant; thirdly, that glycosuria *per se* was indicative of diabetes, thus rendering blood tests unnecessary; and, fourthly, that true insulin dependence was extremely rare. Despite this no real prevalence studies have been reported for South African Indians. Wood's survey was confined to adults, based on a non-representative group, and testing consisted of examination of the urine for glycosuria only. Batchelor and Campbell<sup>10</sup> performed a glycosuria survey, but also without any blood-sugar studies. Small surveys of special limited groups of Indians have been made in the Transvaal, mostly by Walker and Seftel and their colleagues,<sup>12,13</sup> which have confirmed the presence of a high frequency of diabetes in these groups.

Turning to the Bantu, the general belief has been that diabetes is rather uncommon. This was partly confirmed by Politzer and co-workers,<sup>14</sup> who found a prevalence of only 0.23% in Basutoland; but the survey was based on random urine-testing of clinic attenders. There is little doubt that diabetes becomes more common with urbanization, and the same authors reported approximately a 3 times higher prevalence of diabetes in the Johannesburg Bantu.<sup>15</sup> Campbell has also commented on the increase of diabetes with urbanization. Again, Walker and Seftel and colleagues<sup>13,16</sup> have reported studies on small groups and on hospital and other non-representative populations, finding in very general terms a prevalence of around 1%.

An accurate knowledge of the prevalence and emergence of diabetes in different races is plainly of great importance with regard to public health, insurance and aetiology. Testing for glycosuria alone is not suitable for diagnosis or even for screening, since it may frequently be absent in the presence of considerable hyperglycaemia. Consequently we have performed 4 surveys based on blood- and urine-sugar testing in Bantu and Indians in different parts of South Africa, attempting in each survey to test all members of all families living in a chosen area. This paper summarizes some of our results.\*

#### PRESENT SURVEY

##### Subjects

1. *Cape Indians.* This group comprised families living in two residential areas, Rylands Estate and Wynberg, and contained English, Kokni and a few Gujerati and Tamil-speaking people. Fifty percent were Muslim and about 80% had been born in South Africa. They were screened in their own homes, 1 hour after consuming 50 G of glucose. Most tests were made in the evening and subjects were not necessarily fasting before the glucose load. Of 789 subjects over 10 years old who resided in the selected area, 622 were screened (79%).

2. *Cape Bantu.* A residential Bantu township, Guguletu,

about 5 miles from Cape Town was chosen. We attempted to test all people over the age of 10 years living in one main central street which ran across the whole diameter of the area, and in two parallel streets. Screening was performed on Saturday and Sunday mornings after overnight fasting. It proved extremely difficult to persuade the populace to attend clinics for screening, and on one occasion our staff was forced to retreat rapidly for fear of attack by a group under the influence of alcohol. Of 1,029 people in the chosen streets, 882 were tested (85.5%).

3. *Natal Indians.* The village of Tongaat near Durban was chosen for a detailed survey. Screening was performed 2 hours after consumption of 50 G of glucose. Subjects over the age of 10 years who were tested represented 90% of the total selected (2,427). Sociological studies showed that the Tongaat population is highly representative of the Natal Indian community as a whole, in socio-economic status, religion, diet and sex and age structure.

4. *Transvaal Bantu.* The township of Mamelodi, near Pretoria, was chosen and 2,015 subjects over the age of 10 years were screened by methods exactly similar to those used in the Tongaat survey. The tribes represented were Sotho, Shangaan and Venda.

##### Age and Sex Structure of Survey Groups

The age distribution of both Indian and the Transvaal Bantu groups compared closely with the general population structure. The Cape Bantu showed a hump in their distribution curve indicating the presence of an excess of young to middle-aged men, as is typical of the urban Bantu population. The sexes were nearly equal in all age ranges, except in the Transvaal Bantu, where the male:female ratio was 1:2 at all ages.

