Studies on Sugar Intake and Overweight in South African Black and White Schoolchildren

A. R. P. WALKER

SUMMARY

In primitive and emerging populations in rural areas, adults gain little or even no weight with age. In emerging populations in urban areas, also Western populations, adults gain considerable weight with age. Among children of all ethnic groups, it is usual for them to grow faster with rising socio-economic circumstances. Associated with these changes, the most conspicuous alterations in manner of life concern diet and physical activity. Whether it be Western populations during the last century, or present emerging populations in towns, the pattern of dietary changes is the same, and includes marked increases in the consumption of fat and sugar. The accompanying decrease in everyday physical activity requires no enlargement. In view of increases in prevalences of overweight and obesity in children and adults, many regard the progressive rise in the sugar consumption to be the primary responsible factor.

To throw light on the problem, height, weight, and daily sugar intake have been determined on South African Black and White school pupils. Briefly, observations revealed that in each ethnic - sex group studied, mean height and weight data of the upper, compared with the lower, third, in respect of sugar intake, were closely similar. In corresponding studies on two ethnic groups of adults, preliminary results lead to the same conclusions. Accordingly, our observations suggest that in the circumstances described, a high compared with a much lower intake of sugar does not promote overweight.

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To the nutritionist in the field of epidemiological research, there are two major fields of interest. The first concerns the ill-effects which occur in people who consume too little of this or that nutrient, or combinations of nutrients, or whose diet is grossly imbalanced. These people are to be found among populations who are primitive or developing, or who are just underprivileged or poor. The second field has to do with the ill-effects found in people who eat too much, whether it be of a single nutrient or foodstuff, or whether it concerns just too much of everything. This field embraces Western populations.

MRC Human Biochemistry Research Unit, South African Institute for Medical Research, Johannesburg
A. R. P. WALKER, D.SC.

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In the first field, we know that in situations where there are not enough calories and protein, insufficiencies will lead to near-starvation. In infants and young children marasmus and kwashiorkor may result. If there is too little iron, one outcome is anaemia. With too little of particular vitamins, deficiency diseases such as pellagra, rickets and scurvy may occur.

In the second field, which has to do with those who overeat, there is less specificity of the resulting ill-effects. There are some exceptions. We know that too much fluorine can lead to mottling of the teeth, too much iron can lead to siderosis or abnormally high iron deposits in the body, too much common salt can cause or promote high blood pressure, and so forth. But in the broader field, we know that in populations who consume a Western diet, there are high prevalences of a number of conditions: dental caries, overweight, hypertension, diabetes, coronary heart disease, 'strokes', and certain bowel diseases—appendicitis, diverticulitis, colonic cancer. There is, of course, great interest in regard to which nutrient or food consumed to excess is most responsible for the emergence of the above diseases. All these ills have been linked, directly or indirectly, with over-consumption of sugar.

In this article the following will be discussed: (*i*) why in emerging and Western populations we have this widespread problem of overweight, a problem becoming increasingly prevalent in children and adults; (*ii*) studies we have carried out in South African populations which bear upon the problem of overweight as it is affected by the level of sugar intake; and (*iii*) the implication of our findings.

DEVELOPMENT OF THE OVERWEIGHT PROBLEM

Primitive and Emerging Populations in Rural Areas

There is extensive evidence that overweight is uncommon in both children and adults in primitive and emerging populations in country areas.

Children. The situation in child populations is illustrated in Table I. Data are given on the growth of Pakistani,[1] Haitian,[2] and South African Black[3] children, compared with the growth of a White child population in London.[4]

The much lower height and weight of the less privileged populations is apparent. These are due in part to insufficiency of calories and other nutrients, but also to the active manner of life pursued.

TABLE I. MEAN HEIGHT AND WEIGHT AT 16 YEARS OF RURAL, LESS PRIVILEGED POPULATIONS, AND A WHITE POPULATION

	Height (cm)		Weight (kg)	
Population	Boys	Girls	Boys	Girls
Pakistani[1]	158,0	153,0	47,0	41,5
Haitian[2]	152,4	156,8	40,1	44,6
South African Black[3]	158,8	154,8	49,7	49,5
Whites (London)[4]	173,7	162,2	61,0	56,1

Adults. Populations of the type under discussion experience little or no gain in weight with age,[5-7] a situation entirely different to that in Western populations.[8] The contrast is illustrated in Table II.

