GEOGRAPHICAL AND RACIAL DISTRIBUTION OF DIPHTHERIA IN SOUTH AFRICA

V. BOKKENHEUSER, *South African Institute for Medical Research, Johannesburg*

Until World War II South Africa enjoyed a low diphtheria rate compared with other countries.[1-3] Since then, the disease has been suppressed or even eliminated in many countries, whereas the last survey in South Africa (1952)[3] showed that the annual incidence here had remained unchanged.

The purpose of this paper is to bring up to date the national picture of diphtheria and to examine the geographical and racial distribution of the disease.

MATERIAL AND METHODS

Demographic figures for the period before 1958 were extracted from the annual reports of the Department of Health (South Africa)[4] and those for 1958 and 1959 were made available by courtesy of the Department.[5] The notifications of diphtheria by province and race were obtained from the same sources and the Department classified the reported cases according to the domicile of the patients in urban or rural districts.[5] The figures from Johannesburg were supplied by courtesy of the City Health Department.[6] For comparative purposes, demographic figures and notifications were also collected from England and Wales,[7] Australia,[8] and Copenhagen,[9] and the annual number of notifications per 100,000 population, hereinafter referred to as the notification rate, was calculated. Where it has been considered sufficient to indicate the size of population groups, the estimates of 1956 have been chosen because of their central position in the observation period.

RESULTS

The estimated populations in the areas under consideration together with the annual notification of diphtheria are shown in Table I. The calculated notification rates, presented graphically in Fig. 1, illustrate clearly the gravity of diphtheria in South Africa, where the observed incidence is 4 times higher than in Australia and 75 times higher than in England and Wales; clinical diphtheria has been eliminated from Copenhagen, and in the United States of America the notification rate fell from 1·9 in 1952 to 1·2 in 1959.[1,9] Until 1957 the national notification rate in South Africa was remarkably constant, but fell slightly in 1958 and 1959. Diphtheria occurred in all races (Fig. 2). During the period 1953 - 59 the notification rate in Whites decreased by about 60% to 16·69 per 100,000 and the rates in the Asians and Bantu are approaching the same figure. In recent years diphtheria has been observed relatively more frequently among the Coloured population.

Diphtheria has been reported regularly from all 4 provinces (Fig. 3). Despite moderate annual fluctuations in

TABLE I. ANNUAL NOTIFICATIONS OF DIPHTHERIA PER 100,000 POPULATION IN SOUTH AFRICA AND OVERSEAS (POPULATION IN THOUSANDS)

	South Africa			*England and Wales*			*Australia*			*Copenhagen*		
Year	*Population*	*Cases*	*Rate*	*Population*	*Cases*	*Rate*	*Population*	*Cases*	*Rate*	*Population*	*Cases*	*Rate*
1953 ..	13,153	3,228	24·54	44,090	265	0·60	8,918	1,081	12·12	759	0	0
1954 ..	13,427	3,342	24·89	44,274	166	0·37	9,090	704	7·74	755	0	0
1955 ..	13,669	3,382	24·74	44,441	154	0·35	9,313	892	9·58	753	0	0
1956 ..	13,915	3,521	25·30	44,667	51	0·11	9,533	348	3·65	746	0	0
1957 ..	14,167	3,440	24·28	44,907	37	0·08	9,747	237	2·43	739	0	0
1958 ..	14,418	3,304	22·92				9,952	103	1·03	733	0	0
1959 ..	14,673	2,733	18·63									

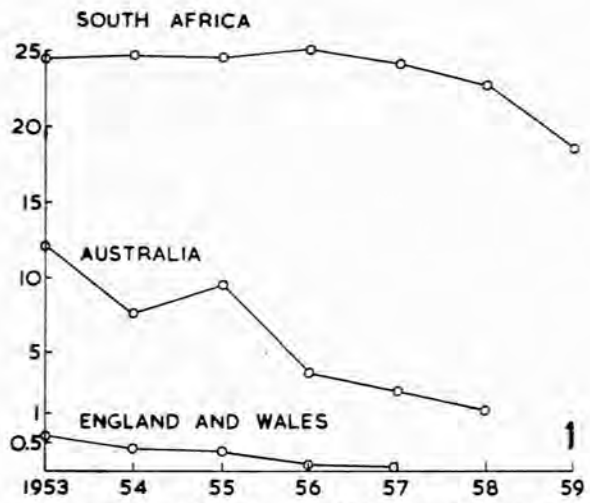

Fig. 1. Annual notifications per 100,000 population in South Africa, Australia, and England and Wales.