##### Methods\*

Screening included urine testing for glucose (Tes-tape) and in surveys 1 and 2 capillary blood-sugar estimation (Hagedorn-Jensen) one hour after glucose and in surveys 3 and 4 venous plasma-sugar estimations (auto-analyser—Hoffman) two hours after glucose. In surveys 1 and 2, subjects were considered 'screened positive' if the blood-sugar level was above 160 mg./100 ml. or if glycosuria was present. In survey 3 a plasma level of 110 mg./100 ml. was used. All positive screenees were invited to attend the laboratory for full 50-G glucose-tolerance tests after overnight fasting, with measurements of plasma immunoreactive insulin (IRI) and free-fatty-acid (FFA) levels. A number of negative screenees were similarly tested. In survey 4 no further testing was performed. 'Trace' glycosuria (i.e. below 0.1% glucose) was considered negative.

A final diagnosis of 'discovered diabetes mellitus' in surveys 1 and 2 was made if two of the three estimations on blood taken while fasting, at 1 hour and at 2 hours, exceeded 120, 200 and 140 mg./100 ml. respectively. In survey 3, both 1- and 2-hour levels of 185 and 140 mg./100 ml. had to be satisfied. We believe these criteria to be approximately identical, bearing in mind the methods used.

In survey 4 diabetes was considered present when the screening level was 150 mg./100 ml. or above. (This approximation to the diagnosis can be validated from survey 3, which indicates that 150 mg./100 ml. comes

\*Further details of the Cape surveys appear elsewhere.<sup>17</sup>

\*Methodology is discussed in greater detail elsewhere (in the press).<sup>17</sup>

nearest to agreement with the final diagnosis after full GTT.)

Results will be expressed in percentages to overcome confusion regarding comparisons of unequal numbers. (Tables showing actual numbers are available on request.)

In all groups the populations are young in comparison with White populations, so that no direct comparisons between White and non-White values are valid; such comparisons must be restricted to defined age-groups or the results must be age-adjusted.

RESULTS

Blood-Glucose Screening

The frequency-distribution of blood-sugar levels was remarkably similar in Cape Indians and Bantu (1 hour after glucose) and in Natal Indians and Transvaal Bantu (2 hours after glucose) as shown in Figs. 1 and 2.

On the other hand, the mean blood-sugar levels were higher in the Cape Indians than in Cape Bantu at all

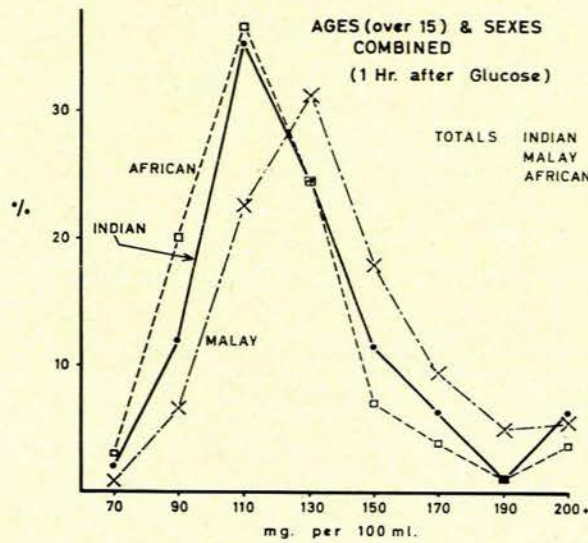


Fig. 1. Note similarity of distribution of blood-sugar levels among Indians and Bantu. The distribution of blood-sugar levels among Malays is quite different (not considered in text).

ages for both sexes (Table II). This tendency is much less pronounced when Natal Indian and Transvaal Bantu 2-hour figures are compared (Table III); in fact, in several

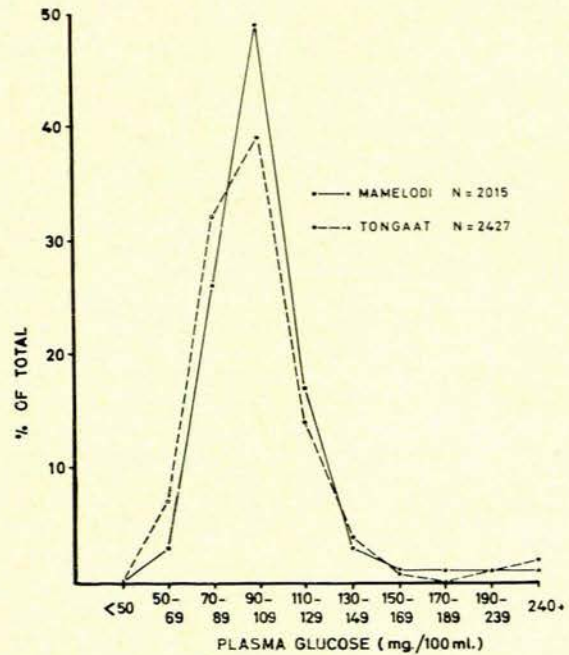


Fig. 2. Plasma-glucose values 2 hours after oral glucose. Note similarity of distribution of blood-sugar levels among Indians and Bantu.

age/sex groupings the Bantu had higher mean glucose values.