TABLE II. CHANGES IN WEIGHT (kg) WITH AGE IN ADULT MALES IN LESS PRIVILEGED POPULATIONS, AND IN A WESTERN POPULATION (UK)

Period (years)	India (indigent)[5]	Central Africa (Samburu)[6]	Zambians (mineworkers)[7]	UK (General practice study)[8]
20 - 29	53,4	57,9	61,6	70,0
30 - 39	54,5	57,5	62,0	75,5
40 - 49	54,7	57,3	62,0	80,0
50 - 59	57,5	57,4	62,0	73,2
60 - 69	44,9	57,6		66,8

The pattern of little or no gain in weight with age in this group is also due to lack of calories and other nutrients and to the active life pursued.

Emerging and Western Populations in Urban Areas

The situation in these circumstances is quite different.

Children. It is usual, although not invariable, for schoolchildren, especially in emerging populations, to be taller and heavier in urban areas,[9] as is illustrated in Table III.

TABLE III. HEIGHT AND WEIGHT AT 16 YEARS OF SOUTH AFRICAN BLACKS IN RURAL AND URBAN AREAS, ALSO OF A WHITE POPULATION

	Height (cm)		Weight (kg)	
	Boys	Girls	Boys	Girls
Rural Zulu	160,6	155,4	50,4	50,6
Urban Zulu	163,8	156,8	52,7	56,3
Rural Tswana	158,8	154,8	49,7	49,5
Urban Tswana	161,9	156,3	50,2	53,3
Whites (London)	173,7	162,2	61,0	56,1

It will be observed that while the growth of Black children is faster in urban areas, it is still slower than that of Whites,[4] the disparity being more marked in males. Among Negroes in the USA, some recent reports indicate that they grow faster than Whites.[9]

There are two items I wish to mention. Firstly, in some contexts, we have noted that older Black high school girls in country regions, although shorter, weigh more than White girls of the same age. These girls, who live in hostels, seldom play games, and are almost wholly sedentary. In contrast, Black boys at the same high school invariably weigh less than their White counterparts. Although Black students of both sexes partake of the same type of diet, which includes a low intake of sugar, the boys are far more physically active.[10] The relevant anthropometric data are depicted in Table IV.

TABLE IV. HEIGHT AND WEIGHT AT 18 - 20 YEARS OF HIGH SCHOOL AND UNIVERSITY STUDENTS LIVING IN HOSTELS

	Height (cm)		Weight (kg)	
	Boys	Girls	Boys	Girls
Blacks	169,2	160,3	64,7	61,8
Whites	173,1	164,4	71,8	56,6

Secondly, I wish to mention the many young Black men from country areas in South Africa and surrounding territories, who come to work on the gold mines for periods of 4 - 15 months. The change to the excellent diet provided by the mines is associated with an average weight gain of 4 - 5 kg. This increase is usually accepted as indicating a previous deficiency of calories. It is necessary, however, to be cautious over this interpretation, since it is usual for young White men also to gain weight during their period of military service. Furthermore, we have found that White university students living in hostels experience a considerable gain in weight compared with students living at home.[3] Accordingly, a gain in weight consequent on entering an institutional type of life does not necessarily reflect a previous deficiency of calories.

Adults. In emerging populations in urban areas, invariably there is a very marked gain in weight with age. Moreover, country Blacks who migrate to towns soon evince a large gain in weight.[9,11] The major changes experienced are, firstly, an alteration in the pattern of diet, and secondly, usually, although not invariably, a decrease in physical activity and hence energy expenditure. White populations, as already indicated, are characterised by a considerable gain in weight with age;[3] moreover, the gain is still increasing. In England, in men, there has been an average gain in weight of 7 kg in the past 30 years.[12] Some comparative data are given in Table V.

To recapitulate, with certain exceptions, overweight in emerging populations is uncommon in country regions, but common in towns. The two factors primarily responsible are changes in diet and physical activity. These will now be enlarged upon very briefly.