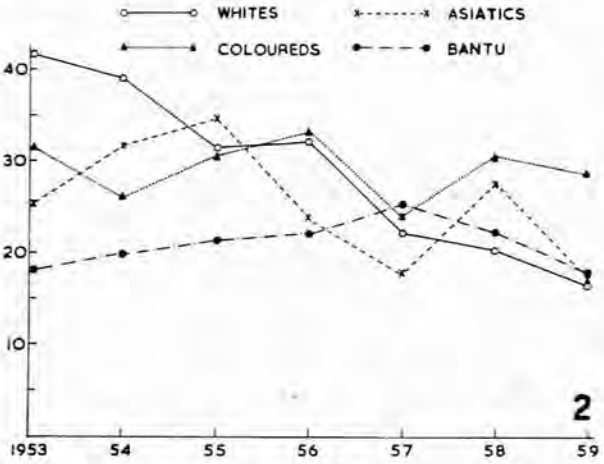

Fig. 2. Racial notification per 100,000 population per annum. (Population in thousands in 1956: White, 2,907; Asian, 431; Coloured, 1,319; Bantu, 9,460.)

notification rates during the observation period, the morbidity appears to have been much the same in each province. This, however, does not exclude the existence of racial foci. Their racial make-up in 1956 is shown in Table II and the notification rates for the groups are plotted in Fig. 4. For comparison a graph giving the mean for the whole country is included in each section. It emerges that the observed incidence of diphtheria in the races varies to some extent with the geographical division. Thus, in Natal and the Transvaal, the White, Asian and Coloured groups appear to have suffered more from diphtheria than in the other provinces. While the notification rates of the Bantu in the Orange Free State were comparatively high, they were below the mean for the Union in all other provinces. More important than these variations, however, is the observation that the disease showed no distinct evidence of racial predilection.

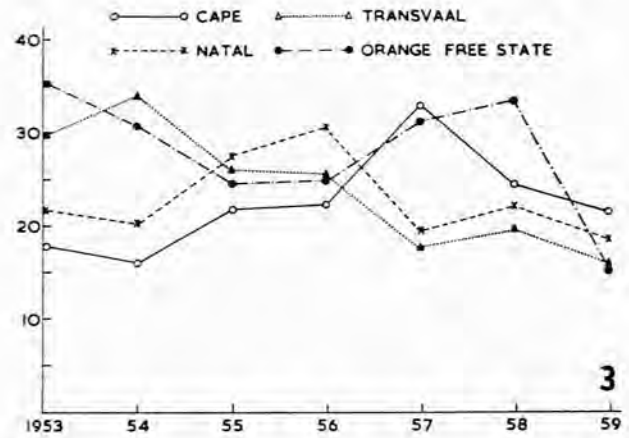

Fig. 3. Annual notifications by province per 100,000 population. (Population in thousands in 1956: Cape, 4,804; Natal, 2,609; Transvaal, 5,346; Orange Free State, 1,156.)

TABLE II. RACIAL COMPOSITION OF THE POPULATION IN THE PROVINCES OF THE UNION OF SOUTH AFRICA, 1956 (POPULATION IN THOUSANDS)

Province	*White*	*Asian*	*Coloured*	*Bantu*
Cape	999	20	1,136	2,649
Natal	311	344	39	1,915
Transvaal	1,344	57	91	3,854
Orange Free State ..	253	—	15	888

Since crowded conditions favour the spread of diphtheria, the disease would be expected to be more common in urban than in rural districts. Estimates of the population so divided are available from 1957 (Table III), but these differ by 2,000 individuals from the numbers given in Table I. While just over half the population lives in rural districts, about 80% of the White and Asian groups, 68% of the Coloured and only 30% of the Bantu group are city dwellers. Calculation of notification rates on this basis shows that the observed diphtheria morbidity is similar in urban and rural districts (Fig. 5). Moreover, the notification rates of the individual

TABLE III. ESTIMATED URBAN AND RURAL POPULATION IN SOUTH AFRICA (POPULATION IN THOUSANDS)

Year	Urban					Rural				
	White	Asian	Coloured	Bantu	Total	White	Asian	Coloured	Bantu	Total
1957	2,395	345	897	2,838	6,475	562	87	423	6,622	7,694
1958	2,439	353	925	2,882	6,599	572	90	435	6,724	7,821
1959	2,485	360	955	2,925	6,725	582	92	450	6,826	7,950