Other points that clearly emerge are: (i) There was a general tendency for the mean glucose levels to rise with age but only over the age of 30 years—children had blood-sugar values no lower than young adults; (ii) in the Bantu there was no further rise in blood-sugar levels over the age of 50 years, but the Indian levels continued upwards; and (iii) the one-hour figures (i.e. more or less 'peak' blood-sugar levels) showed no sex difference (Table II), while the 2-hour figures in both Indians and Bantu were significantly higher in females over the age of 40 years (over 70 years the numbers are too small for proper comparison).

TABLE I. PROCEDURE

Survey population	Screening challenge	Blood sample	Glucose determination		Positive criteria	Pos. screenees had GTT	Diabetes diagnosed
			Blood	Urine			
1. Cape Indian 2. Cape Bantu	50 G glucose	Capillary whole blood	Hagedorn-Jensen	Tes-tape	160 mg./100 ml. at 1 hr	Yes	>120 fasting, 200 at 1 hr, 140 at 2 hrs. Two of these on GTT
3. Natal Indian			Autoana. Hoffman	Tes-tape			
4. Transvaal Bantu	50 G glucose	Ven. plasma	Autoana. Hoffman	Tes-tape	—	No	≥150 mg./100 ml. at screen

TABLE II. MEAN 1-HOUR BLOOD-SUGAR SCREENING VALUES IN INDIANS AND BANTU (CAPE TOWN) IN MG./100 ML.

Age-group in years	Blood-sugar levels			
	Indian		Bantu	
	Male	Female	Male	Female
10-14	120	120	105	107
15-34	122	120	113	106
35-54	132	138	127	128
55+	163	144	128	130

TABLE III. MEAN 2-HOUR PLASMA-GLUCOSE SCREENING VALUES IN 2,427 NATAL INDIANS (TONGAAT) AND 2,015 TRANSVAAL BANTU (MAMELODI) IN MG./100 ML.

Age-group in years	Plasma-glucose levels			
	Indian		Bantu	
	Male	Female	Male	Female
10-19	89	96	98	99
20-29	87	95	100	97
30-39	92	101	99	98
40-49	97	123	99	114
50-59	111	125	127	123
60-69	120	153	108*	141
70+	152*	121*	106*	133*

\* More than 40 in each group except where indicated.

#### Prevalence of Diabetes (Tables IV and V)

The presence of 'known diabetes' was confirmed by hospital or doctors' history or by blood-sugar estimation.

There were far more known diabetics among Indians than Bantu, the prevalence being 4.3% over the age of 15 years for Indians and below 1% for Bantu in the Cape. Among Cape Indians the prevalence over the age of 55 years was 24%; for Bantu the prevalence was 2.5%. Among Natal Indians the prevalence of known diabetes was 1.8% including all ages, while there was only one known diabetic among the Transvaal Bantu.

Diabetes discovered on survey was also more common among the Indians, being over 4% as against 2-3% for Bantu. Total diabetes (known and discovered combined) was most frequent in Cape Indians over 55 years, at 39% for both sexes and over 50% in women. Among Bantu in the Cape the prevalence of discovered diabetes was clearly higher (5.9%) in middle age (35-54 years) than in the elderly (1.5%).

Total diabetes for all ages over 10 years was thus 8.4% for Cape Indians and 2.7% for Cape Bantu.

Age-correction to compare with the British population gives figures that are nearly double for Cape Indians—approximately 16% total diabetes for all ages—and rather less an increase for Cape Bantu to approximately 3.7%.

#### Glycosuria (Table VI)

The over-all prevalence of glycosuria following a glucose load was similar in each of the first 3 surveys, lying between 5.3 and 6.9%. The Transvaal Bantu had a glycosuria rate of only 1.0%.