TABLE V. GAIN IN WEIGHT WITH AGE IN RURAL AND URBAN BLACK MALES

Age (years)	Weight (kg) Zulu Rural	Zulu Urban	Venda Rural	Venda Urban	UK general practice study
20 - 29	57,0	59,9	56,8	60,1	70,0
30 - 39	58,5	63,3	58,9	63,5	75,5
40 - 49	60,4	64,5	56,7	64,6	80,0
50 - 59	60,0	66,0	54,9	65,8	73,2

Changes in Diet and Physical Activity with Westernisation

The changes in pattern of diet in a population that is emerging are much the same as the changes which have occurred over the last few generations, when the diet of our ancestors became more sophisticated. Dietary changes in both cultures became accelerated with urbanisation. The salient alterations are shown in Table VI, which indicates the nutritional situations regarding energy and protein supplies in privileged compared with less privileged populations.[13]

TABLE VI. ENERGY AND PROTEIN SUPPLIES (S) AND REQUIREMENTS (R) BY REGIONS IN BASE YEARS 1962 - 64 AT PER CAPUT LEVEL (FOOD AND AGRICULTURE ORGANISATION 1966)

Region	Calories (per day) S	R	S/R (%)	Protein* (g/day) St†	R	S/R (%)
North America	3 090	2 710	114	91 (64)	74	123
Oceania	3 200	2 540	126	93 (62)	73	127
Eastern Europe	3 020	2 570	118	94 (34)		
Latin America	2 600	2 380	109	68 (25)	65	105
Africa south of Sahara	2 130	2 240	95	58 (9)	63	91
Near East and North Africa	2 140	2 340	91	64 (13)	64	100
Asia and Far East	1 990	2 210	90	51 (7)	58	88

* Practical allowance.
† Total proteins, with animal sources shown in parenthesis.

It is apparent that some populations take in more than their needs of calories and protein, whereas others consume less. Rises in national economic prosperity are associated with rises in the intake of calories from fat, especially animal fat, a fall in the intake of calories from starch carbohydrate, but a rise in the case of calories from sugar. The proportion of calories from total protein changes little, although there is a replacement of part of vegetable protein by animal protein. Probably the most conspicuous dietary changes are the increases which have progressively occurred in the percentages of calories from fats (separated edible fats and unseparated animal fat) and from sugar. De Wijn[14] has pointed out, in regard to the changing character of the Dutchman's diet, that whereas fat and sugar made up 30 - 35% of calories at the turn of the century, the present figure is 55 - 60%. Another dietary change that has also progressively occurred is the reduction in crude fibre intake, i.e. the bulk-forming capacity of the diet. This change may be of greater significance to health than is usually appreciated.[15–18]

Associated with the changes in diet there have been decreases in physical activity. Both changes occur when less privileged populations move from country to town. The changes described are analogous to those which occurred as our ancestors became adapted to a predominantly urban manner of life.

Many examples could be given of this state of decreasing physical activity, I will give three.

(1) South African Black schoolchildren in country areas perform very well at running races, in spite of malnutrition and infections. Yet on urbanisation, despite consumption of a more adequate diet, running capacity and physical fitness are far lower, especially among girls.

(2) In investigations on young women in the USA and Australia, it was found that 90% of the time was spent in sleeping or sitting still; only 3% was spent in energy expenditure greater than that of walking.

(3) As an index of non-active time in a Western population, the average Australian spends 30 hours per week before the television set: this implicit sedentariness must prevail in many Western populations.

THE BEARING OF SUGAR INTAKE ON PATTERNS OF HEALTH AND DISEASE WITH SPECIAL REFERENCE TO OVERWEIGHT

Simultaneous with the dietary and activity changes described, there have been increases in the growth rate of children and, as mentioned, in prevalence of dental caries, overweight, diabetes, and coronary heart disease. There have also been increases in prevalences of a number of bowel conditions and diseases—constipation, appendicitis, diverticulitis, and cancer of the colon. Sugar is the dietary component whose increase in consumption has been linked, indeed, blamed, by many for much that is adverse in the health picture described.[18,19]

There are two avenues by which the blameworthiness or otherwise of sugar may be investigated. The first is to consider persons who are suffering from the particular condition or disease, and then to learn whether their customary intake of sugar is higher than that of those not obviously affected. The next approach requires the determination of the habitual sugar intake of individuals in random population groups. From this information it should then be possible, in the particular population group at risk, to determine whether the prevalence of the condition or disease in question is significantly greater in high sugar eaters (say, the upper third) compared with low sugar eaters (say, the lower third).

