THE NUTRITIONAL STATE OF SOUTH AFRICAN CHILD POPULATION GROUPS AS REFLECTED BY HEIGHT, WEIGHT, AND NITROGEN PARTITION IN THE URINE

ALEXANDER R. P. WALKER, *C.S.I.R. Human Biochemistry Research Unit, South African Institute for Medical Research, Johannesburg*

In South Africa there are Whites, Coloureds, Indians, and Bantu. Certainly among the last 3 groups there are many who are undernourished or malnourished. While the primary cause is lack of nourishing food, the part played by infections must be kept in mind. Thus, among at least the non-White populations, a high infant mortality from gastro-intestinal infections may prevail even when infants are wholly breast fed.[1] In older children, too, infections may be very common. Thus, among 2 Bantu school-children groups studied in rural and peri-urban areas, serial examination of stools throughout the period of a year revealed that 3 of every 4 children had evidence of typhoid or dysentery infections.[2,3] In addition, infestations by helminths are common and intense in certain regional populations.[4] Apart from handicaps from poor nutrition and infections, deleterious effects may result from overcrowding, long distances to be travelled to school or to work, and other environmental factors. Nevertheless, there is no doubt that quantity and quality of food consumed are of decisive importance in the nutritional state.

There are many reasons why we require knowledge of the nutritional state of population groups:

1. The first reason is for public-health purposes. This requires no amplification.

2. In all ethnic groups the standard of living has risen. The 'Poor White' problem is far less serious now than 30 years ago, the time of writing of the Carnegie Report.[5,6] Turning to more privileged communities, there is evidence that Pretoria White children are now taller and heavier than corresponding children studied 20 years ago.[7,8] Among the Bantu, elevation of socio-economic status is reflected by an increasing rate of growth found in certain rural school-child populations observed over the past 10 years;[6] moreover, it has been shown recently that growth among better-class urban groups is similar to that of Whites.[9] Associated with these changes, particularly among the Bantu, bio-

chemical and metabolic patterns are also changing; so too are patterns of disease. Reversal of the serum albumin/globulin ratio is encountered less frequently in present urban Bantu compared with the situation prevailing 10 years ago.[5] Observations indicate a progressive rise in serum cholesterol when comparing rural Bantu (120 - 150 mg.%), general urban Bantu (160 - 180 mg.%), and 'sophisticated' urban Bantu (190 - 220 mg.%); this reflects increased intakes of calories and fat in urban residents.[6,10] Regarding conditions or diseases associated with increasing privilege, there is evidence that obesity is now commoner amongst 'Poor Whites'[5,6] and among urban Bantu.[5,11] Diabetes in the latter is probably increasing,[12] and coronary heart disease, although still very rare, appears to be becoming slightly commoner.[13] Numerous other items of relevant information could be adduced. The salient point is that there is a dynamic state of change in South African populations, especially among the Bantu, in regard to diet, growth, literacy, socio-economic status, intensity of urbanization, and other factors. If medical science is to learn worth-while lessons from these changes, with regard to epidemiology, aetiology, metabolism, etc., then it is imperative to know the rate of change of the general nutritional state of constituent population groups.

3. A third reason for this need (actually an extension of the second reason) may be illustrated from problems at present confronting this unit:

(*a*) In seeking to obtain information about the milestones of development in the young in the different ethnic groups, one aspect we are enquiring into is the mean age of onset of menarche. When making interracial comparisons it is obviously necessary to know the general state of nutrition of the groups under study.

(*b*) In endeavours to throw light on the handicap to health imposed by parasitism, it is necessary when making comparative observations to know of the nutritional state of the populations showing different degrees of parasitism.[14,15]

(*c*) Current research on the aetiology of osteoporosis in Whites suggests that in a large proportion of cases a low intake of calcium may be chiefly responsible.[16,17] Since the Bantu are used to a much lower calcium intake than Whites, it might be expected that they would evince more osteoporosis. To throw light on the calcium status of these people, we are, on the recommendation of Nordin,[18] determining the phosphorus excretion index and the urinary calcium/creatinine ratio in different groups of Bantu and other ethnic groups. Understandably, the nutritional state of subjects must be determined.

(*d*) While there is little doubt that the primary aetiological factor in siderosis in the Bantu is their intermittent high iron intake,[19,20] it is necessary to determine whether malnutrition *per se* plays a role.[21] Hence, it is essential to make an assessment of the nutritional state of subjects upon whom serum-iron and other data are being obtained.