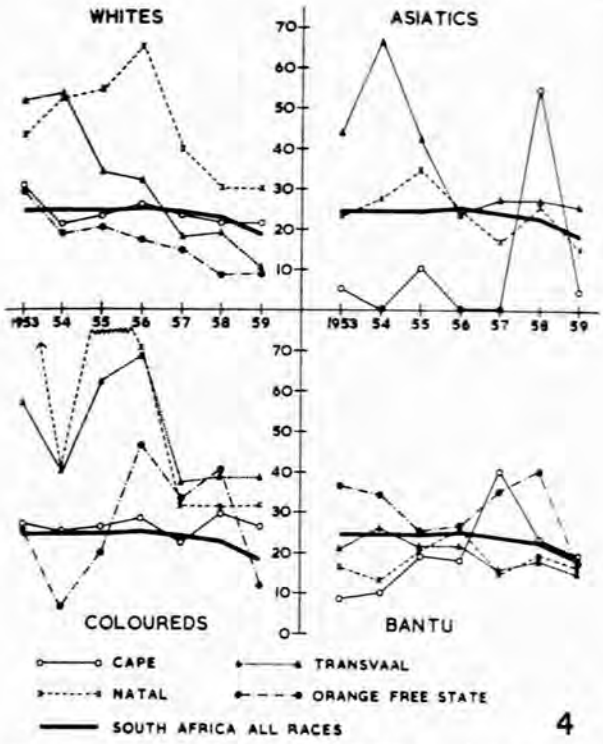

Fig. 4. Racial notification per 100,000 population in the four provinces.

races living under urban and rural conditions respectively (not presented) do not differ substantially from the mean rates shown in Fig. 5.

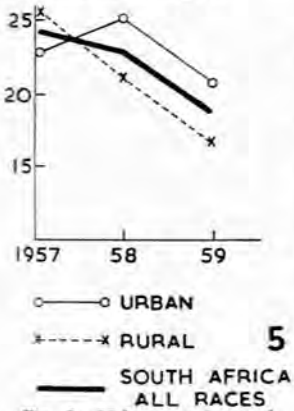

Fig. 5. Urban and rural notification per 100,000 population.

The difficulty of defining urban areas accurately and the incorporation of many small towns in this group,[5] may mask a difference between the occurrence of diphtheria in urban and rural populations. To test this, the notification rates of the country's largest city, Johannesburg, were plotted in Fig. 6. It emerges that, throughout the observation period, diphtheria has been very prevalent in Johannesburg, but the overall rates have declined considerably and now approach the average for the country. Although diphtheria has been reported fairly uniformly from all races in Johannesburg, the Whites have enjoyed the most spectacular fall in notification rates. Traditionally, the notification rates have been recorded by relating the notifications from a given population to the total number of individuals, although the disease is confined to a certain age group.

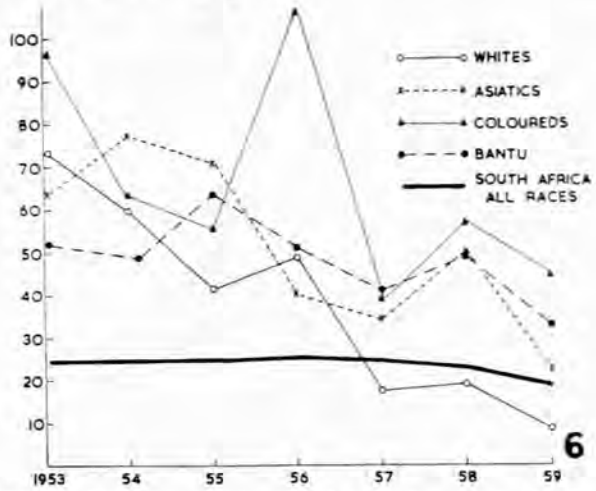

Fig. 6. Racial notification in Johannesburg per 100,000 population. (Population in thousands in 1956: White, 363; Asian, 25; Coloured, 37; Bantu, 539.)

In South Africa practically all cases occur in individuals of less than 20 years of age[3,11] and, since the age distribution of the races, at least in Johannesburg, differs considerably,[20] the crude notification rates may present a distorted picture.[21] This objection has been met in Table IV, which shows the

TABLE IV. RACIAL NOTIFICATION IN JOHANNESBURG PER 10,000 POPULATION UNDER 20 YEARS OF AGE

Year	White	Asian	Coloured	Bantu
1953	20·69	11·42	21·14	17·34
1954	16·86	13·86	13·88	16·34
1955	11·67	12·71	12·20	21·22
1956	13·65	7·18	23·59	17·00
1957	4·92	6·21	8·49	13·96
1958	5·36	8·97	12·38	16·63
1959	2·42	3·99	9·76	10·95

notifications related to the population of less than 20 years of age. These fractions were calculated from the annual estimates of the City population[6] on the assumption that the relative age distribution throughout the period was the same as in 1951.[20] It emerges that the disease on the whole has been reported more often from Bantu children, while the observed incidence was very similar in children of other ethnic groups. This conclusion differs from that arrived at by the study of crude notification rates (Fig. 6), in showing that proportionately fewer cases are reported from Coloured than Bantu children.