There was more glycosuria in men than in women in Transvaal Bantu and in the two Cape surveys (10 : 3.9% in Indians and 9.1 : 3.9% in Bantu), but no difference between the sexes in the Natal Indian survey.

All surveys showed a clear increase of glycosuria with age but only up to middle-age; i.e. there was no further or only a minimal rise over 55 years. Under 15 years there was virtually no glycosuria.

#### Relation of Glycosuria to Diabetes

Every Cape Indian diabetic, previously known and newly diagnosed, had glycosuria at screen and/or GTT. Five out of the 28 (18%) discovered Indian diabetics; however, did not have glycosuria after the glucose at screening. Four of the 18 Cape Bantu discovered diabetics never showed glycosuria at all. Of the Transvaal Bantu, 43 out of 59 'diabetics' (i.e. with 2-hour screening values of over 150 mg./100 ml.) were aglycosuric.

TABLE IV. PREVALENCE OF PREVIOUSLY KNOWN DIABETES IN INDIANS AND BANTU AT SURVEY (IN PERCENTAGES)

Age-group in years	Indian						Bantu					
	Cape			Natal			Cape			Transvaal		
	M	F	Both sexes	M	F	Both sexes	M	F	Both sexes	M	F	Both sexes
10-14	0	0	0	0	0	0	0	0	0	0	0	0
15-34	1.3	0.5	0.8	0.6	0.1	0.3	0	0	0	0	0	0
35-54	7.4	5.2	6.5	4.6	4.2	4.3	1.7	1.3	1.5	0	0	0
55+	11	45	24	6.6	11	8.5	0	7.4	2.5	0	1.0	0.5
All ages	3.5	4.3	3.9	1.8	1.8	1.8	0.6	0.7	0.7	0	0.1	0.05

TABLE V. PREVALENCE OF NEWLY DISCOVERED DIABETES IN INDIANS AND BANTU (IN PERCENTAGES)

Age-group in years	Indian						Bantu					
	Cape			Natal			Cape			Transvaal		
	M	F	Both sexes	M	F	Both sexes	M	F	Both sexes	M	F	Both sexes
10-14	0	0	0	0	2.4	1.3	0	0	0	1	1	1
15-24	1.8	1.2	1.4	0.3	1.6	1.0	0	0	0	1.3	1.1	1.2
35-54	10	9.6	9.8	4.1	12	9.5	6.0	5.8	5.9	5.0	4.6	4.7
55+	18	8.3	15	12	13	12	2.6	0	1.5	9.0	13	12
All ages	5.5	3.5	4.5	3.0	5.1	4.2	2.4	1.8	2.0	2.8	3.0	2.9

TABLE VI. PREVALENCE OF GLYCOSURIA IN INDIANS AND AFRICANS AT SCREENING (IN PERCENTAGES)

Age-group in years	Indian						Bantu					
	Cape			Natal			Cape			Transvaal		
	M	F	Both sexes	M	F	Both sexes	M	F	Both sexes	M	F	Both sexes
10-14	0	0	0	1	1	1	2	0	1	0	0	0
15-34	5.2	1.2	3.5	2.0	1.1	1.5	6.9	3.6	4.7	0.5	0.2	0.3
35-54	20	11	15	9.3	0	9.1	14	7.3	10	3.6	1.4	2.0
55+	22	9.0	17	14	10	12	13	3.9	9.2	6.0	3.0	4.0
All ages	10	3.9	6.9	5.5	5.2	5.3	9.1	3.9	6.0	1.6	0.7	1.0

The finding of glycosuria indicated diabetes in approximately 40% of all cases in the Cape surveys—in 30% of men and 50% of women. The chance of glycosuria being diabetic rose with age from below 20% in young people to over 60% in the elderly. There was no clear difference between Indian and Bantu in this regard. In the Natal Indian survey about two-thirds of the glycosuria was found to be diabetic.

