

# MORTALITY FROM CORONARY HEART DISEASE AND FROM CEREBRAL VASCULAR DISEASE IN THE DIFFERENT RACIAL POPULATIONS IN SOUTH AFRICA

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The mortality pictures relating to coronary heart disease (CHD) and cerebral vascular disease (CVD) in South African populations (Whites, Coloured, Indians, Bantu) are of considerable interest on account of the wide extremes of mortality prevailing, particularly in respect of CHD.

For investigations on the epidemiology (and hence on the aetiology) of these diseases in different populations to be of value, it is necessary to know of their incidence in relation to sex, age, ethnic group, diet, socio-economic state, and other factors. Whereas definitive information on these different factors themselves in a given population group may be acquired with varying difficulty, the accuracy of knowledge on the incidence of the diseases, as modified by these factors, is very much open to question. The uncertainties concerning death certification are well known. There are real or apparent differences in CHD mortality rates, some at least constituting anomalies, in different regions in the same country (e.g. England and Wales,<sup>1</sup> Finland<sup>2</sup>), in adjacent states in the same country (e.g. USA<sup>3</sup>), between urban and rural regions (e.g. Chicago and rural Illinois<sup>4</sup>), and between constituent parts of big centres of population (e.g. Manhattan<sup>5</sup>). Because of these various differences some authorities, understandably, have questioned, if not rejected outright, the conclusions based upon death certificates except where the cause of death has been confirmed at necropsy. Permission for postmortem is

given readily by some ethnic groups, e.g. Japanese and Bantu, but is normally refused by others, e.g. Indians. To what extent then can a study of death certificates of different racial population groups in the same country yield meaningful information? It is submitted that if the study be limited to large cities, and if only striking and significant differences in mortality are taken into consideration, especially when in accord with clinical and postmortem experience, then findings may be of value, at least in providing leads for other relevant avenues of research.

Death certificates of persons resident in the Johannesburg municipal area in the 2-year period 1959-60 have been examined in relation to total deaths, and deaths in the classifications 420 and 330-334. Classification 420 denotes arteriosclerotic heart disease, arteriosclerotic heart disease including coronary disease, or arteriosclerosis of the coronary arteries; the classification includes angina pectoris, myocardial infarction, and coronary occlusion. Classifications 300-334 include sub-arachnoid haemorrhage (330), cerebral haemorrhage (331), cerebral embolism and thrombosis (332), spasm of the cerebral arteries (333), and other ill-defined vascular lesions affecting the central nervous system (334).

The present population of Johannesburg includes about 376,000 Whites, 40,000 Coloured (Eurafricans), 28,000 Asiatics (almost exclusively Indians and considered as such throughout this paper), and 594,000 Bantu. On account of

the relatively small Coloured and Indian populations at risk, their death certificates have been examined for the 6-year period 1955-60.

Unfortunately, the age distributions of the populations are not known with certainty, so that only the percentages of deaths in the different age groups due to CHD and

TABLE I.\* NUMBERS AND PERCENTAGES OF TOTAL DEATHS FROM CORONARY HEART DISEASE IN DIFFERENT RACIAL POPULATIONS IN JOHANNESBURG

Age group (years)	White		Coloured		Indian		Bantu	
	Male	Female	Male	Female	Male	Female	Male	Female
45-54	195/524 37.2%	52/305 17.0%	21/191 11.0%	6/83 7.2%	32/83 38.5%	9/57 15.8%	8/774 1.0%	3/236 1.3%
55-64	275/649 42.4%	77/357 21.6%	21/165 12.7%	20/129 15.5%	30/74 40.5%	13/52 25.0%	16/441 3.6%	6/283 2.1%
65-74	219/686 31.9%	188/653 28.8%	20/125 16.0%	19/124 15.3%	25/70 35.7%	11/38 28.9%	7/262 2.7%	2/198 1.0%
75+	198/821 24.1%	162/990 16.4%	10/87 11.5%	7/147 4.8%	20/85 23.5%	5/40 12.5%	5/206 2.4%	3/268 1.1%

TABLE II.\* NUMBERS AND PERCENTAGES OF TOTAL DEATHS FROM CEREBRAL VASCULAR DISEASE IN DIFFERENT RACIAL POPULATIONS IN JOHANNESBURG