(*e*) In trying to learn of the bearing of hormonal activity on atherosclerosis and coronary heart disease, we must have knowledge, *inter alia,* of the androgen-oestrogen excretion patterns in the different population groups.[22,23] Here again, the need to assess the state of nutrition, or, in certain groups, the extent of 'Westernization', is understandable.

For the above and for many other investigations that could be cited, it is necessary to have the means of learning of the nutritional state of groups of people and of individuals, of children and of adults.

How may nutritional status be measured? To provide adequate information it is necessary to know (1) habitual quantity and quality of food components consumed; (2) weight, height, skinfold thickness, and clinical deficiency stigmata; (3) biochemistry of blood and excreta.

Along these avenues of approach, however, full information is very difficult to obtain. Estimates of the intakes of specific nutrients for large numbers of subjects are skilled and costly procedures to carry out. The assessment of mild clinical deficiency stigmata is subject to considerable observer bias; some authorities have even queried whether the results are worth while.[24] Many of the biochemical methods are complex and time-consuming and subject, moreover, to differences of interpretation. What really is required for the specific purposes just detailed is a relatively simple test or series of tests which will provide a broad indication whether population groups or individuals, particularly the young, are poorly, moderately, or well nourished.

Of all nutrients, protein is most influential in determining nutritional state, and the amount of nitrogen excreted *per diem* in the urine is believed to be a good reflection of protein intake.[25] But to obtain accurate 24-hour urine samples is difficult, even under hospital conditions; collections from non-hospital people present a much greater task. Furthermore, while the excretion figure as an index appears valid for adults, it is somewhat less reliable for children.[25]

An associated approach is based on the observation of Folin[26] that with an intake of protein nitrogen of 16 G. *per diem* (i.e. about 100 G. of protein), 87·5% of the total nitrogen in the urine is excreted as urea. This finding has been developed by Platt and Heard,[27] who consider that, in a morning sample of urine, urea nitrogen plus ammonia nitrogen as a percentage of total nitrogen provides a rough but reliable index of nitrogen intake and hence of protein intake. The proportion may be as low as 30% in severely malnourished subjects, but reaches 90% or more on a high-protein diet.[27,28] Arroyave[25,29] considers that urea nitrogen/total nitrogen percentage is equally satisfactory, but maintains that the examination should be carried out on fasting samples of urine. Luyken and Luyken-Koning,[30] however, have found the effect of a meal to be slight. Arroyave[29] also considers that since creatinine, for practical purposes, is not affected directly by variations in protein intake, the amount of urea excreted can be expressed per unit of creatinine, in the same manner as is customary for the water-soluble vitamins or their metabolites; this index may be more sensitive for the purpose in mind than the urea nitrogen/total nitrogen percentage.

The two topics for study which primarily stimulated our interest in this subject are those listed above in this column as (1) and (2). In the present investigation, which is preliminary in character, we have concentrated upon them, and have determined the nitrogen partition percentage and the urea/creatinine ratio in the urine, and the weight, height, and certain other criteria in a number of different groups of school children (White, Indian and Bantu).

SUBJECTS AND METHODS

The subjects ranged from 14 to 17 years old, and included the following groups (see table):

Whites. 38 boys in a rural high school in the Transvaal.

Indians. (1) 43 boys in an urban high school of good socio-economic position, predominantly Moslem. (2) 41 boys in an urban high school of good socio-economic position, predominantly Hindu. (3) 45 boys in an urban school of poor economic status, predominantly Hindu. (4) 30 boys in a rural school, poor, and mainly Hindu. All these schools were in Natal. Studies on Indian girls were not considered expedient by the teachers.

Bantu. (1) — (6) are 30 boys and 30 girls from each of 3 schools, Tleseng (no bilharzia), Tweedepoort (almost 100% bilharzia), and Kana (about 50% bilharzia), all in the Native Reserve region 10 - 15 miles north-west of Rustenburg. (7) and (8) are respectively 21 boys and 24 girls from a rural Bantu school, in very poor circumstances. (9), (10) and (11) are 35 boys each from schools in the Johannesburg area, viz. Shalom Manne (Higher Primary School, Dube), Ebomini (Higher Primary School, Edenvale), and Farm School, Witkoppen.