In Durban, after 1950, the crude notification rate of diphtheria has been highest in the Coloured, followed by

the Bantu, White, and Asian groups,[10] As above, it may be more profitable to relate the notifications to the most susceptible portion of the population. Accordingly, the number of individuals of less than 20 years of age was calculated by relating the age distribution of the 1951 census[22] to the annual estimates of the population.[10,23] On this basis (Table V) it is evident that diphtheria, as in Johannesburg, was observed more often in Bantu children than in Coloured children. This is contrary to observations made from crude notification rates, but is consistent with the fact that 26·02% of the Bantu population is less than 20 years old, while 51·94% of the Coloured population fall in this category. In regard to Whites and Asians, the impressions gained from the crude notification rates[10] are substantiated.

TABLE V. RACIAL NOTIFICATION IN DURBAN PER 10,000 POPULATION UNDER 20 YEARS OF AGE

Year	White	Asian	Coloured	Bantu
1950	35·45	7·87	51·06	37·38
1951	14·46	5·59	18·02	42·88
1952	12·10	5·89	8·68	28·04
1953	9·17	5·49	29·11	19·70
1954	17·34	6·31	17·26	27·16
1955	16·26	7·18	35·01	23·40
1956	14·73	7·38	13·00	15·08
1957	8·08	2·72	4·04	7·94
1958	7·92	4·80	4·62	14·48
0 - 19 years old at 1951 census ..	31·00%	57·81%	51·94%	26·02%

DISCUSSION

The reliability of estimations of the morbidity of a disease depends on the accuracy of the census and the reporting of cases. These problems were considered in a recent publication[10] and the view was expressed that in South Africa only minor errors were introduced by census inaccuracies, but there were strong indications of a considerable under-notification of diphtheria, particularly among the non-Whites. Provided that the distribution of types of *C. diphtheriae* was constant among infected individuals, and that the duration of illness before treatment was comparable,[10,11] it was concluded that death rates rather than notification rates might be more reliable standards for the assessment of the incidence of the disease. However, the lack of tabulation of deaths from diphtheria notified from rural non-Whites[4] makes this approach impracticable.

Sporadic cases caused by the gravis type of *C. diphtheriae* have occurred in South Africa,[12-15] but no outbreaks have been reported. Surveying the type distribution of *C. diphtheriae* in Cape Town in 1937, Wright[12] found that 66·1% of the strains from clinical infections belonged to the mitis, and 29·3% to the gravis, type. Of those classified as gravis strains, 75% lacked the characteristic ability to ferment polysaccharides,[16] while this was found in 20% of the mitis strains. Wright's observations[12] have not been confirmed and, in later surveys on the Witwatersrand,[13-15] approximately 90% of the strains were classified as mitis and 5% as gravis. Thus, for calculation purposes, it may be permissible to consider all infections in South Africa to have been caused by the mitis type.

Assuming that the medical facilities for Whites in the country as a whole are similar to those found in Durban, then the case mortality should be expected to be about 3%.[10] The observed mean case mortality in Whites in South Africa for the period 1950 - 57 was 6·8%,[4] which suggests that only 50% of the cases have been reported or that the incidence of diphtheria among Whites is twice as high as revealed by notification rates. Based on an estimated 6% case mortality among non-Whites in Durban,[10] it was calculated that only 33 - 40% of the non-White cases were reported. Since the notification of the disease in the non-White in rural districts is probably less accurate than in Durban, their observed overall case mortality should be about 20% or higher.[10] With the poorer medical facilities prevailing in many rural districts, it may well be that the true case mortality is close to the maximum of 10%,[11] suggesting that the incidence of diphtheria among non-Whites in the whole of South Africa is at least twice as high as that indicated by notification rates. Thus, the deficit in notifications appears to be reasonably uniform throughout the population and, consequently, the notification rates can be assumed to reflect fairly accurately the relative distribution of the disease. It should be pointed out, however, that the picture in Johannesburg and Durban is somewhat distorted by the excess of adults in the Bantu population.

