

## STUDIES IN GLYCOSURIA AND DIABETES IN NON-WHITE POPULATIONS OF THE TRANSVAAL

### PART II. INDIANS

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The commonness of diabetes among the immigrant Indian population of South Africa has been known for many years.<sup>1</sup> Recently it has attracted considerable attention, chiefly on account of observations made in Natal, particularly by Cosnett,<sup>2,3</sup> Campbell,<sup>4-6</sup> Wood,<sup>7</sup> and McKechnie.<sup>8</sup> The studies of these and other workers give the impression that not only is diabetes commoner in Indians than in Whites, but that vascular complications occur perhaps at an earlier age, are of greater severity, and develop more rapidly. These views are almost wholly based on the examination of patients attending hospitals and clinics.

*Diabetes, coronary heart disease, and cerebral vascular disease.* Our desire to study diabetes in local Indians was stimulated primarily by our interest in the prevalence of vascular diseases in interracial populations of South Africa.<sup>9,10</sup> It is known that the death rate of Indians from coronary heart disease (CHD) is almost as high, and from cerebral vascular disease (CVD) higher, than the respective rates for Whites.<sup>11,12</sup> Understandably, we have wondered about the extent to which these mortalities are due, directly or indirectly, to the commonness of diabetes among Indians. Inspection of death certificates is of very limited value. Nevertheless, by taking into account both primary and secondary causes of death, it has been noted that in Durban diabetes associated with either CHD or CVD is commoner in Indians than in Whites.<sup>13</sup>

*Suitability of Indians for epidemiological studies.* It is perhaps insufficiently appreciated how very well the number of variables in South African Indians lend themselves to aetiological investigations. Briefly, there are Hindus, Moslems and Christians, vegetarians and non-vegetarians, rich and also very poor, urban and rural dwellers and, not least, groups that favour cousin marriages and those that prohibit them. Moreover, in most groups, there are those that pursue either active or sedentary occupations. The local Indian populations therefore are eminently suitable for studies of the type in mind. Hence it was thought that, by determining the prevalence of glycosuria and of diabetes in Indian communities in the Transvaal, the elucidation of the influencing factors might well provide information of value in relation not only to diabetes but also to coronary heart disease and cerebral vascular disease.

#### *Indian Groups in the Transvaal*

In 1960 the total number of Asiatics in the Republic of South Africa was 477,414, of whom 62,918 (i.e. 13.2%) were living in the Transvaal. Of these, 95% were Indians and 5% Chinese. Among the Indians, 58-60% were Moslems, 33-35% Hindus, and 6-7% Christians. In Johannesburg there are about 24,500 Indians and in Pretoria 7,500; the remaining Transvaal Indians dwell in

Reef towns and in country districts. In the country there are several centres having Indian populations of less than 1,000 persons, which are thus of a size that permits investigation of each member.

In the groups studied by us, most of the Indians (both Hindus and Moslems) or their forefathers had their origin in the Gujarat State of India, particularly in the following districts: Surat, Kheira, Porbander, Jamnagar and Rajkot. Gujarati, Urdu and Memon are their main home languages. The Memon people originally were Lohana Hindus, but subsequently were converted to Islam.

Marriages between cousins or near relations are encouraged by Moslems, and by Hindus who have emigrated from South India. Among all other Hindus such marriages are forbidden. In Natal, about two-thirds of Hindus originated from South India, whereas in the Transvaal the proportion is about one-third.

The average middle-aged Indian parents studied had 5-7 children.

Broadly speaking, Transvaal Indians are economically more advanced than those of Natal. Admittedly, a proportion of Indians in Johannesburg and Pretoria are very poor; but most Indians living in smaller towns are middle-class.

Concerning diet, Moslems, as a rule, are non-vegetarians and partake of all common foods except such as are prohibited by their religion (e.g. pork). Some Hindus are vegetarian, others non-vegetarian. We do not know very much about the energy value of the diets consumed, but from the information already assembled it is our impression that about half of the calories are derived from carbohydrate, 30-40% from fat, and about 15% from protein. Carbohydrate is largely supplied by rice, wheat, potatoes and sugar. The fat moiety is mainly derived from ghee (produced by heating butter and removing the sediment by filtering through cloth), and to a lesser extent from vegetable oils. Milk, pulses, and cereals (sometimes eggs), are the chief sources of protein for the vegetarian Hindus. Mutton, chicken, eggs, milk, pulses and cereals are the main sources of protein for Hindu non-vegetarians. The latter do not eat beef, which is forbidden by their religion. Spices, chillies, garlic, and other flavourings, are frequent ingredients in everyday dishes. Among local Indians obesity in the middle-aged is by no means uncommon.

