Atherosclerosis and Nutrition with Special Reference to Populations in Africa

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SUMMARY

Severe atherosclerosis and its sequelae—coronary heart disease, cerebral vascular disease, and peripheral vascular disease—share major responsibility for half the mortality rate in affluent Western populations. In Africa, particularly South Africa, a study of the extent and severity of lesions is particularly interesting because of the different population groups in various stages of transition. In the most primitive populations, evidence shows that lesions are sufficiently mild to be of little or no clinical significance. Among prosperous populations, the conclusion is reached that unless dietary and other changes (relevant to risk factors) are introduced in youth, such changes implemented in later life are unlikely to accomplish much by way of reducing or delaying mortality from atherosclerotic diseases.

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In a recent issue of *The Lancet*[1] there was a contribution on a very apposite subject, the strain on the heart associated with public speaking. In this study, heart rates up to 180 beats per minute, electrocardiogram abnormalities (ST-segment depression, ectopic beats), and increases in plasma noradrenaline and free fatty acids, were noted in a large proportion of people investigated. The article concluded 'These data show how emotional challenges may produce conspicuous cardiovascular effects, especially in susceptible persons'. The findings described, at least qualitatively, are not new. Many people will know of John Hunter who, because of his angina, said that his life was at the mercy of any rascal who chose to upset him. This actually happened, and he died during an acrimonious hospital board meeting.

THE ALL-PERVADING CHARACTER OF ATHEROSCLEROSIS

It would be no exaggeration to say that at virtually every present-day congress on nutrition, or for that matter, on public health, clinical medicine, geographical pathology, and many other related fields, there will invariably be at least one contribution on diet, atherosclerosis and coronary heart disease (CHD), or, to a much lesser extent, atherosclerosis, cerebral vascular disease (CVD) and peripheral vascular disease (PVD). The reason for this is that CHD is now the leading cause of death, not only in affluent populations, but also in less-affluent populations. In 1970, in Australia, CHD and CVD accounted for almost half (44%) of all deaths in persons under 65 years of age.[2]

The major reason for sustained interest in this subject is that atherosclerosis or at least severe atherosclerosis, with its associated high mortality rate from CHD and CVD, does not *have* to develop. Morbid degeneration is not inevitable. Were this so, i.e. were the process simply an accompaniment of ageing, and afflicting all people almost equally, interest would decline. The fascinating aspect about atherosclerosis is that neither population groups nor the constituent individuals are equally affected by the disease process.

The problem of atherosclerosis in Africa, and particularly in South Africa, is especially interesting. There are 4 ethnic groups in this country, at least 3 of which are at various stages of westernisation of diet and manner of life. In these 4 population groups there are different prevalences of severe atherosclerosis. While not wanting to firmly equate severity of atherosclerosis in the appropriate arteries with frequencies of CHD and CVD, I would like to provide some information on the magnitude of the respective mortality situations to indicate how contrasting, and therefore how interesting, are the data in our different population groups.

MORBIDITY AND MORTALITY BURDEN OF ATHEROSCLEROSIS IN SOUTH AFRICAN POPULATIONS

Among the White population, CHD is responsible for about one-third of adult deaths; the picture is much the same as that in the USA, Australia and other prosperous Western populations.[3,4] Among Indians the mortality rate is much the same, except that peak mortality occurs earlier. However, CHD can be regarded as extremely rare among Blacks. Soweto, in Johannesburg, is by far the largest, most densely populated (¾-million) and most sophisticated Black township in Southern Africa. In a White population of the same size and age structure as that of Soweto, one could expect about 1 200 coronary episodes or sudden deaths each year. From the information available, and despite reports of slight increases, I question whether more than 20 Blacks die annually from CHD.[4] The CHD position in Cape Coloureds is intermediate.