The first approach has been explored relatively little, apart from the now well-known studies bearing on coronary heart disease and level of sugar intake. It will

be recalled that the investigations of Yudkin and co-workers[19] indicated a positive association; whereas studies by later groups of research workers were unable to confirm this association.[20]

The second approach, which has also been employed very little, was adopted in the investigations now to be described.

What would one expect regarding the influence of level of sugar intake and prevalence of overweight? It is well known that virtually all regimens aimed at weight reduction involve a decrease in the intake of refined carbohydrate foods, especially sugar. Accordingly, it would be plausible to expect that high, compared with low sugar consumers, would be characterised in children by greater height and weight, and in adults by greater weight for age than the average.

Sugar Intake and Anthropometric Data in South African Populations

To throw light on the problem we measured the height and weight of representative series of Black and White pupils, of 16 - 17 years, in South Africa. The pupils studied included all of that age enrolled on the school registers. Each sex-ethnic group included 80 to 100 persons. Sugar intake was estimated by using a slight modification of the questionnaire used originally by Yudkin,[21] and which has been shown to yield repeatable results.[22]

Results are summarised in Tables VII and VIII. Table VII shows anthropometric and sugar data for total groups. Table VIII provides anthropometric data for the upper and lower thirds, with respect to sugar intake, in each sex-ethnic group.

TABLE VII. MEAN HEIGHT, WEIGHT AND SUGAR INTAKE AT 17 YEARS IN SOUTH AFRICAN BLACK AND WHITE SCHOOLCHILDREN

Population	Boys			Girls		
	Height (cm)	Weight (kg)	Sugar intake (g/day)	Height (cm)	Weight (kg)	Sugar intake (g/day)
Urban Blacks	**164,2**	**52,5**	**125**	**155,5**	**54,0**	**111**
Whites	**171,8**	**64,8**	**162**	**163,4**	**57,5**	**99**

It is apparent that in comparing anthropometric data for the upper and the lower thirds, for sugar intake, the results were inconsistent. In the group of Black boys studied, mean height and weight were greater in the upper third ($P<0,01$); the reverse being the case with the White boys. Among the groups of Black and White girls, corresponding data were almost identical.

Studies of the same type are being made on representative series of Indian and Coloured schoolchildren, also on series of adults in the four ethnic groups. Thus far, the pattern of results is similar to that obtained on the Black and White schoolchildren.

While the data presented cannot be regarded as final, since studies on other and larger groups are still in progress, it is already clear that differences in height and weight between groups accustomed to high and low sugar intakes, respectively, are small indeed, smaller than one would have predicted.

DISCUSSION AND IMPLICATIONS OF FINDINGS

To account for the slight mean differences in height and weight in the groups with contrasting sugar intake, there are two obvious explanations.

Firstly, the upper third of sugar eaters are more active than the lower third. Their higher energy expenditure is such that it precludes them from markedly putting on weight.

Secondly, the upper third of sugar eaters have roughly the same energy expenditure as the lower third. This would imply in respect of the high sugar eaters that the greater number of calories afforded are not extra, but are replacing a corresponding number of calories from non-sugar sources of food.