#### DISCUSSION

##### Diagnosis of 'Diabetes'

We have begged the question of whether our definition of hyperglycaemia on GTT really means 'diabetes mellitus'. We have discussed this in detail elsewhere.<sup>18,19</sup> Small points in these surveys suggesting that the diagnosis is valid are, firstly, that our criteria are stringent in comparison with most others, that is to say our criteria for abnormality in blood-sugar levels are high, approximately 3 standard deviations above our normal mean values; secondly, the great majority of our 'discovered diabetics' had glycosuria, and thirdly, approximately 60% of 'discovered diabetics' had a fasting blood-sugar level over 120 mg./100 ml. (this applies, of course, only to the first 3 surveys, since fasting levels were not measured in the Mamelodi survey). Nevertheless it could reasonably be argued that, especially in older people, diabetes should not be diagnosed on hyperglycaemia alone, but only when symptoms or clearly diabetic complications are present. (Our clinical data will be presented in another paper, but we must admit that symptoms and complications were rare in these diabetics, even in several cases where the 1- or 2-hour blood-sugar levels were over 300 mg./100 ml. Another pointer that unrecognized hyperglycaemia is of clinical significance lies in its close relationship to vascular disease, apart from that specifically of diabetic origin.<sup>20-22</sup> Thus we use the term 'discovered diabetes' in this paper, realizing that we mean 'discovered hyperglycaemia of a degree we believe to be clinically significant or potentially important as an index of an underlying diabetic state'.

##### Blood-Sugar Screening Levels and Diabetes

It is perhaps surprising that the distribution of blood-sugar values after glucose at screening were so similar between Indians and Bantu, both in the 1- and 2-hour postglucose surveys (Figs. 1 and 2). In the 1-hour surveys the mean blood-sugar levels were clearly higher in Indians, but not in the 2-hour surveys. The similarity between Transvaal Bantu and Natal Indians is further shown by the similar number of cases of discovered diabetes (Table V). In fact, if the diagnosis in both surveys were

based on a screening figure of over 150 mg./100 ml., the total prevalence of diabetes would be almost identical for both races (2.9% and 3.3% respectively). This is certainly surprising, and it is not clear why this should be different from the findings in the Cape, where the Indians had over twice as many cases of discovered diabetes as the Bantu.

In both Indian surveys there was a clear-cut rise of total diabetes (known plus discovered) with age. Our results are similar to those found in the older age-group by Walker in the Transvaal.<sup>23</sup> In the Cape Bantu the highest prevalence of discovered diabetes occurred in the middle-aged and not in the elderly group. This tallies with the mean screening blood-sugar levels, which continued to rise with age in Indians but were not higher in the elderly Bantu than in the middle-aged.

There was no consistent difference between the sexes in prevalence of diabetes in any age-group for either race, and total male and female rates were virtually identical. This is unlike the usual female preponderance found in White populations. We found no difference in prevalence of diabetes between Hindus and Moslems in the Cape—other investigators have observed more glycosuria and diabetes in Moslems.<sup>22</sup>

The prevalence of known diabetes among the Cape Indians over 10 years of age was extremely high—3.9% is about 4 times the generally reported prevalence among White races, and is even higher (7.4%) when age-corrected for the British population. This was unaccountably higher than the 1.8% for the Natal Indians. Both Bantu populations had a low prevalence of known diabetes (under 1%), yet the frequency of 'discovered diabetes' among them was not far from that among Indians. An obvious explanation is that there was more awareness of diabetes among the Indians, so that much of it was already diagnosed.

##### Glycosuria

We found in general a far lower glycosuria rate after a glucose load than reported by Butterfield *et al.*<sup>23</sup> for the Bedford survey (30%). This is partly because they included 'trace' tests. We found the expected rise of glycosuria prevalence with age and a greater amount in men than in women. The virtual absence of glycosuria (even renal glycosuria) in the very young is striking in view of the fact that their mean blood-sugar levels are not lower than those of young adults. This suggests that in some individuals the renal threshold must fall with age.

In the Cape surveys only some 40% of glycosuric subjects were diabetic, but in Natal about two-thirds

were diabetic. The great majority of all diagnosed diabetics had glycosuria, though not necessarily with every glucose load; however, the Transvaal Bantu had very little glycosuria at all. More than half of the hyperglycaemics in this survey had no glycosuria.

