The Geography of Diabetes and Vascular Occlusive Disease in Relation to Chromium

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SUMMARY

Prima facie evidence is presented that, where naturally occuring chromium in water supplies occurs, it is associated with a lower prevalence of diabetes and a lower incidence of mortality from vascular occlusive disease.

It is postulated that increased prevalence of such disease in a population is associated with chromium 3 deprivation. This results from consumption of highly refined cereal foods which are known to have most of the chromium content removed with the fibre. Water chromium may mitigate these effects.

INTRODUCTION

In animal experiments trivalent chromium (Cr3) deficiency leads to a number of ill effects, including glucose intolerance, the diabetic state, and the deposition of plaques in the arteries.[1,2] If introduced before end states are reached, Cr3 in the drinking water will prevent the glucose intolerance.[1]

A number of trials has indicated that a high proportion of diabetics, especially those not dependent on insulin, benefit from oral or parenteral administration of Cr3.[2,3]

Most bio-available dietary chronium is derived from cereals and absorbed from the gut at a rate

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of about 1% irrespective of the dose or on the nutritional state of the organism.[4]

The greater part of cereal chromium is removed during the refining process and is, therefore, not available for absorption.[5] In addition rises in blood glucose mobilise chromium from body stores into the plasma, eventually to be lost in the urine.[6]

Over the last two or three decades the Black people of Zimbabwe, including many in rural areas, have developed a preference for diets in which refined maize meal, white wheaten bread and white sugar predominate.

During this time older physicians have noted and commented on what they believe to be a great increase in the numbers of diabetics and a change in pattern from a high proportion of insulin-dependent patients to a situation where most new patients appear to be elderly or middle-aged, controllable on oral medication. This change has paralleled a striking increase in obesity and hypertension in urban and rural communities, together with a modest rise in reported occlusive vascular disease.

Though most deaths amongst Black Zimbabweans are not subject to certification, if they occur outside certain urban limits, there is some support for clinical impressions in the annual reports of the Secretary for Health. In the mid-1960s, when the population was about 3,5 million, deaths attributed to diabetes averaged about 21 per annum (6 per million). In the early 1980s such reported deaths average about 150 in a population of perhaps 7,5 million (20 per million). The reported deaths are likely to be a small proportion of actual deaths, but the apparent threefold increase may be indicative of a looming problem.

Since Zimbabwe has an unusual distribution of chromium it appears reasonable to ask: 'Does naturally occurring chromium tend to have a protective effect in those areas where there is measurable chromium in the water?'

MATERIALS AND METHODS

Water sampled from numerous sources was tested for chromium content by courtesy of the US Department of Agriculture. This revealed that water flowing over or from the chromium-containing Great Dyke of Zimbabwe contains chromium in significant amounts. Waters in the eastern regions tested contain less than 0,05 parts per billion, and for practical purposes can be said to contain none. Government hospitals and their client catchment zones were chosen to match as far as possible in most charateristics such as population but contrasting in whether or not their water supplies contained chromium.

Diabetes. The most useful numerator to obtain appeared to be the numbers of diabetics. Hospitals were unable to give accurate figures in most cases. Recourse was, therefore, made to the issues of drugs. These were not available from the hospitals concerned and so the issues from central medical stores were studied. It was established that the stores had not run out of any of the drugs between July 1982 and June 1984 and that, therefore, hospital pharmacists had not been forced to 'buy out' from more expensive sources. The issues to each of the hospitals were totalled and the figure halved to give an annual average.

An arbitrary assumption was made that the average patient on insulin was using 40 units daily. Those on oral preparations were assumed to be taking either 10 mg glibenclamide or 500 mg Chlorpropamide daily. Other oral preparations were issued in negligible quantities and, therefore, ignored. From the total issues to each hospital it was, therefore, possible to derive an estimated number of diabetics under the care of each hospital and its outreach health centres.

Despite strictures against hospital figures, it appeared that the best denominator would come from this source. Since admission policies differ for many reasons, it was deemed more accurate to take the sum of the admissions and first attendances at out-patients as the denominator. These figures were available for 1983 from the annual report of the Secretary for Health.

Vascular occlusive disease. Morbidity from vascular occlusive disease is impossible to obtain with any accuracy, since it is often silent until death or a dramatic episode occurs. In this case the mortality statistics were deemed to be more useful.

The Central Statistical Office was able to provide a detailed breakdown of causes of death within the cities of Gweru and Mutare, and the total populations of the two cities as found in the 1982 census. These figures have been taken for this study.

RESULTS

Chromium in water. The city of Gweru and the town of Kadoma were chosen from the chrome-containing area, to compare and contrast with the city of Mutare and the town of Rusape. Gweru and Kadoma have water containing approximately 0,13 parts per billion chromium while the water in the other two areas contains none, either in municipal or peripheral supplies (see Fig. 1).