In the groups of subjects studied we required a crude assessment of each pupil's everyday level of physical activity in consultation with school staff, particularly the physical training instructors. The gradings were—sedentary, average activity, and very active. Results, in relation to sugar intake, were not consistent; there was only a slight trend for a higher proportion of very active persons to be in the higher sugar intake segments. This finding, however, must be regarded as tentative. To inquire into the problem further, we are going to determine the maximum oxygen consumption of groups of boys accustomed to

TABLE VIII. MEAN HEIGHT, WEIGHT, AND SUGAR INTAKE AT 17 YEARS IN UPPER AND LOWER THIRDS AS REGARDS SUGAR INTAKE

		Boys			Girls		
		Height (cm)	Weight (kg)	Sugar intake (g/day)	Height (cm)	Weight (kg)	Sugar intake (g/day)
Urban Blacks	**Upper**	**165,3**	**55,4**	**188**	**155,7**	**53,9**	**160**
	Lower	**163,1**	**51,6**	**71**	**155,0**	**54,1**	**58**
Whites	**Upper**	**171,4**	**62,5**	**241**	**163,5**	**57,0**	**171**
	Lower	**174,4**	**65,5**	**90**	**163,2**	**58,9**	**43**

contrasting sugar intakes. This aspect will be investigated initially by estimating the distance that each boy is able to cover in the 12-minute walk-run test.[23] The distance travelled provides an approximate measure of maximum oxygen consumption, and hence of physical fitness and of level of everyday activity.

Although, as indicated, we are pursuing this aspect of the subject further, we very much doubt whether the sugar intake differential between the contrasting groups, namely about 130 g in the case of boys and about 120 g in the case of girls, is likely to be expended largely or wholly in increased energy expenditure. In the case of the boys, for the sake of argument, 130 g sugar contributes roughly 500 calories, i.e. the energy required for about an hour of heavy recreation, e.g. athletics, football. From our knowledge of the habits of the pupils, especially the Black groups, and more especially the girls who are almost wholly sedentary, it is believed that only a small part of the energy derived from the higher sugar intake is spent in increased physical activity.

To what extent could 130 g sugar, the differential in the case of the boys, cause overweight? An intake of 130 g sugar daily, which contributes about 500 calories, would, in the course of a year, afford 182 500 calories. Assuming that 3 000 calories are equivalent to 0,45 kg body weight, then the above quantity of 182 500 calories, is equivalent to 27,6 kg. A theoretical gain in weight of this magnitude obviously is not occurring at all. The conclusion is therefore reached that very roughly the calorie intakes of the high and low sugar eaters are of the same order, which leads to the inference that the higher sugar eaters, compared with the lower sugar eaters, are obtaining less of their calories from non-sugar foods. Hence, it would seem that the diet of high sugar eaters includes not only more 'empty calories' (from sugar) but less non-'empty calories' (from non-sugar foods). If this is valid, it could be speculated that persons regularly consuming exceptionally large amounts of sugar are in danger of malnutrition, since the excessive sugar intake is displacing a considerable portion of other food nutrients. The question arises—is this malnutrition demonstrable in propitious circumstances?

In seeking to answer this question, there is one particularly apposite study, by Hodges and Krehl[24] in 1965 on representative groups of teenagers in Iowa City, USA. These workers reported mean sugar intakes of boys and girls to be very high, namely 389 g and 276 g per day, respectively. Such intakes are far higher than those which we have found in South African Whites[3,22] or Yudkin[19] found in his studies on children in London. Judging by the distribution of sugar intake in population groups in our own studies, it is considered that possibly a quarter of the boys and a fifth or less of the girls must have been accustomed to consuming 500 g or more of sugar per day. The important point is—were these particular segments detectably less favourably placed in well-being, e.g. in respect of malnutritional lesions, anaemia, glucose tolerance, insulinaemia, school attendance, scholastic ability, physical fitness, etc? Although the nutrition survey at Iowa was very carefully undertaken by a team which included four physicians, there is no information in the findings reported which provides answers to the above questions raised. In other words, there appeared to be no findings in the clinical and laboratory examinations undertaken which clearly discriminated between the very high and far lower consumers of sugar.

Comment

I have said enough to indicate that the subject of the relevance of sugar to overweight is not as straightforward as might be predicted. In the studies we have undertaken thus far, our findings provide no support for the view that a high sugar intake compared with a low sugar intake, within a given population of children or adults, promotes the gaining of weight. Although unaware until recently, the same conclusions as ours have been reached by workers in the Netherlands.[25,26] Obviously, research projects of this type should be explored much further, for far more should be known of the long-term effects of high compared with low intakes, not only of sugar, but also in regard to other nutrients, e.g. fat, common salt, calcium, and vitamin D.

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