The occurrence of CVD depends primarily on atherosclerosis of the cerebral arteries and sustained elevated

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blood pressure. In 1962, according to death certificates, CVD accounted for about 5% of deaths of White adults in Johannesburg.[3] This percentage is lower than that of many White populations overseas, for example, 12% in Denmark.[5] The reason for this disparity, even allowing for differences in age structure, is not apparent. In 1962, CVD caused a higher mortality rate among Indians than among Whites—6 - 8% of adult deaths. The figure for Coloureds was about 8 - 10%, and for Blacks, about 6 - 8%.[3] Although CVD is still an important cause of death among rural Blacks, its occurrence is lower than that among urban dwellers.[8] It is now well documented that CVD is common, but CHD very uncommon, among Blacks. It is relevant that several studies as well as our own have shown that blood pressures of urban Blacks are higher than those of rural Blacks.[8-10]

It would seem that the incidence of peripheral vascular disease (PVD) is much the same among South Africans as that of Whites overseas. The disease appears to be less common among Indians and Coloureds, still less common among urban Blacks, and much less common among rural Blacks.[6] In Uganda, Trowell stated that PVD was rare among Blacks.[11]

Special Groups

Apart from the 4 ethnic groups in South Africa, there are a number of subgroups. Among Whites, there are the Jewish population, and long-term White prisoners.

South African Jews. In this population group CHD causes a higher mortality rate than among non-Jewish Whites.[12] It is of interest that an unusually high incidence of CHD has also been noted among Jews who emigrated from Turkey to Israel. The relevant mortality figure was stated to be as high as that in many Western populations,[13] although Turkey is far from being an affluent country. Whether the position of risk among Jews also places them at a disadvantage in respect of CVD and PVD is not known. It may be mentioned that in the USA the life expectation of Jews at 65 years is actually decreasing.[14]

South African long-term White prisoners. Middle-aged Whites in South African gaols suffer less from CHD than their counterparts at liberty.[15] This reduced proneness has been reported, although in lesser measure, in prisoners in the USA.[16] I have no information on whether similar reductions occur regarding CVD and PVD in White prisoners.

ATHEROSCLEROSIS IN POPULATIONS IN AFRICA

If arterial disease is wholly of environmental causation, and not an inescapable ageing process, what is the extreme minimum of its occurrence, or of its manifestations, in adults? Dr J. Higginson (formerly at the South African Institute for Medical Research, and now Head of the International Agency for Research on Cancer, at Lyons, France), recently asked this question in respect of cancer.[17] He took the minimal frequency of cancer in each organ or tissue of the body obtained in different parts of the world, e.g. a Central African population group was chosen for cancer of the lung and a USA population group for cancer of the liver. From the information obtained Higginson concluded that the absolute irreducible minimum of the total cancer mortality rate would be about one-third of that currently prevailing in the USA. If the same procedure is applied to atherosclerosis and its lethal sequelae, the answer is that atherosclerosis can be sufficiently minimal, so that CHD, CVD and PVD hardly occur at all. This conclusion poses a practical question to what extent it is possible in a Western context of living to reduce the prevalence of severe atherosclerosis, and its associated killer diseases. It may well be asked, since elderly primitive Blacks seldom die from atherosclerotic diseases, just from what do they die? It is interesting to note that in a recent investigation of elderly Blacks in Uganda, it was stated that they die, not from degenerative diseases, but from 'diseases of childhood, such as infections, acute tuberculosis, neglect and malnutrition'.[18]

The minimal serious degenerative changes in the arteries are found in indigenous populations consuming a frugal diet and pursuing active lives. This is the case in many less-privileged Black populations. It has been noted among these people, that of the middle-aged only rare small fatty streaks occur in the aorta as are found in children in the USA and fibrous plaques only occur occasionally.[19] It has been found that in the coronary vessels the thickness of the wall scarcely increases with age, whereas in people in the USA the thickness doubles.[20] Among such people, mortality from CHD is nil, and from CVD, slight.

Several comparative studies have been done in South Africa, e.g. by Higginson and Pepler,[21] Reef and Isaacson,[22] and Andersson *et al.*[23] in Johannesburg, and Wainwright[24] in Durban, and Sacks[25] and others in Cape Town. Probably the most detailed of interracial studies is that recently published by Meyer *et al.*[26] of the Department of Physiology, University of Pretoria. These workers carried out a careful comparative study on the chemical and structural aspects of atherosclerosis, and determined the atherosclerotic profile of aorta, coronary, and cerebral vessels, using the atherogenic index method of Gore and Tejada. They examined necropsy material from 540 unselected Whites and Blacks who had died in the Pretoria area. Atherosclerotic indices were found to be very low in all cases until about the third decade. Thereafter there was a progressive rise, which was most dramatic in the aorta and coronary arteries of White men. It is noteworthy that significant racial differences were not found in the cerebral arteries. These workers summarised their findings as follows: (*a*) vascular beds differ from each other in chemical composition; (*e*) this difference is apparent at birth and increases in magnitude with increasing age; (*c*) the chemical composition of the corresponding blood vessels of Whites and Blacks does not differ significantly at birth; (*d*) in Whites, vascular beds differ in their susceptibility to atherosclerosis (this selective susceptibility is much less obvious in the Blacks); and (*e*) anatomical differences between the coronary vascular beds of Blacks and Whites were noted, the significance of which is not clear.