Age group (years)	White		Coloured		Indian		Bantu	
	Male	Female	Male	Female	Male	Female	Male	Female
45-54	13/524 2.5%	16/305 5.2%	8/191 4.2%	7/83 8.4%	6/83 7.2%	3/57 5.2%	38/774 4.9%	22/236 9.3%
55-64	20/649 3.1%	18/357 5.0%	10/165 6.1%	15/129 11.6%	7/74 9.4%	7/52 13.4%	11/441 2.5%	21/283 7.4%
65-74	23/686 3.3%	40/653 6.1%	8/125 6.4%	13/124 10.5%	7/70 10.0%	6/38 15.8%	18/262 6.8%	12/198 6.1%
75+	51/821 6.2%	74/990 7.5%	9/87 10.3%	17/147 11.6%	8/85 9.4%	6/40 15.0%	17/206 8.2%	23/268 8.6%

\*In Tables I and II the statistics of the White and Bantu groups are for 2 years 1959-60, and those for the Coloured and Indian groups for the 6 years 1955-60.

TABLE III. AGE-SPECIFIC, ANNUAL MORTALITY RATE FROM CORONARY HEART DISEASE FOR DIFFERENT RACIAL POPULATIONS IN SOUTH AFRICA, 1954-58 (ANNUAL RATES PER 100,000)

Age group (years)	White		Coloured		Asiatic	
	Male	Female	Male	Female	Male	Female
40-44	142.4	24.6	78.9	37.2	157.9	42.3
45-49	266.8	57.5	147.5	71.0	267.6	74.5
50-54	449.9	101.3	215.9	113.5	398.4	175.8
55-59	641.6	183.4	303.9	169.7	532.5	275.3
60-64	916.6	329.8	603.1	312.9	831.8	548.5
65-69	1,249.0	526.8	587.1	306.8	976.0	698.4
70-74	1,552.3	777.7	605.1	332.6	1,089.3	957.6

TABLE IV. AGE-SPECIFIC MORTALITY RATES FROM CEREBRAL VASCULAR DISEASE FOR DIFFERENT RACIAL POPULATIONS IN SOUTH AFRICA, 1954-58 (ANNUAL RATES PER 100,000)

Age group (years)	White		Coloured		Asiatic	
	Male	Female	Male	Female	Male	Female
40-44	19.6	29.0	56.9	101.0	65.4	56.5
45-49	44.1	64.7	79.1	147.8	141.9	96.1
50-54	87.7	103.4	237.1	219.8	274.6	378.2
55-59	161.1	155.0	341.6	363.9	496.0	388.0
60-64	278.7	252.7	576.1	734.4	625.5	833.3
65-69	414.6	428.8	829.2	827.9	1,059.2	1,135.6
70-74	657.2	734.3	1,280.8	1,145.1	1,806.3	2,123.4

CVD can be given (Tables I and II). However, in order to be able to compare mortality rates, values for total populations of South Africa for the 5-year period 1954-58 (Tables III and IV) are given for Whites (3 million), Coloured (1½ million), and Indians (½ million), the data being provided by the Department of Census and Statistics, and calculated by Dr. A. M. Adelstein, previously Senior Medical Officer, South African Railways and Harbours. Rates for the Bantu (11 million) are not known with certainty.

#### DISCUSSION OF TABLES I-IV

In view of marked differences in the age structure of the populations concerned, age must be taken into account. Compared with Whites elsewhere (Table V), even White South Africans are a relatively young population.<sup>6</sup> The non-White groups, with their lower life expectancies (due perhaps to high mortality among child life) are still younger.

TABLE V. AGE STRUCTURE OF SOUTH AFRICAN AND OTHER POPULATIONS

Population	Percentage 45-64 years	Percentage over 65 years
Japan	15	5
Canada	18	8
New Zealand	19	8
USA (total)	20	8
Sweden	23	10
England and Wales	24	11
France	25	12
S.A. Whites	17	7
S.A. Coloured	14	5
S.A. Asiatics	13	4
Johannesburg Bantu	10	2

The data given in Tables I-IV will now be discussed, together with comparative figures from elsewhere, and certain other information (e.g. serum-cholesterol levels and blood-pressure data).