Investigations thus far have been wholly epidemiological; in this paper no observations will be made regarding clinical features, complications, or treatment.

#### INITIAL STUDY AT JOHANNESBURG AND PRETORIA

Our first study was carried out on adult Indian volunteers (20 years and over) in Johannesburg and Pretoria from

predominantly middle-class homes. Persons were examined on a house-to-house basis, at mosques, and at other places where Indians are apt to congregate. Investigations included measurements of height, weight, blood pressure, and arm girth, ECG observations at rest, enquiries into socio-economic state and diet, examination of urine for sugar ('tes-tape' technique), and certain haematological and biochemical studies on a limited number of blood samples. Altogether 315 males (175 Moslem, 140 Hindu) and 361 females (165 Moslem, 196 Hindu) were examined. In this initial study it was not possible to determine the blood-sugar levels of all persons with glycosuria. The total prevalence of glycosuria in the adults studied (20 years and over) was 7.0%. It was 10% in the age group 40-49 years (both sexes), and 15% in the 50-59 year group (both sexes). Moslems appeared to be affected more than Hindus, and better-class persons more than the poor. There seemed to be no sex bias.

#### SUBSEQUENT STUDIES ON CLOSED POPULATIONS

In the studies to be described attempts have been and continue to be made to examine a number of population groups on a statistically satisfactory basis. Investigations at the undermentioned centres are being undertaken.

#### Subjects

*Pietersburg.* In the Indian community of this town 85% are Moslems, 10% Hindus, and 5% Christians. Of 390 adults (20 years and over), 323 (i.e. 82%) have been investigated.

*Louis Trichardt.* 44% of the Indians are Moslems, and 56% Hindus. The whole population, namely 484 persons of all ages, has been studied.

*Rustenburg.* 96% of the Indians are Moslems, and 4% Hindus. Of the whole population, namely 770 persons of all ages, 690 (i.e. 89%) have been examined up to the present.

*Johannesburg.* In the second study undertaken in this city, an endeavour is being made to make observations on the households of all children attending the Indian College at Fordsburg. Of the total population involved, 73% are Moslems, 24% Hindus, and 3% Christians. Total family members amount to 1,830 persons of all ages, of whom 1,500 (i.e. 82%) have been examined thus far.

#### Method of Study

At Pietersburg the glycosuria and diabetes studies constituted part of a more detailed survey, thus requiring a different approach from that used at Louis Trichardt, Rustenburg and the second Johannesburg study. Investigations at these latter places were primarily for glycosuria and diabetes. Firstly, preliminary discussions took place with the prominent leaders of the community as well as with the school board and staff. Next, through the medium of the school pupils, a form was distributed for the head of the family to fill in. This form yielded details of the age and sex of all household members, as well as information on persons known to be suffering from diabetes. Thereafter, each pupil was given the requisite number of glass sample bottles fitted with a screw top (capacity about 30 ml.); each bottle had a label attached on which was written the name of one member of the relevant house-

hold. An information sheet outlining the purpose and emphasizing the importance of the survey was also distributed. Subjects collected urine samples one hour after the main meal of the day, which were then brought to the school either by the pupils or by messengers. Urines were examined by means of glucose oxidase tapes ('tes-tape', 'clintix'), and all urines showing a positive reaction were examined by a modification of Benedict's test ('clintest'). In the first instance certain families refused to participate, either from apathy or pronounced opposition. Afterwards, however, by patient enlightenment and reasoning, as well as by much house-to-house visiting, the proportion examined rose steadily. Examinations were then made of blood samples, and also of further urine samples, collected from all subjects found to have glycosuria (including those known to be diabetic although not having glycosuria at the time of study), the samples being taken about 2 hours (range 1½-2½ hours) after the main meal of the day. Additionally, blood was collected a second time from all persons whose blood-sugar values were found to lie between 110 and 140 mg. per 100 ml. Blood sugar (true glucose) was determined by the method described by King and Wootton.<sup>14</sup> Diabetes was considered to be present when the postprandial blood-sugar concentration exceeded 140 mg. per 100 ml.<sup>15</sup> Blood samples were also examined haematologically, and the serum for cholesterol<sup>16</sup> and other lipid components, uric acid,<sup>17</sup> protein fractionation, liver-function tests, and other constituents. In addition to testing for sugar, urines were also examined for albumin ('albus-tix'), chlorides, and sodium; also for nitrogen partition (total nitrogen, urea, creatinine). A limited number of 24-hour samples of urine from both non-diabetic and diabetic subjects were examined for 17-ketosteroids<sup>18</sup> and 17-hydroxycorticosteroids.<sup>19</sup> Finally, information regarding family history of diabetes was obtained from all subjects who came for blood tests, and measurements of weight, height, build, blood pressure, and arm girth, were carried out.