Other studies have been done elsewhere in Africa, but enough has been said to give a general impression of the range of changes found in the arteries of a partially sophisticated Black population. I would, however, like to mention 3 further studies relevant to the local position. In an international study in New Orleans, where material from populations in many parts of the world has been examined, it was found that arterial tissue from Durban Indians was affected only slightly less than that of Whites, whereas tissues from Durban Blacks were the least affected of all the populations studied.[27] In comparative studies made in the USA, Negroes were found to have more severe atherosclerosis in intracranial arteries and as severe, or more severe, in the cervical arteries, while Whites have more severe atherosclerosis in aorta and coronary vessels. It was stated that these findings parallel mortality rates from CVD and CHD.[28] From an examination of serum from Black and White subjects, it was found that mean SF (ultracentrifuge) lipoprotein values for Blacks at 70 years and over yielded the same Atherogenic Index (Gofman) as values from White subjects of 15 - 24 years.[29]

FACTORS INFLUENCING THE DEVELOPMENT OF ATHEROSCLEROSIS

Many factors have been postulated as influencing the development of atherosclerosis. In a contribution entitled 'Atherosclerosis and coronary heart disease: the contribution of epidemiology', Strasser[30] listed 40 factors that have been submitted as having a relationship to atherosclerosis or its complications (mainly coronary). The nutritional factors mentioned were: radioactivity in water; chromium deficiency; total fat intake; heavy metals; magnesium deficiency; national energy consumption; pectin consumption; polyunsaturated fatty acids; saturated fats; sugar intake; vanadium deficiency; and water softness. Strasser stated 'A critical glance at the list at once differentiates controversial items (e.g. sugar intake, water softness, stress) from those that are widely accepted (e.g. blood cholesterol, hypertension) with many shades of transition inbetween. Some of the relationships described in the literature can be considered as having been virtually refuted (e.g. high sugar intake); it is characteristic of most controversial items that there is some evidence in their favour but little work has been done to bring evidence against them. It is difficult to draw a dividing line between the controversial and the accepted relationships: there is a continuum of decreasing certitude and the relationships of atherosclerosis with age, serum cholesterol, and blood pressure are at the top of the list.'

It would be expected that long-term prospective studies would shed considerable light on which nutritional components are most influential in respect of atherosclerosis and its consequences. In this connection, I quote from a paper entitled 'Predisposition to atherosclerosis in the head, heart and legs'.[31] Of the numerous careful studies which have been undertaken, probably the best-known findings concern this 16-year follow-up study of 5 209 adults in Framingham, reported by Gordon and Kannel. From the investigations which were made on a fairly representative population group, it became evident that blood pressure, serum cholesterol level, cigarette smoking, ECG evidence of left ventricular hypertrophy, and glucose intolerance, are precursors of all 3 major atherosclerotic events—atherosclerotic brain infarction (ABI), coronary heart disease (CHD), and intermittent claudication (IC). None are clearly dominant for CHD. Glucose intolerance is only slightly related to the disease, while cigarette smoking is slightly related (if at all) to angina pectoris. All 5 factors play an important role in IC. In general relationships appear to be as strong for women as for men. When all 5 variables are considered jointly, they have a closer relationship with ABI and IC than with CHD, and equally strong relationships prevail in every age group between 45 and 74 years of age. In respect of the role of diet, it was concluded that the chief factor which influenced the serum cholesterol level was the fat moiety, in particular the proportion of calories from polyunsaturated fatty acids.

PREVENTION AND REMEDIAL MEASURES

Ever since diet has been linked with CHD, there have been many suggestions for changes in food habits.

