Journal of the Dental Association of South Africa, 33, 539-544

Total sucrose intake and dental caries in Black and in White South African Children of 1 - 6 years
Part II : Dental caries and sucrose intake

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Keywords: Caries; diet; ethnic groups; sucrose

SUMMARY

Investigation has been made of the relationship between daily sucrose intake and dental health in 687 Black and 467 White South African children of 1 - 6 years. Sucrose intakes were assessed using a questionnaire, and teeth were examined for decayed, missing and filled teeth, using mirror and probe. Principal findings were: (i) prevalence of caries, rampant caries (5+ carious teeth) and labial caries (lesion/s on labial surface of one or more incisor or canine teeth) were not associated with mean level of sucrose intake in every group studied; (ii) sucrose intake was low yet labial caries prevalence high in rural Black children; (iii) an equal labial caries prevalence was found in White and in rural Black children and this was associated with far higher sucrose intakes; and (iv) although sucrose intakes were higher in urban than in rural Black children (with the exception of high sucrose eaters who had greater intakes in rural than in urban areas), urban dwellers had a very low prevalence of labial caries. Clearly, the causes of caries, rampant caries, and more particularly labial caries in the deciduous dentition, urgently needed elucidation.

OPSOMMING

'n Ondersoek is gedoen aangaande die verband tussen daaglikse sukrose-inname en tandheelkundige gesondheid by 687 Swart kinders en 467 Wit kinders van 1 - 6 jaar oud in Suid-Afrika. Die sukrose-inname is bepaal deur middel van 'n vraelys en met behulp van 'n spieëltjie en sonde is die tande ondersoek vir karies sowel as afwesige en gestopte tande. Die belangrikste bevindings was die volgende: (i) die algemene voorkoms van kariës, wydverspreide kariës (5+ karieuse tande) en labiale kariës (letsel/s aan die labiele oppervlak van een of meer sny- of oogtande) het nie verband gehou met die gemiddelde surkose-inname in elke groep wat bestudeer is nie; (ii) by plattelandse Swart kinders was die sukrose-inname laag, maar die voorkoms van labiale kariës hoog; (iii) 'n ewe hoë voorkoms van labiale kariës is opgemerk by Wit en by plattelandse Swart kinders, en dit word toegeskryf aan 'n hoë sukrose-inname; en (iv) alhoewel die sukrose-inname hoer was by die stedelike Swart kind as by die plattelandse Swart kind (met die uitsondering van hoe sukrose-eters, wat meer sukrose ingeneem het in plattelandse as in stedelike gebiede), het stadsbewoners 'n baie lae voorkoms van labiale kariës getoon. Dit is duidelik dat die oorsake van kariës, wydverspreide kariës en veral labiale kariës in die melkdentisie dringend deegliker ondersoek moet word.

Views on the detrimental effects of excessive consumption of carbohydrate foods on deciduous teeth have been expressed by workers in Britain (Winter *et al.* 1971) and elsewhere (Volker, 1972), but little is known of daily sucrose intake or of dental health in comparative groups of South African Black and South African White preschool children. In this paper, an investigation on the relationship between daily sucrose intake in preschool children and their dental health is described.

METHOD

The daily sucrose intakes and dental health in 687 Black

(437 rural and 250 urban), and 467 urban White preschool children of 1 - 6 years were studied. Daily sucrose intake was assessed for each child using a dietary questionnaire described in Part I (Richardson *et al.* 1978).

Teeth were examined using mirror and probe, in a mixture of natural and artificial light, for the presence of decayed, missing and filled teeth (dmft), also for decay on the labial surfaces of incisor and canine teeth, both maxillary and mandibular (labial caries). Dental caries was diagnosed when the probe 'caught' in suspicious areas, pits or fissures. Teeth in rural areas were examined by Professor P. E. Cleaton-Jones (dentist); J. M. Rantsho, a Black nurse field-worker, trained by Professor Cleaton-Jones, examined the teeth of urban Black groups in Soweto; and Dr P. M. McInnes, a final year dental student at the time of the survey, examined those of the White urban group. Examiners' results were checked to standardise diagnoses and no significant differences were found. According to W.H.O. recommendations (W.H.O. 1971) spot checks were made on two series of study children, who were unaware of the purpose of the procedure. Dental examiners were not aware of the children's sucrose intakes, nor were the dental results known to the sucrose questionnaire interviewers.