#### Mortality from Coronary Heart Disease in the White Population

The percentages of deaths from CHD among Johannesburg White males and females aged 45-74 years were 37.0 and 24.1%. Corresponding figures (for 1952 or 1953) for England and Wales<sup>7</sup> were 19.3 and 11.8%, Scotland<sup>7</sup> 21.7 and 13.2%, and USA (total population)<sup>7</sup> 33.0 and 22.1%. Figures for certain cities were: New York (1955)<sup>8</sup> 38.1 and 31.0%, and Edinburgh (1955)<sup>9</sup> 27.8 and 26.7%, respectively for males and females. The mortality of Johannesburg Whites from CHD is thus unusually high.

Regarding rates, total South African Whites up to 65 years, both male and female, have values similar to those of USA Whites (1954);<sup>7</sup> thereafter, the rate rises more steeply in the USA.

Blood-lipid data of our middle-aged White adults<sup>10</sup> appear to be of the same order as those of Whites in the USA<sup>11</sup> and in England.<sup>12</sup>

Very roughly, Johannesburg Whites include about 50% of English extraction, 30% Afrikaans-speaking people, and 15% of Jewish origin. Judging nationality by name, a rough classification has been made to permit calculation of percentage of deaths from CHD among these three groups. Compared with the percentage in the English, the Afrikaans figure is slightly greater, but that of Jewish adults is much greater. Thus, in agreement with this finding, in Cape Town recently it has been shown that, among consecutive cases of infarction admitted to hospital, the number of Jews is disproportionately high.<sup>13</sup> Blood-lipid data of English and Afrikaans adults are of the same order; values for Jews are somewhat higher,<sup>14</sup> but insufficient subjects have been studied to define the picture satisfactorily. Further enquiry regarding these ethnic differences is proceeding.

A further classification has been made on the basis of

suburb of domicile at time of death. For obvious reasons such as movement of families, etc., findings in this respect must be viewed with reserve. Nevertheless, almost certainly there is a greater mortality from CHD among the highest socio-economic group compared with the average and lowest, a finding in harmony with that reported for White populations elsewhere.<sup>1</sup>

#### *Mortality from Coronary Heart Disease in the Coloured (Eurafrican) Population*

Table I shows that percentage mortality from CHD is lower for Johannesburg Coloured males and females compared with corresponding data for Whites, a finding in agreement with that reported for the Coloured in Cape Town.<sup>15</sup> While the CHD death rate for Coloured males is lower than that of White males, that for Coloured females appears to be much the same as that of White females until 65 years; thereafter, the Coloured female CHD death rate is stationary, while that of White females increases rapidly with age (Table III). In Cape Town<sup>15</sup> and in Johannesburg,<sup>14</sup> Coloured (both sexes) have lower serum-cholesterol levels than Whites.

#### *Mortality from Coronary Heart Disease in the Indian Population*

The percentage mortality from CHD (Table I) in Johannesburg Indians is much the same as that of Whites. CHD death rates (Table III) for total South African Indian males are slightly lower than for White males; however, for Indian females, these rates are higher than for White females at all ages. The adverse picture among immigrant Indian groups, whether living in Singapore, Kenya, Uganda, or South Africa, has been pointed out elsewhere.<sup>16</sup> Serum-cholesterol levels for local Indians are much the same as such for the White population.

Locally, our studies indicate that death from CHD is commoner among Moslems, usually middle-class, than among Hindus, the major proportion of whom are relatively poor. There are differences, of course, in dietary and other practices between the two groups.

In passing, it may be remarked that among Johannesburg Chinese, the other but very much smaller moiety of the Asiatic population, CHD is very uncommon;<sup>17</sup> this also obtains for the general population of Chinese in China.<sup>18</sup>

In Indians in India CHD mortality is, in general, relatively low among the masses.<sup>19-22</sup> Deaths occur more frequently among population groups like army officers, wealthy merchants, and the professional classes.<sup>23</sup> While accurate information is lacking, there is no doubt that death from CHD is much less frequent in India than among the immigrant Indian groups in Africa; certainly serum-cholesterol levels are lower in the former<sup>24</sup> than in the latter.<sup>24,25</sup>