Presentation of most of these data will appear in later papers.

#### Discussion of Results

As already emphasized, most of the studies described remain to be completed or at least to be brought to a stage of finality. In the present paper, therefore, remarks will be confined to giving impressions of trends of some of the parameters mentioned. All comments must therefore be regarded as tentative.

1. *Prevalences of glycosuria and diabetes.* Of the groups studied as total populations (Louis Trichardt, Rustenburg, and Johannesburg) the prevalences of glycosuria and of diabetes lie between 5 and 6%, and between 2.5 and 3.5%, respectively. In all groups investigated, for persons of 20 years and over, the corresponding figures lie between 8 and 9%, and between 4.5 and 5.5%, respectively. The diabetes prevalence is similar to that found by Wood<sup>7</sup> in a non-hospital Indian population in Durban. In comparison with observations made overseas, the prevalence of glycosuria in the Transvaal Indian populations studied is of the same order as that reported for certain White populations, e.g. at Oxford (USA),<sup>20</sup> Newcastle-on-Tyne (UK),<sup>21</sup> and Leicester (UK).<sup>22</sup> The prevalence of diabetes,

as judged by the criterion employed, appears to be somewhat higher than that reported in a number of studies on Whites, e.g. at Oxford (USA),<sup>20</sup> Ontario (Canada),<sup>23</sup> Newcastle-on-Tyne (UK),<sup>21</sup> Birmingham (UK),<sup>24</sup> Halstead (UK),<sup>25</sup> and Mecklenburg (E. Germany).<sup>26</sup> The figure for the Indians, however, would seem to be little different to that reported for groups of Whites in New York (USA),<sup>27</sup> and of Ashkenazi Jews (Israel),<sup>28</sup> who are of western origin. It must be borne in mind, however, that the method used for the detection of diabetes is different in almost every investigation cited. Our observations suggest that glycosuria and diabetes occur more frequently in Moslems than in Hindus. This has been noted by the workers in Durban,<sup>2-6</sup> and also at Kampala.<sup>29</sup> Whether the higher prevalence in Moslems is due to their higher socio-economic status, their being non-vegetarian, their practice of intermarriage, or other reasons, is not yet apparent. In India, corresponding information is not available.<sup>30</sup>

2. *Sex.* Observations indicate that there is little sex bias in respect of either glycosuria or diabetes. In Durban, from studies on Indians in hospitals and clinics, the general impression is that females outnumber males.<sup>3,4</sup> Among western populations, it is usual for females to exceed males.<sup>31</sup> However, in some parts of Africa, Pakistan, India, China, and Japan, it has been stated that men with diabetes outnumber women.<sup>32-34</sup>

3. *Age.* Our information on this aspect is incomplete. In Durban, Cosnett<sup>3</sup> considered that the maximum susceptibility to diabetes occurs at a slightly earlier age in Indians than Whites. Among the latter, the maximum age of susceptibility has been given as 50-59 years for males and 60-69 years for females.<sup>35</sup> Among Indians in East Pakistan<sup>31</sup> it has been reported that the common age of emergence of the disease is soon after 40 years.

4. *Family history.* Among the Indian diabetics at Pietersburg, Louis Trichardt, and Rustenburg, a definite family history of the disease was recorded in 19 out of 45 cases (43%). In Cosnett's series,<sup>3</sup> the figure was 28.5%. This is similar to proportions reported from Pakistan<sup>31</sup> and India.<sup>32</sup> In Campbell's series, however, a family history was found in 48.4%. Joslin<sup>31</sup> gives a figure of 41% for White diabetics.