The lack of a precise definition of labial and rampant caries, terms which are used synonomously by some workers, has led to considerable confusion. Thus, Winter, Hamilton and James (1966) have defined rampant caries as lesions present on labial or palatal surfaces of 2 or more maxillary teeth including those extracted; Jackson, Murray and Fairpo (1974) as caries on the labial surface of at least one maxillary incisor; Timmis (1971) as caries involving 5 or more teeth; and Whitehouse (1973) as 10 or more carious teeth. These definitions were not entirely applicable to our field experience; for example caries on the labial surface may be absent in the presence of much caries elsewhere, and present where no other teeth are carious. Accordingly, in this study, labial caries has been defined as carious lesion/s on the labial surface of one or more incisor or canine teeth; rampant caries as a dmft score of 5 or more, i.e. 25 percent of the deciduous dentition as recently suggested by Richardson and Cleaton-Jones (1977a), and caries as a dmft score of one or more. In this contribution, caries, labial caries and rampant caries, are thus treated as separate entities, and presented as prevalences rather than as dmft scores.

The dental caries and sucrose consumption data were transferred onto punch cards and analysed in an IBM 370/158 computer using the Statistical Package for the Social Sciences (Nie *et al.* 1975). The statistical tests used were Student's t test and the Chi-square test; the level of statistical significance chosen was p 0,01.

Water samples analysed from all areas confirmed that they were fluoride deficient, with a concentration in the drinking water of less than 0,25 ppm F.

SUBJECTS

Numbers and groups of Black rural and urban, and White subjects are the same as those described in Part I.

RESULTS

In **Table I,** mean daily sucrose intakes, percentages of those with and without caries, also rampant caries and labial caries are given for preschool boys and girls.

Table II shows mean daily sucrose intakes, percentages of caries, rampant caries and liabial caries, for preschool children according to age.

Table III presents mean daily sucrose intakes in preschool children, also means intakes one standard deviation above and one below the mean, together with their respective percentages of caries, rampant caries and labial caries.

In **Table IV** preschool children were divided into

Table I. Mean daily sucrose intakes and percentages of those with and without caries, rampant caries and labial caries, in preschool boys and girls

Group	Sex	N	Sucrose intake g/d ±S.D.	% Caries free	% Caries	% Rampant caries	% Labial caries
Black rural	Male	220	55,3 ±37,5	60,5	39,5	13,2	10,5
	Female	217	49,1 ±31,9	61,3	38,7	15,7	12,9
	Total	437	52,2 ±35,0	60,9	39,1	14,4	11,7
Black urban	Male	122	61,3 ±17,9	50,8	49,2	23,8	3,3
	Female	128	62,4 ±18,5	52,3	47,7	26,6	4,7
	Total	250	61,9 ±18,2	51,6	48,4	25,2	4,0
White urban	Male	250	89,5 ±45,5	32,4	67,6	36,0	12,4
	Female	217	85,9 ±51,3	34,6	65,4	31,8	11,5
	Total	467	87,8 ±48,2	33,4	66,6	34,0	12,0

±S.D. - Standard deviation, and N - number of subjects used throughout tables.

average (upper-middle) and lower socio-economic groups; their mean daily sucrose intakes, percentages of caries, rampant caries and labial caries are presented.

As socio-economic status is a relative concept, only meaningful in its own context, and within each individual group, it was considered desirable to divide data into average and lower groups rather than into upper, middle and lower socio-economic classes.

COMMENTS AND DISCUSSION

Mean daily sucrose intake

As described in Part I, sucrose intakes were significantly lower in groups of rural compared with urban Black children, both were significantly lower than those of White children. Consumption in rural groups was lower because of (i) lack of money, (ii) distance from shops and (iii) perhaps of the greatest interest, in one area parents did not wish the teeth of their children to decay from eating too much sugar. Mean intakes of children, when divided into high and low sucrose eaters, i.e. one standard deviation above and one below the mean, varied markedly. As expected from studies on groups of White adults (Walker, Holdsworth and Walker, 1971), the groups of better-off children studied had lower mean intakes than the less privileged groups. The opposite was the case with Black children, among whom better-off groups had higher intakes than poorer groups.

A brief summary of results of dietary sucrose intake patterns for infants and preschool children, as shown in Figure 1, presents the main similarities also the differences existing between groups.