#### *Mortality from Coronary Heart Disease in the Bantu Population*

According to death certificates, mortality from CHD among Johannesburg Bantu is far higher than would be expected either from hospital necropsy experience or from clinical observations.<sup>6</sup> A careful follow-up investigation is now being made to examine the validity of the relevant death certificates for the last few years.<sup>26</sup> The general

opinion is that Bantu dying from CHD annually in Johannesburg probably number less than 10. Admittedly the Bantu constitute a young population, about half being under 20 years. Nevertheless, there are over 10,000 Bantu in Johannesburg between 60 and 100 years of age, and among these old people a careful clinical and ECG study disclosed only one case of unequivocal infarction among 300 thus far investigated.<sup>27</sup> Among rural Bantu groups extensive ECG studies, together with the opinion held in numerous scattered mission hospitals, indicates that myocardial infarction is extremely rare.<sup>28</sup> Serum-cholesterol levels, especially among rural dwellers, are much lower than among the White population.<sup>30</sup>

In certain African populations elsewhere the disease, if anything, is rarer. At Kampala, Uganda, one case of coronary thrombosis was noted by Trowell and Singh<sup>28</sup> in a series of 6,500 necropsies, and that person was an African judge, obese, and accustomed to a westernized diet.

In the USA the mortality rate from CHD among Negroes generally is less than that of Whites.<sup>29,30</sup>

#### *Mortality from Cerebral Vascular Disease in the White Population*

Among Johannesburg Whites, in 1959, the percentages of deaths from CVD in the age groups 45 - 74 years for males and females were 3.0 and 5.5%, respectively. These proportions are much lower than such for England and Wales<sup>7</sup> (10.6 and 16.9%), Scotland<sup>7</sup> (12.2 and 19.4%), and USA<sup>7</sup> (9.6 and 14.1%). No explanation can be given for the unusually low mortality from CVD among Johannesburg Whites. For the 45 - 54 and the 55 - 64 year age groups the CVD death rates for South African Whites compared with Chicago Whites,<sup>4</sup> male and female, are 66 and 84, as against 62 and 67; and 220 and 204, as against 184 and 162, per 100,000 respectively. In Chicago<sup>4</sup> in 1951, the percentage mortality from CVD for the 55 - 64 year age groups, both sexes combined, showed a wide differential to prevail between constituent White groups, namely, 1.8% for English-born residents and 8.9% for Czech-born residents; the total White figure was 6.8%; the corresponding figure for Johannesburg was 3.8%. Blood pressure data on our local Whites<sup>31</sup> are of the same order as those of American Whites.<sup>31,32</sup>

#### *Mortality from Cerebral Vascular Disease in the Coloured Population*

Among Johannesburg Coloured the percentage mortality, and among total South African Coloured the mortality rate from CVD, show far higher figures (more than double in some age groups) than in Johannesburg Whites. For the 55 - 64 year age groups, rates for Coloured are similar to those of Chicago<sup>4</sup> non-Whites, namely 454 and 560, as against 441 and 491, for males and females respectively. Hypertension (defined as diastolic pressure exceeding 90 mm.Hg) is commoner, both in Johannesburg<sup>33</sup> and in Cape Town,<sup>33</sup> in Coloured than in Whites.

#### *Mortality from Cerebral Vascular Disease in the Indian Population*

Among Johannesburg Indians, and also total South African Indians, mortality from CVD shows very high figures, higher even than among Coloured, compared with

Johannesburg Whites. Among Indians in India no comparative figures are available. In Ceylon<sup>7</sup> in 1953 CVD was responsible for 2.2 and 2.3% of deaths of males and females respectively in the 60-69 year age group; the corresponding percentages for Indians in Johannesburg (1955-60) were 9.7 and 14.9%, and for Whites in England and Wales<sup>7</sup> (1953) 12.8% respectively.