Despite minor racial differences in notification rates in the provinces, distinct ethnic foci of the infection have not been demonstrated. Although Johannesburg proved to be the only locality with a consistently high notification rate, similar conditions have been observed in Durban.[10] In recent years these foci of infection have been greatly reduced, and in 1959 the observed incidence of diphtheria in Johannesburg and Durban did not differ significantly from that of the rest of the country.

Figures on prophylactic immunization relevant to this survey are available only for the White, Asian and Coloured groups in Johannesburg.[17,18] It is interesting to note that the overall immunization rate in Whites born in the period 1950 - 54 was 75·5% and that 64·5% of the children received their primary course before 2 years of age.[18] Although these preventive measures coincide with a reduction in observed incidence (Fig. 6), they were clearly insufficient to eliminate the disease. A similar reduction in notification rates was observed in the Coloured and Asian groups, but in these groups both the overall immunization rates and the proportion immunized before 2 years of age were so low[18] that they could hardly be claimed to have any influence on the morbidity.[17] The Bantu have experienced only a slight decline in notification rate, but though their immunization status is unknown, it is probably safe to assume that it is no better and perhaps worse than that in the Coloured population.

It may be concluded, therefore, that unless the health authorities are able to stimulate the population's interest in immunization, it is probable that the incidence of diphtheria in Johannesburg will remain at a higher level than that prevailing elsewhere. A similar conclusion was drawn from the study in Durban,[10] and there is every indication that it applies to South Africa as a whole.

SUMMARY

Contrary to popular impression, diphtheria has not ceased to be of public concern in South Africa. It appears to be about twice as frequent as indicated by notification rates. Although minor differences in distribution were observed,

it was not possible to detect a distinct focus of the disease in any of the provinces, in the urban or rural districts, or in the ethnic groups. Nor could any district or section of the population claim to have eliminated the disease.

I wish to thank Dr. E. J. H. Foullois, State Health Department, Pretoria, for valuable advice; the City Health Department of Johannesburg for notifications from that city; Mr. N. J. Richardson for technical assistance; and the Director of this Institute, Dr. J. H. S. Gear, for permission to publish this paper.

REFERENCES

1. Grasset, E. (1929): *Diphtheria Prophylaxis. The Use of Anatoxin—Ramon for Immunization against Diphtheria.* Johannesburg: South African Institute for Medical Research.
2. Murray, N. L. (1943): S. Afr. Med. J., **17**, 334.
3. Bokkenheuser, V. and Heymann, C. S. (1954): *Ibid.*, **28**, 685.
4. Department of Health, Union of South Africa (1950 - 57): *Annual Reports.* Pretoria: The Government Printer.
5. Department of Health, Union of South Africa (1960): Personal communication.
6. City Health Department, Johannesburg (1960): Personal communication.
7. Registrar-General (1953 - 57): *Statistical Review of England and Wales. Medical Section.* London: H.M. Stationery Office.
8. Department of Health, Australia (1959): Personal communication from the Director-General, Dr. A. J. Metcalfe.
9. Public Health Department, Copenhagen (1953 - 58): *State of Health in Copenhagen—Annual Report of the Commissioner of Health.*
10. Bokkenheuser, V. and Stephen, A. (1961): S. Afr. Med. J., **35**, 289.
11. Bokkenheuser, V. (1955): *Ibid.*, **29**, 461.
12. Wright, J. (1937): Brit. Med. J., **1**, 259.
13. Murray, J. F. (1942): S. Afr. Med. J., **16**, 247.
14. *Idem* (1943): J. Hyg. (Lond.), **43**, 159.
15. Bokkenheuser, V., von Haebler, T. and Jackson, A. L. (1956): Med. Proc., **2**, 484.
16. Wilson, G. S. and Miles, A. A. (1946): In *Topley and Wilson's Principles of Bacteriology and Immunity*, 3rd. ed., p. 462. London: Arnold.
17. Bokkenheuser, V. (1955): S. Afr. Med. J., **29**, 1249.
18. Bokkenheuser, V. and Smith, A. H. (1960): *Ibid.*, **34**, 928.
19. Moore, H. A. and Larsen, G. L. (1957): Publ. Hlth Rep. (Wash.), **72**, 537.
20. Bokkenheuser, V.: Submitted for publication.
21. Hill, A. B. (1955): *Principles of Medical Statistics*, 6th ed., p. 199. London: The Lancet.
22. Union of South Africa (1951): Population census, vol. 5. Pretoria: Government Printer.
23. City Medical Officer of Health, Durban (1950 - 58): Annual Reports.