One advantage of having performed surveys on different groups of Indians and two different groups of Bantu has been to show that what applies to one group does not necessarily apply to the other, even though each group appears to be reasonably representative of the community at large. In general it is clear, however, that known diabetes is far more common in the Indian, but that latent diabetes may not be so different in the two races. It is also clear that glycosuria cannot be taken to indicate diabetes without blood-sugar analysis and that the great majority of Indian diabetics have glycosuria. The position regarding glycosuria among Bantu diabetics is still unclear because of the different findings in our two surveys. The Mamelodi Bantu, although living as an urban community, are by and large distinctly less 'urbanized' than the Cape Bantu.

We should like to emphasize again how difficult it is to compare the results of different surveys, unless identical or near-identical methods are used. Our findings cannot, for example, be compared with other surveys of Bantu or Indians in which random urine-sugar-testing is used as a screening or definitive procedure.

#### SUMMARY

Two representative groups of South African Indians and two groups of Bantu were surveyed for diabetes mellitus and related variables. They all received a glucose load and subsequent tests for glycosuria and blood-sugar levels as screening procedures. In three surveys all subjects who screened positive were invited to undergo full glucose-tolerance tests. Note is made of the age structure of the survey groups.

Frequency distribution of blood-glucose levels is described and is similar in all groups, though the mean blood-sugar levels are higher in Cape Indians than in Cape Bantu.

Known diabetes rates were higher in Indians—as much as 4.3% among Cape Indians, and very low in the Transvaal Bantu. Diabetes discovered on survey was also more common among Indians.

Total diabetes rose with age, and was greater than 50% among Cape Indian women over 55 years.

Glycosuria was equally common among Cape Indians, Cape Bantu and Natal Indians, at around 6% of total population groups, but was much less among the Transvaal Bantu. The prevalence of glycosuria, including renal glycosuria, rose with age. Glycosuria is a poor screening test for diabetes.

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#### REFERENCES

1. Cosnett, J. E. (1957): *S. Afr. Med. J.*, **31**, 1109.
2. *Idem* (1959): *Brit. Med. J.*, **1**, 187.
3. Wood, M. M. (1960): *Med. Proc.*, **6**, 140.
4. Campbell, G. D. (1959): *Ibid.*, **5**, 559.
5. Campbell, G. D. and McKechnie, J. (1961): *S. Afr. Med. J.*, **35**, 1008.
6. Campbell, G. D. (1961): *Med. Proc.*, **7**, 395.
7. *Idem* (1960): *Brit. Med. J.*, **2**, 537.
8. *Idem* (1962): *S. Afr. Med. J.*, **36**, 288.
9. *Idem* (1963): *E. Afr. Med. J.*, **5**, 267.
10. *Idem* (1963): *S. Afr. Med. J.*, **37**, 1195.
11. *Idem* (1964): *Leech (Johannesburg)*, **34**, 125.
12. Walker, A. R. P., Mistry, S. D. and Seftel, H. C. (1963): *S. Afr. Med. J.*, **37**, 1217.
13. Walker, A. R. P. (1966): *S. Afr. J. Nutr.*, **2**, 71.
14. Politzer, W. M., Hardegger, B. and Schneider, T. (1960): *Brit. Med. J.*, **1**, 615.
15. Politzer, W. M. and Schneider, T. (1962): *S. Afr. Med. J.*, **36**, 608.
16. Seftel, H. C., Keely, K. J. and Walker, A. R. P. (1963): *Ibid.*, **37**, 1213.
17. Marine, N., Vinik, A. I., Edelstein, I. and Jackson, W. P. U. (1969): *Diabetes* (in the press).
18. Jackson, W. P. U. (1964): *On Diabetes Mellitus*. Springfield, Ill.: Charles C. Thomas.
19. *Idem* (1965): *Méd. et Hyg. (Genève)*, **23**, 864.
20. Keen, H. (1964): *Proc. Roy. Soc. Med.*, **57**, 200.
21. Kingsbury, K. J. (1966): *Lancet*, **2**, 1374.
22. Ostrander, L. D., Francis, T., Hayner, N. S., Kjelsberg, M. O. and Epstein, F. H. (1965): *Ann. Intern. Med.*, **62**, 1188.
23. Butterfield, W. J. H., Keen, H. and Whicelow, M. J. (1967): *Brit. Med. J.*, **2**, 505.