Blood-pressure studies are now being undertaken on South African Indian groups in Johannesburg, Pretoria, and Pietersburg. Observations indicate the incidence of hypertension possibly to be lower in local Indians than in local Whites.<sup>34</sup> Regarding blood-pressure levels of Indians in India, the incidence of hypertension would seem to be low in the poorer people,<sup>34,35</sup> although high compared with Whites, among the well-to-do.<sup>36</sup>

#### *Mortality from Cerebral Vascular Disease in the Bantu*

Mortality from CVD among the Bantu appears to be at least as high as among Whites.<sup>6</sup> The high figure is in accordance with experience both in and out of hospital. Mortality is high among South African Bantu compared with more primitive African groups elsewhere, e.g. Kampala, Uganda.<sup>37</sup> Studies on the incidence of hypertension among local Bantu by Ordman,<sup>38</sup> and Bronte-Stewart,<sup>33</sup> suggest that it may not be commoner than among Whites. At this centre, however, we have found that whereas there is little difference between the proportions of Bantu and White subjects with diastolic pressure of 90 mm. or more, the proportion with 100 mm. or more is higher in the Bantu; but more observations need to be undertaken to define the position. The latter observation, however, is in harmony with the commonness of hypertensive heart disease among the Bantu.<sup>39,40</sup> Yet the situation still stands in contrast to the much higher incidence of hypertension among American Negroes,<sup>41</sup> among whom mortality from CVD is far higher than among USA Whites.<sup>4,29</sup>

#### GENERAL DISCUSSION

Bearing in mind the reservations mentioned earlier, and also the small numbers in certain age groups, the question now arises, what can be learnt from the information given?

Briefly, it appears that Johannesburg Whites have a high age-specific percentage mortality from CHD, but a much lower mortality from CVD. By comparison, the Coloured have a lower mortality from CHD, but a much higher mortality from CVD. Indians have a high mortality from CHD, and also a high mortality from CVD. The Bantu have an extremely low mortality from CHD, but a mortality from CVD much the same as that of the White population, both rates being much lower than those for Coloured and Indians. It is possible therefore for populations to have high mortality from CHD (Whites, Indians) in the presence of widely different mortalities from CVD; and for populations with roughly equal mortalities from CVD (Whites, Bantu) to have very different mortalities from CHD.<sup>42</sup> This information, combined that from local necropsy studies,<sup>43</sup> supports the belief that different arteries in the vascular system change at different rates, and are expressions in measure of different disease processes.<sup>44,45</sup>

In the four groups—Bantu, Coloured, Indians, Whites—the progressive rise in CHD mortality is broadly paralleled by a rise in mean serum-cholesterol level and other blood-

lipid data. But this is not the case with CVD. Thus, although Indians and Coloured very roughly have similar CVD rates, the former have much higher cholesterol levels. Similarly, although Whites and Bantu appear to have roughly equal CVD rates, the lipid levels of the former are far higher than those of the latter. It has been recommended that reduction in fat intake, by affecting reduction in serum-lipid levels, may well be prophylactic or ameliorative against CVD.<sup>46</sup> In this connection, a recent investigation demonstrated that a series of patients with cerebral infarcts had a slight, although significant, elevation (about 22 mg.%) of serum-cholesterol level compared with controls.<sup>47</sup> However, a reviewer<sup>48</sup> of this latter contribution has urged caution in the interpretation and application of this finding. Elucidation of the problem is rendered difficult by the fact that the proportion of deaths from cerebral haemorrhage and that from cerebral thrombosis are not known.

Regarding the information bearing on CVD mortality and the incidence of hypertension in random samples of racial sections of the population, while White and Bantu appear to have not dissimilar incidences of elevated blood pressure and of CVD mortality, the Coloured have more, yet Indians possibly less, hypertension than Whites, although in comparison, both non-White groups suffer very much more from CVD. Thus, populations with high CVD rates, need not display equally high hypertension rates in random population samples.

The information derived in this paper may be profitable for a further reason. Epidemiological studies are simplified when there are extremes of mortality in constituent portions of a given population. In South Africa it was hoped that, in respect of the White population, 'Poor Whites', in contrast perhaps to Johannesburg Jews, might provide comparative populations; but these hopes in respect of 'Poor Whites', may not be realized.<sup>49</sup> Turning to the Bantu population, CHD is negligible; among even sophisticated Bantu in the upper income bracket, our ECG studies thus far indicate that infarction is rare.<sup>34</sup> The information given in this paper suggests that studies on the Indian population may be most rewarding, bearing in mind (a) the high mortality figure for CHD; (b) that there are available two main sub-groups, Moslem and Hindu, with different dietary (vegetarian and non-vegetarian) and other backgrounds, dwelling in both urban and rural areas; and (c) that there are large numbers of well-to-do and also very poor Indians available for study. A further line of investigation suggested concerns the fact that between one and two generations ago immigrant groups came from a very small number of centres in India, where information suggests that CHD is far from being the major public-health problem that it presents in South African Indians. The studies on the South African Indians and on Indians in the region of origin in India may well be profitable, and would be analogous to the comprehensive studies by Keys<sup>50</sup> *et al.* on Japanese in Japan, Hawaii, and California; and also the investigation now in progress on CHD in Irishmen in Boston and in Ireland.<sup>51</sup>