Within the last few years, a number of prospective studies have been made, some aimed at primary prevention of CHD, others at avoiding a further episode in persons already affected. Most results have been relatively encouraging.[32-34] But it would be unrealistic to ignore the fact that the outlook regarding the prevention or amelioration of atherosclerosis is depressing, in as far as the likelihood of attaining a worth-while delay or reduction in CHD episodes and deaths. This was made clear in a recent study published in *The Lancet*, in which Meade and Chakrabarti[35] concluded that 'Known risk factors for ischaemic heart disease account for only a modest proportion of its incidence; in particular, dietary fat intake and blood cholesterol levels explain less than is often claimed. Intervention studies are, with a few exceptions, not at present likely to improve understanding of aetiology or pathogenesis very substantially. The forcible chances of successful primary intervention on any major scale are slender, particularly by the modification of personal habits.' These workers went on to stress, 'There is a pressing need for prospective observational studies in which new risk factors are identified, particularly those likely to give a more direct measure of thrombotic tendency.' This latter aspect is extremely important, although there has been insufficient time to enlarge on it. It has been stated that 'it is clear that the way to obtain an immediate reduction in the death rate due to ischaemic heart disease is to find the causes of the increased tendency to thrombosis.'[35]

The question arises, if it is too late or impracticable to benefit adults, what are the chances of influencing the dietary habits of the young? In practice, Kannel and Dawber[37] maintain, on the basis of the long-term Framingham study, that 'It would seem reasonable for paediatricians to counsel mothers on the feeding of a diet, emphasising skim milk, cottage cheese, and other dairy products derived from skim milk, legumes, fruits, starches, lean meats, poultry and fish. Candies, pastries, egg yolks,

animal fats (including dairy fats), and organ meats should be de-emphasised'. Blumenthal[38] agreed that 'primary prevention instituted in early life offers the most promising opportunity to affect morbidity and mortality of atherosclerosis'. He continued 'It is now possible to identify children at high risk of premature development of complications of the disease utilising known risk factors and their tendency to familial aggregation'. However, in a contribution on 'Fat nutrition and diet in childhood', Schubert[39] contended that 'Since the benefits of large-scale dietary alterations are unproved and the risks unknown, screening and prospective treatment of the estimated 5 to 7% of persons at risk is advocated rather than tampering with the diet of all American children'.

What can be said of preventive or ameliorative measures in relation to influencing the development of CVD and PVD? In a recent article in *Nutrition Reviews*, it was concluded that 'any of the preventive measures which might alter the risk of coronary heart disease would seem to be also appropriate for mitigating the risk of thrombotic cerebrovascular and atherosclerotic peripheral vascular disease.'

The outlook regarding the prevention or delay of the development of 'strokes' is more optimistic than that in respect of CHD. This has been secured by the treatment of high blood pressure, mainly by hypotensive agents; several studies have now been reported which have consistently shown considerable reductions in CVD incidence, but little or no benefit in CHD experience.[40]

CONCLUSION

Regarding the future, I believe that major changes in diet and in personal habits can only come about when there is enthusiasm in both the young and adults. This is found in neither.

We have the effective means to combat many lethal diseases such as severe malnutrition, a whole series of infections (tuberculosis; diphtheria; smallpox; malaria; leprosy; etc.), and certain types of cancer. We also have the knowledge of what pattern of diet and manner of life is consistent with minimal atherosclerosis and its sequelae, but the price to be paid by affluent societies, in terms of changes, is too exacting for practical implementation.

It would, however, be wrong to end on a note of unrelieved gloom for the future. Ancel Keys and associate workers,[41] in their studies on coronary heart disease in seven countries, concluded, *inter alia*, 'It is apparent that death rates from coronary heart disease much lower than those observed in the USA are quite compatible with a comfortable way of life and a subsistence level well above that found in primitive societies'. Obviously, therefore, we need to know far more of populations, such as that of Yugoslavia, which exhibit little CHD, but pursue lives not largely different in diet and a manner of life from that prevailing in Western populations. Also, we ought to know much more of minority groups within Western contexts, who suffer much less from atherosclerotic diseases than the national average. One investigation would be the careful study of strict vegetarians in respect of prevalences of arterial diseases. Finally, I would like to emphasise the conclusion of Meade and Chakrabarti,[35] that 'the prime need in arterial disease prevention is still, and will probably long remain, the identification of causes and mechanisms whose subsequent modification will lead to large rather than marginal improvements in incidence'.