5. *Serum-cholesterol level.* We have found mean serum-cholesterol concentration in diabetic males and females to be significantly higher than in the sex groups without the disease. This finding is frequently reported among Whites.<sup>31,36</sup> Mean serum-cholesterol levels in the different age and sex groups have been found to exceed figures reported for Whites.<sup>37,38</sup> Our values are greater than those published for Indians in Kampala.<sup>29</sup> Concentrations, too, are higher than those found in privileged Indians in India, e.g. officers of defence forces, merchants, professional classes.<sup>39,40</sup> As in reports from Kampala,<sup>29</sup> we have found that the rise of cholesterol level with age is greater in non-vegetarians than vegetarians.

6. *Serum uric-acid concentration.* Only in the case of Louis Trichardt Moslem males and females have we found elevations in mean serum uric-acid levels in diabetics compared with non-diabetics in the two sex groups. Otherwise, mean values of sexes with and without the disease have very closely resembled values reported for 'normal'

Whites.<sup>41-43</sup> In Durban, Campbell<sup>5</sup> found higher values in Indians with diabetes than in those without the disease. The reverse was reported in the study made by Beckett and Lewis<sup>44</sup> on Whites in London.

7. *17-Ketosteroids and 17-hydroxycorticosteroids.* Mean values for the excretions of these components have been obtained for 24-hourly collection from a number of diabetic and non-diabetic subjects. Both mean values are lower than the mean values for non-diabetic White subjects.<sup>45</sup> This aspect of our work is still in progress; thus far, however, there appears to be little difference in mean values for persons with and without diabetes.

#### Comment

It is hoped that further observations, including glucose-tolerance tests, will help to define more closely the extent by which the incidence of diabetes in local Indians exceeds that in the White population. It is planned to extend observations to selected groups of indigent Indians to throw more light on the influence of socio-economic state. It is also planned to carry out further work to reveal more of the differences between Moslems and Hindus, especially in regard to the role of consanguinity.

On the basis of death certificates, we have found that about 35-40% of Indians in Durban in the age group 45-64 years die from coronary heart disease or from cerebral vascular disease (both sexes); in the same age group (both sexes), about 9-10% are listed as dying from or with diabetes, as primary or secondary causes of death. The corresponding proportions in Johannesburg appear higher, although data over a sufficiently long period of years are not yet available. In the Transvaal Indians studied and described by us, for the same age period, about 16% have diabetes. It would seem certain that among Indians dying from CHD and CVD, the responsibility of diabetes, directly or indirectly, is greater than among Whites. Further observations and inquiries may be expected to help to clarify the situation.

#### SUMMARY

The commonness in South African Indians of coronary heart disease and of cerebral vascular disease, as well as of diabetes, has prompted us to try to obtain definitive information on the incidence of diabetes in order to throw some light on the aetiology of the other two diseases in these people.

The present paper describes studies on the prevalence of glycosuria and of diabetes in Indian populations in the Transvaal, namely at Johannesburg, Pretoria, Pietersburg, Louis Trichardt, and Rustenburg. Most of these investigations are incomplete, and comments must therefore be regarded as tentative.

The picture of glycosuria as a whole appears to be of the same order as that found in many studies on White populations. Diabetes, especially among the Moslems, has a higher prevalence than that reported in most studies carried out on White populations.

Serum-cholesterol levels of the Indians studied, especially of the diabetics, are higher than mean values in corresponding White groups. Mean serum uric-acid levels were normal, both in the presence and absence of diabetes; values resemble those of Whites. Mean values for the

excretion of steroid hormones, namely 17-ketosteroids and 17-hydroxycorticosteroids, appear lower than corresponding values in Whites. Mean values for those with and without diabetes are similar.

Studies of the type described depend almost wholly on the goodwill of the leaders of the different Indian communities, the principals and staffs of schools, the members of school boards and, of course, all the people studied. The principal collaborators will be mentioned in detail in the final publication. Many whole-time and part-time workers assisted in the examinations of persons and their urine and blood, and helped in the requisite clerical and other work. These include Misses C. de Lacy, D. C. Fletcher, G. Schoen, A. Nurse, P. Coles and T. Schoen and Mesdames A. R. P. Walker, B. D. Richardson and J. D. Jones. The expenses of the investigation were met in part by a grant (H:4244) from the National Heart Institute, United States Public Health Service.

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