Subjects were weighed and measured. Urine was voided between 9 and 11 a.m., except on 2 occasions (Kana Bantu School), when accurate 4-hour collections were made between 8.15 a.m. and 12.15 p.m. Volumes were measured, tests made for albumin ('albustix') and sugar ('tes-tape' or 'clinistix'), and the specific gravity determined. In certain groups individual samples were chemically examined; otherwise equal aliquots from samples were combined to provide a representative pooled sample from each school group. Samples were preserved by the addition of concentrated hydrochloric acid at a dilution of 1 per 100.

WEIGHT, HEIGHT, AND URINE NITROGEN PARTITION IN DIFFERENT 14–17 YEAR-OLD POPULATION GROUPS

Population group	*Sex*	*No. of subjects*	*Weight* (lb.)*	*Height* (ins.)*	*% Urea nitrogen / Total nitrogen*	*Urea / Creatinine*
Whites	M	38	118	65·8	85·5	25·0
Indian:						
(1) (better-class Moslem) ..	M	43	120	65·4	85·2	22·2
(2) (better-class Hindu) ..	M	41	112	63·6	84·0	21·5
(3) (poor urban Hindu) ..	M	45	96	62·0	73·2	13·7
(4) (poor rural Hindu) ..	M	30	90	62·3	72·4	12·8
Bantu:						
(1) (no bilharzia)	M	30	83	59·8	78·8	18·2
(2) (no bilharzia)	F	30	93	59·8	78·4	17·7
(3) (100% bilharzia) ..	M	30	82	59·3	76·3	16·8
(4) (100% bilharzia) ..	F	30	89	60·2	77·7	17·1
(5) (50% bilharzia) ..	M	30	80	59·4	78·6	17·2
(6) (50% bilharzia) ..	F	30	89	59·7	77·4	17·4
Bantu:						
(7) (poor rural school) ..	M	21	75	59·1	68·1	13·2
(8) (poor rural school) ..	F	24	78	58·8	66·2	12·0
Bantu:						
(9) Johannesburg area,	M	35	99	62·3	81·6	20·1
(10) Higher Primary	M	35	97	61·5	80·5	19·7
(11) Schools	M	35	102	62·4	82·1	20·8

* Weight and height data refer to the 15-year age group only in each school studied.

Total nitrogen (Kjeldahl method) was determined, and creatinine as described by King and Wooton.[32] Urea was estimated by the method of Levine *et al.*[33]

COMMENTS ON RESULTS

At Kana Bantu School, the two consecutive daily 4-hour urine collections for boys examined *individually* gave mean nitrogen indices of 78·0% and 79·3%, and 16·9 and 17·6, respectively. The values for the first day's *pooled* sample were 78·6% and 17·1 respectively. Since agreement was close, only *pooled* urine samples from the other schools were examined for nitrogen, urea and creatinine.

Whites. The partition percentage, 85·5%, is closely similar to mean figures reported for White children elsewhere,[29,30,31] ranging from 82 to 91%. The urea/creatinine ratio, 25·0, corresponds with other reported mean values of 25·2 and 28·0.[30] Weights and heights are similar to those of Cape Town boys.[34]

Indians. The mean figures for the urines of the boys in the better-class schools (1) and (2), like their mean weights and heights, are similar to those of the White children. Values for the poorer Indian groups (3) and (4) are lower. In India, respective urine indices of 72·5% and 13·9, and 65·4% and 7·5 were found in adult groups of better-class (protein intake, 50·4 G.) and poorer (protein intake, 42·6 G.) Rajasthanis.[35]

Bantu. The values for the 3 Rustenburg male and female Bantu groups (1) — (6) are closely similar; hence these groups would seem to have similar nitrogen intakes. This inference is in harmony with the close similarity in mean age-group values for weight, height and skinfold, and for blood biochemical components (determined previously[6,14,15]). The mean figures are lower than those of the Whites or better-class Indians studied.

The other rural Bantu groups (7) and (8), who were unquestionably poor, had still lower figures. Children were underweight and under-height compared to Bantu groups (1) - (6). The former, moreover, were heavily parasitized in contrast to (1) — (6), who suffered only lightly from helminthic infestation.

The figures for the 3 groups of Johannesburg Bantu boys are closely uniform; the subjects would appear to have a greater intake of nitrogen than the Rustenburg groups. The higher figures of the former are in agreement with their greater mean weights and heights, which are about a year behind those of the White boys.