#### SUMMARY

The population of Johannesburg is composed of about 376,000 Whites, 40,000 Coloured, 28,000 Asiatics (almost

exclusively Indians), and 594,000 Bantu. Death certificates for these population groups have been examined in relation to total deaths, and also deaths from coronary heart disease (CHD) and cerebral vascular disease (CVD). The information gathered suggests the following:

1. Age-specific percentage mortality from CHD among Whites is higher than corresponding data for England and Wales, and also the USA (with certain limitations). Percentage mortality from CVD among Johannesburg Whites is low.

2. Among Coloured, age-specific mortality from CHD is lower than among local Whites, but that from CVD is much higher.

3. Among Indians, age-specific mortality from CHD is as high as that among local Whites; CVD mortality rate is far higher among Indians.

4. Among the Bantu, CHD mortality is virtually nil; age-specific percentage mortality from CVD is about the same as that among local Whites.

The uncertainties latent in death-certificate data are well known, and the utmost caution is required in drawing even tentative conclusions. Notwithstanding, it has seemed reasonable to comment on certain trends:—

1. Information is supplied which supports the belief that different arteries of the vascular system change at different rates; and that lesions or metabolic disorders causing or promoting CHD and CVD are the expression at least in measure of different disease processes.

2. The progressive rise in CHD mortality from Bantu to Coloured, and thence to Whites and Indians, is roughly paralleled by a rise in blood-lipid levels. This correlation, however, does not prevail with CVD. Hence, the view that reduction of serum cholesterol by dietary or other means may lessen the risk of, or ameliorate, CVD must be treated with increased reserve.

3. Blood-pressure data on population groups suggest that groups with equally high CVD mortality rates (e.g. Coloured and Indians) may have different incidences of hypertension.

4. The South African Indian population is composed of groups differing in religion, diet, socio-economic state, activity, and other factors and would seem highly apposite for studies on the aetiology of CHD, particularly if they could be combined with studies on Indians dwelling in the regions in India where the South African immigrants came from originally.