REFERENCES

1. Taggart, P., Carruthers, M. and Somerville, W. (1973): Lancet, 2 341.
2. Editorial (1972): Med. J. Aust., **59**, 725.
3. Walker, A. R. P. (1963): S. Afr. Med. J., **37**, 1155.
4. *Idem* (1973): *Ibid.*, **47**, 85.
5. Dreyer, K. and Hamtoft, H. (1968): Dan. Med. Bull., **15**, 182.
6. Edington, M. E., Hodkinson, J. and Seftel, H. C. (1972): S. Afr. Med. J., **46**, 962.
7. Cosnett, J. *in* Campbell, G. D., Seedat, Y. K. and Daynes, G. eds (1973): *Clinical Medicine in Africans in Southern Africa*. London: Churchill Livingstone.
8. Scotch, N. A. (1960): Ann. N. Y. Acad. Sci., **84**, 1000.
9. Walker, A. R. P. (1964): Amer. Heart J., **68**, 581.
10. *Idem* (1973): *Ibid.* (in press).
11. Trowell, H. C. (1960): *Non-Infective Disease in Africa*. London: Edward Arnold.
12. Walker, A. R. P. (1963): Amer. Heart J., **66**, 293.
13. Groen, J. J., Dreyfuss, F. and Guttman, L. (1968): Progr. Biochem. Pharmacol., **4**, 20.
14. Fauman, S. J. and Mayer, A. J. (1969): Hum. Biol., **41**, 416.
15. Walker, A. R. P. (1968): Circulation, **37**, 126.
16. Hatch, F. T., Reissell, P. K., Poon-King, T. M. W., Canellos, G. P., Lees, R. S. and Hagopian, L. M. (1966): *Ibid.*, **33**, 679.
17. Higginson, J. (1968): Proc. Roy. Soc. Med., **61**, 723.
18. Drury, R. A. B. (1972): Trop. Geogr. Med., **24**, 385.
19. Biss, K., Bruce Taylor, C., Lewis, L. A., Mikkelson, B. and Kang-Jey, H. (1971): S. Afr. J. Med. Sci., **2**, 249.
20. Lee, K. T. (1971): *Ibid.*, **2**, 191.
21. Higginson, J. and Pepler, W. J. (1954): J. Clin. Invest., **33**, 1366.
22. Reef, H. and Isaacson, C. (1962): Circulation, **25**, 66.
23. Andersson, M., Walker, A. R. P., Lutz, W. and Higginson, J. (1959): Arch. Path., **68**, 380.
24. Wainwright, J. (1961): Lancet, **2**, 336.
25. Sacks, M. I. (1960): Circulation, **22**, 96.
26. Meyer, B. L., Meyer, A. C. and Pepler, W. J. (1971): S. Afr. J. Med. Sci., **2**, 283.
27. Strong, J. P. (1972): Atherosclerosis, **16**, 193.
28. Solberg, M. A. and McGarry, P. A. (1972): *Ibid.*, **16**, 141.
29. Joubert, F. J., Van Bergen, A., Bersohn, I., Walker, A. R. P. and Lutz, W. (1962): S. Afr. J. Lab. Clin. Med., **8**, 10.
30. Strasser, T. (1972): WHO Chron., **26**, 7.
31. Gordon, T. and Kannel, W. B. (1972): J. Amer. Med. Assoc., **221**, 661.
32. Dayton, S., Pearce, M. L., Hashimoto, S., Dixon, W. J., Tomiyasu, U. (1969): Circulation, **39**, suppl. 2.
33. Miettinen, M., Turpeinen, O., Karvonen, M. J., Elosuo, R. and Paavilainen, E. (1972): Lancet, **2**, 835.
34. Bierenbaum M. L., Fleischmann, A. I., Raichelson, R. L., Hayton, T. and Watson, P. B. (1973): *Ibid.*, **1**, 1404.
35. Meade, T. W. and Chakrabarti, R. (1972): *Ibid.*, **2**, 913.
36. Comments (1973): Med. J. Aust., **1**, 870.
37. Kannel, W. B. and Dawber, T. R. (1972): J. Pediat., **80**, 544.
38. Blumenthal, S. (1973): Amer. J. Cardiol., **31**, 591.
39. Schubert, W. K. (1973): *Ibid.*, **31**, 581.
40. Anon. (1966): Nutr. Rev., **24**, 271.
41. Coronary Heart Disease in Seven Countries (1970): Circulation, **41** and **42**, suppl. 1.