At Surinam, in Dutch Guiana, the following figures for children have been given for urea-N/total-N percentage and urea/creatinine ratio respectively: Bush Negroes, 53 and 7·5, 76 and 11·1; Javanese, 79 and 13·7, and 85 and 18·8; Amerindians, 80 and 17·8;[30] and Kapaukus primitives, 50 and 4·4.[31] Edozien and Phillips[36] have reported percentage values of 79·5 and 54·9% for better-class and for poorer (low protein) Nigerian children, respectively.

While detailed figures are not given here, we found that albuminuria became progressively less frequent with increase in the two nitrogen indices. Incidentally, in the Bantu groups studied, the highest proportion showing albuminuria was 31%, which is a great deal lower than that reported for a Central African child group with bilharzia, namely, 73%.[37]

DISCUSSION

Do the partition percentages, combined with weight and height data, afford any information of value in relation to the specific problems mentioned? Before seeking to answer this question, it may be asked how representative are the samples studied? Of the White and Indian groups, all children normally go to school. This also applies to urban Bantu. But among rural Bantu, backward parents may restrict their children's attendance, especially during certain seasons; such groups therefore may not be representative. At the times of investigation, absenteeism in any group was not more than 5%; since we are dealing with pooled samples of urine, it is unlikely that the absentees would have made a significant difference to the results obtained. Within the limitations indicated, it is believed that the figures obtained are representative.

Turning now to the data acquired, it seems reasonable to suggest, on the basis of the information on the groups of boys, that the girls in the White and the two better-class Indian schools studied are comparable in nutritional state. Thus, if differences are found in mean times of onset of menarche, they are likely to be due to non-nutritional causes. If menarche is delayed in the girls in the poor Indian and in the Bantu schools, then inadequacy of nutrition may share responsibility. At the time of writing, menarche data are incomplete for certain of the school groups.

With regard to the Rustenburg Bantu children, only small differences in urine-nitrogen data were found between school-child groups with and without bilharzia *(S. haematobium)*. These observations are in agreement with those on weight, height, clinical state, blood biochemistry and haematology, physiological tests (e.g. Harvard Step Test), and prowess in school-work studies, already undertaken on the three groups. The present findings narrow down still further the differences detected between the groups studied with and without bilharzia.[6,14,15]

The groups of boys in the diversely situated Johannesburg schools appear to have a similar nitrogen status. While a measure of undernutrition may well have been present, the existence of large-scale malnutrition is ruled out. A weakness in the study of pooled samples of urine is that data on a few well-nourished subjects may balance data on a few very malnourished subjects. In this connection, in each of the 3 Johannesburg schools a careful examination of 120 - 150 boys (undertaken for another purpose by Dr. S. D. Mistry) revealed much the same clinical picture: stigmata of severe deficiency were absent, and the only common lesion was follicular hyperkeratosis.

In the present study, interest has been focused primarily on the *mean* values of the various parameters determined. But, clearly, in the specific research problems previously detailed, determination of components in individual subjects presents no difficulty. Nevertheless, it is considered that the present approach probably holds out more promise for groups of subjects than for individuals, in throwing light broadly upon the nutritional state prevailing.

There is, however, an aspect of this type of investigation which is disquieting, and that is the legitimacy of comparing the various parameters in the non-White groups with those of the Whites, and assuming that when values in the former are lower than those in the latter, then in a measure undernutrition or malnutrition is implied. Too rapid growth in children may not be essentially meritorious; in the adult, at least, underweight is surely to be preferred to overweight. A high protein intake, consistent with a high urine urea/creatinine ratio, and with maximal muscle mass, need not be the optimum for the organism. Certainly in respect of biochemical components such as serum cholesterol and blood sugar, the less privileged may have the advantage over the privileged. It is therefore of importance that care be taken not to draw too hard-and-fast conclusions (except in the presence of obvious deficiency) when making interracial comparisons.

SUMMARY

The need for knowledge of the general nutritional state of South African population groups has been emphasized, whether for public-health purposes, for determining changes in biochemistry and metabolism associated with elevation of socio-economic status, or for current research problems. A number of such problems have been instanced, and attempts have been made to learn whether, in so far as school children are concerned, the simple and easily determined parameters of weight, height, urea nitrogen/total nitrogen percentage, and urea/creatinine ratio, in pooled urine samples from large groups, can provide information of value. Observations suggest that this simple approach is promising and should be further explored and developed.

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