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## REFERENCES

- Morris, J. N. in Keys, A. and White, P. D. eds. (1954): *Cardiovascular Epidemiology*. New York: Hoeber.
- Keys, A., Karvonen, M. J. and Fidanza, F. (1958): *Lancet*, **2**, 175.
- Enterline, P. E. and Stewart, W. H. (1956): *Publ. Hlth Rep.* (Wash.), **71**, 849.
- Stamler, J., Kjelsberg, M., Hall, Y. and Scotch, N. (1960): *J. Chron. Dis.*, **12**, 440, 456 and 464.
- Kent, A. P., McCarroll, J. R., Schweitzer, M. D. and Willard, H. N. (1958): *Amer. J. Publ. Hlth*, **48**, 200.
- Walker, A. R. P. and Grusin, H. (1959): *Amer. J. Clin. Nutr.*, **7**, 264.
- World Health Organization (1956): *Epidem. Vital Statist. Rep.*, **8**, 435.
- City of New York (1955): *Summary of Vital Statistics*. New York: Department of Health.
- City and Royal Borough of Edinburgh: *Annual Report of the Public Health Department for 1956*.
- Walker, A. R. P. and Arvidsson, U. B. (1954): *J. Clin. Invest.*, **33**, 1358.
- Keys, A. and Keys, M. H. (1954): *Brit. J. Nutr.*, **8**, 138.
- Keys, A. (1957): *J. Amer. Med. Assoc.*, **164**, 1912.
- Bronte-Stewart, B., Botha, M. C. and Krut, L. H. (1962): *Brit. Med. J.*, **1**, 1646.
- Walker, A. R. P. *et al.* (1963): Unpublished data.
- Schrier, V. (1959): *Postgrad. Med. J.*, **35**, 218.
- Walker, A. R. P. (1961): *Lancet*, **1**, 512.
- Suzman, M. M. (1962): Personal communication.
- Tung, C. L. and T'as, S. C. (1959): *Chinese Med. J.*, **79**, 290.
- Malhotra, R. P. and Pathania, N. S. (1958): *Brit. Med. J.*, **2**, 528.
- Hadley, G. G., Gault, E. W. and Job, C. K. (1958): *Amer. J. Clin. Path.*, **29**, 141.
- Ibrahim, M. and Ahmed, K. (1959): *Pak. J. Med. Res.*, **2**, 11.
- Padmavati, S. (1962): *Circulation*, **25**, 711.
- Gopalan, C. and Ramanathan, K. S. (1957): *Indian J. Med. Res.*, **45**, 593.
- Idem* (1956): *Lancet*, **2**, 1212.
- Charters, A. D. and Arya, B. P. (1960): *Ibid.*, **1**, 288.
- Seftel, H. C. (1962): Personal communication.
- Seftel, H. C. and Keeley, K. J. (1962): Personal communication.
- Trowel, H. C. and Singh, S. A. (1956): *E. Afr. Med. J.*, **33**, 391.
- Phillips, J. H. and Birch, G. E. (1959): *Amer. J. Med. Sci.*, **238**, 97.
- Berkson, D. M., Stamler, J., Lindberg, H. A., Miller, W., Mathies, H., Lasky, H. and Hall, Y. (1960): *Ann. N.Y. Acad. Sci.*, **84**, 835.
- Master, A. M., Dublin, L. I. and Marks, H. H. (1950): *J. Amer. Med. Assoc.*, **143**, 1464.
- Comstock, G. W. and Kendrick, M. A. (1957): *Amer. Heart J.*, **53**, 825.
- Morris, J. N. (1960): *Mod. Conc. Cardiovasc. Dis.*, **39**, 627 (quoting Bronte-Stewart, B.).
- Padmavati, S. and Gupta, S. (1959): *Circulation*, **19**, 395.
- Mathew, N. T. (1960): *Indian J. Statist.*, **23B**, 13.
- Srikantia, S. G., Jagannathan, S. N. and Gopalan, C. (1961): *Indian J. Med. Res.*, **49**, 99.
- Davies, J. P. N. (1948): *E. Afr. Med. J.*, **25**, 454.
- Ordman, B. (1944): *Clin. Proc.*, **7**, 183.
- Becker, B. J. P. (1946): *S. Afr. J. Med. Sci.*, **11**, 107.
- Schwartz, M. B., Schamroth, L. and Seftel, H. C. (1958): *Med. Proc.*, **4**, 275.
- Moser, M. (1960): *Ann. N.Y. Acad. Sci.*, **84**, 989.
- Walker, A. R. P. (1962): *Nutr. Rev.*, **20**, 318.
- Reef, H. and Isaacson, C. (1962): *Circulation*, **25**, 66.
- Phear, D. N. (1962): *Med. J. Aust.*, **1**, 149.
- Fazekas, J. F., Alman, R. W., Burns, R. A. and Ehrenreich, D. (1962): *Circulation*, **25**, 408.
- Central Committee for Medical and Community Program of the American Heart Association (1961): *Ibid.*, **23**, 133.
- Heyman, A., Nefzger, M. D. and Estes, E. H. jr. (1961): *Arch. Neurol. (Chic.)*, **5**, 264.
- Anonymous (1962): *Nutr. Rev.*, **20**, 36.
- Walker, A. R. P., Mortimer, K. L., Kloppers, P. J., Botha, D., Grusin, H. and Seftel, H. C. (1961): *Amer. J. Clin. Nutr.*, **9**, 643.
- Keys, A., Kimura, N., Kusukawa, A., Bronte-Stewart, B., Larsen, N. and Keys, M. H. (1958): *Ann. Intern. Med.*, **48**, 83.
- McCann, M. B., Clancy, R. E., Trulson, M. F. and Stare, F. J. (1961): *Fed. Proc.*, **20**, 92.