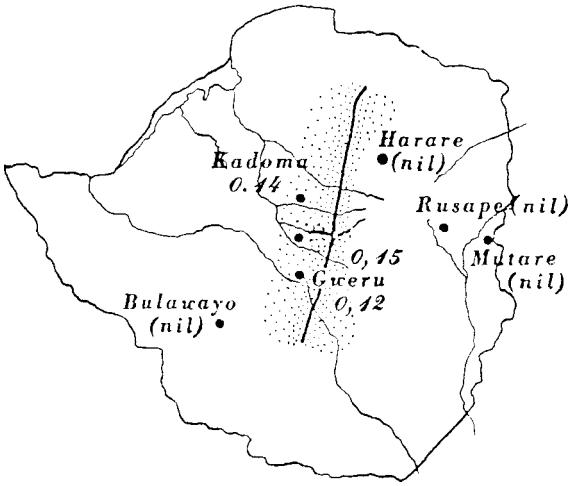

FIG. I—*Zimbabwe showing chromium concentrations and the Dyke*

Diabetic numbers. On the basis of the quantity of antidiabetic drugs issued by central medical stores, and the assumption made on the average treatment needs, estimated numbers treated annually by each hospital are shown in Table I. The total of in-patient admissions and first attenders at out-patients are shown in Table II. Table III shows the estimated number of diabetics served by each hospital per 1 000 patients (total of in-patients and first attenders at out-patients) and further breaks these down into patients on insulin and patients on oral antidiabetic medication.

It will be noted that the hospitals in the non-chrome areas, Mutare and Rusape, deal with over twice the number of diabetics per 1 000 patients than do the hospitals in the chrome areas.

Vascular occlusive disease. Table IV presents the figures derived from the Central Statistical Office showing the deaths associated with vascular occlusive disease. These have been converted into a crude mortality rate showing a much higher comparative death rate in the non-chromium Mutare. A similar difference is shown for non-residents of the cities whose deaths were reported in each area but no denominator exists. A breakdown by race for the deaths is also given: Blacks showing a similar difference, but no denominator is available.

TABLE I—*Estimated numbers of diabetics*

Town	On insulin	On orals	Total
Kadoma	36	30	66
Gweru	49	31	80
Mutare	38	86	134
Rusape	90	33	123

TABLE II—*Total of in-patient admissions and first attenders at out-patients for 1983*

Kadoma	71 157
Gweru	65 005
Mutare	51 463
Rusape	51 485

TABLE III—*Estimated number of diabetics served*

Cr status	Hospital	On insulin	On orals	Total per 1 000
Cr Area	Kadoma	0,50	0,43	0,93
	Gweru	0,75	0,48	1,23
Non-Cr Area	Mutare	0,73	1,67	2,60
	Rusape	1,75	0,64	2,39

TABLE IV—*Deaths associated with vascular occlusive disease*

Cr status	City	Population[7] (1982)	Vascular deaths (1983)	Deaths per thousand
Present	Gweru	78 918	14	0,18
Absent	Mutare	69 621	34	0,49

DISCUSSION

Diabetes mellitus. The use of hospital figures as a denominator is fraught with opportunities for error, but in this instance, where census figures do not necessarily reflect the drainage population, it is probably the most reliable available.

The only diabetes likely to be excluded from the figures given are the richer, mostly White, members of the community who have traditionally received medical care from private sources. The population indicated in this study consists, therefore, mostly of the Black members of the community who are more likely to have subsisted for most of their lives on foods produced in the area concerned, and would certainly have used local water.

Gweru Hospital has kept a chronic diseases register since the early 1970s. Lutilo and Mabanga[8] in a retrospective study of diabetics on the register quote figures which tend to support the calculations of numbers made in this study, as does a less formal register kept in Mutare. These two hospitals—as opposed to Kadoma and Rusape—have relatively large staffs supported by specialist physicians and may, therefore, be expected to achieve more refined diagnosis of their diabetic patients.

Gweru and Mutare both have the same proportion of patients (0,75 per 1 000) who are taking insulin. Though this is by no means necessarily the same as saying they have the same proportion of insulin – dependent diabetics (IDDMs), the chances are that a serious attempt has been made to differentiate IDDM patients from the non-insulin dependent patients (NIDDM). On the other hand, Mutare, with 1,67 per 1 000 has more than three times as many patients on oral preparation as Gweru with 0,48 per 1 000.

If these are truly NIDDM patients, then it fits well with the hypothesis that chromium deficiency is a factor in the development of NIDDM.

The figures from Kadoma, in which IDDM exceeds NIDDM, also accord with the hypothesis. Those from Rusape do not. The people on insulin far out-number those on orals. Since it is common practice to admit patients newly diagnosed as diabetic and initially to gain control with insulin, it may be that an explanation exists in differing practice. It is quite possible that in this exceedingly busy hospital staffed by generalists, the further elucidation of each patient's problem does not often go beyond the diagnosis of diabetes. Thus patients who, with further refinement of diagnosis might be found to be NIDDM, are discharged somewhat prematurely on insulin, on which they remain. Discussion with Rusape medical officers tends to support this view.

Vascular occlusive disease. It was possible to get only the figures for Mutare and Gweru from the Department of Census and Statistics, information from other towns being incomplete, or not available. From the figures obtained it appears that total deaths in Mutare (no chromium) city from myocardial infarction, stroke and a small number of other causes associated with occluded vessels exceeded those occurring in Gweru, in 1983, by a very considerable margin. Studies of other years need to be made to ensure that this is a constantly occurring phenomenon. It would also be useful to include other areas when and if the information becomes available.

Confirmation. The two studies carried out serve to confirm other work in the laboratory and in practice that chromium 3 has a beneficial effect on both diabetes and vascular occlusive disease. The inference is made that the two diseases are in part due to chromium deprivation which is in turn due to cereal refinement. Naturally occurring dissolved chromium in water supplies tends to be protective.

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