A more detailed presentation of the breakdown of sucrose from various dietary sources will be published elsewhere. We only wish to draw attention to several relevant points. The similarity in all groups of infants of sucrose intake derived from the liquid fraction of the diet is of particular interest. Within this fraction, however, sucrose added to feeding bottles was found to be high for White and for Black urban children, but was significantly lower for Black rural children. The difference in intake from fruit syrup concentrates, such as Fortris, etc., was striking, being high in White, but non-existent in town and country Black infants (Richardson and Cleaton-Jones, 1977b). In addition, sweetened comforters were used more often by White than Black mothers. Of perhaps the most interest and significance was the finding that in older children a similar percentage of sucrose intake was derived from sweets in the

Table II. Mean daily sucrose intakes, percentages of caries, rampant caries and labial caries for preschool children by age

Group		Age in Years					
		1	2	3	4	5	6
	N	51	58	91	119	87	31
	Sucrose g/d	38,4	48,1	69,3	48,8	53,0	43,3
	S.D.	34,6	33,2	42,2	28,1	34,8	19,5
Black	% Caries	11,8	37,9	41,7	42,0	50,6	35,5
rural	% Rampant caries	3,9	12,1	13,2	12,6	27,6	9,7
	% Labial caries	9,8	15,5	7,7	14,3	14,9	0,0
	N	33	58	65	41	32	21
	Sucrose g/d	46,7	56,5	64,8	66,6	70,7	68,1
	S.D.	21,7	13,4	13,8	15,9	22,1	16,4
Black	% Caries	9,1	32,8	46,1	73,3	75,0	71,4
urban	% Rampant caries	6,1	10,3	27,7	34,1	43,7	42,9
	% Labial caries	0,0	0,0	3,1	2,4	15,6	9,5
	N	28	94	97	127	106	15
	Sucrose g/d	71,4	93,1	87,1	89,7	87,8	73,8
	S.D.	51,7	53,7	50,7	41,8	49,6	22,7
White	% Caries	42,9	50,0	77,3	66,9	75,5	80,0
urban	% Rampant caries	7,1	20,2	30,9	33,9	52,8	60,0
	% Labial caries	3,6	11,7	11,3	9,4	17,0	20,0

Table III. Mean daily sucrose intakes of groups of preschool children, divided into sucrose intakes one standard deviation above and one below the mean; together with respective percentages of caries, rampant caries and labial caries

Group	N		Sucrose intake g/d ±S.D.	% Caries	% Rampant caries	% Labial caries
	53	Above mean*	122,1 ± 28,5	47,2	24,5	17,0
Black	24	Below mean*	11,4 ± 5,5	45,8	12,5	4,2
rural	437	Mean	52,2 ± 35,0	39,1	14,4	11,7
	32	Above mean	92,6 ± 12,9	96,9	59,4	6,2
Black	25	Below mean	40,9 ± 2,7	32,0	20,0	4,0
urban	250	Mean	61,9 ± 18,2	48,4	25,2	4,0
	61	Above mean	181,2 ± 42,2	75,4	44,3	16,4
White	45	Below mean	28,9 ± 8,9	57,8	24,4	8,9
urban	467	Mean	87,8 ± 48,2	66,6	34,0	12,0

Above mean* – intakes equal to and greater than one standard deviation
Below mean* – intakes equal to and below one standard deviation

Table IV. Mean daily sucrose intakes, percentages of caries, rampant caries and labial caries, in average (upper-middle) and lower socio-economic groups of preschool children

Group		N	Sucrose intake g/d ±S.D.	% Caries	% Rampant caries	% Labial caries
Black rural	Average	161	76,5 ±40,5	34,2	14,9	13,7
	Lower	275	38,6 ±21,8	41,8		10,5
	Total	436	52,2 ±35,0	39,1	14,4	11,7
Black urban	Average	167	65,7 ±19,0	56,3	28,1	5,4
	Lower	83	54,3 ±13,8	32,5	19,2	1,2
	Total	250	61,9 ±18,2	48,4	25,2	4,0
White urban	Average	263	82,4 ±45,8	60,5	30,8	10,6
	Lower	204	94,9 ±50,5	74,5	38,2	13,7
	Total	467	87,8 ±48,2	66,6	34,0	12,0

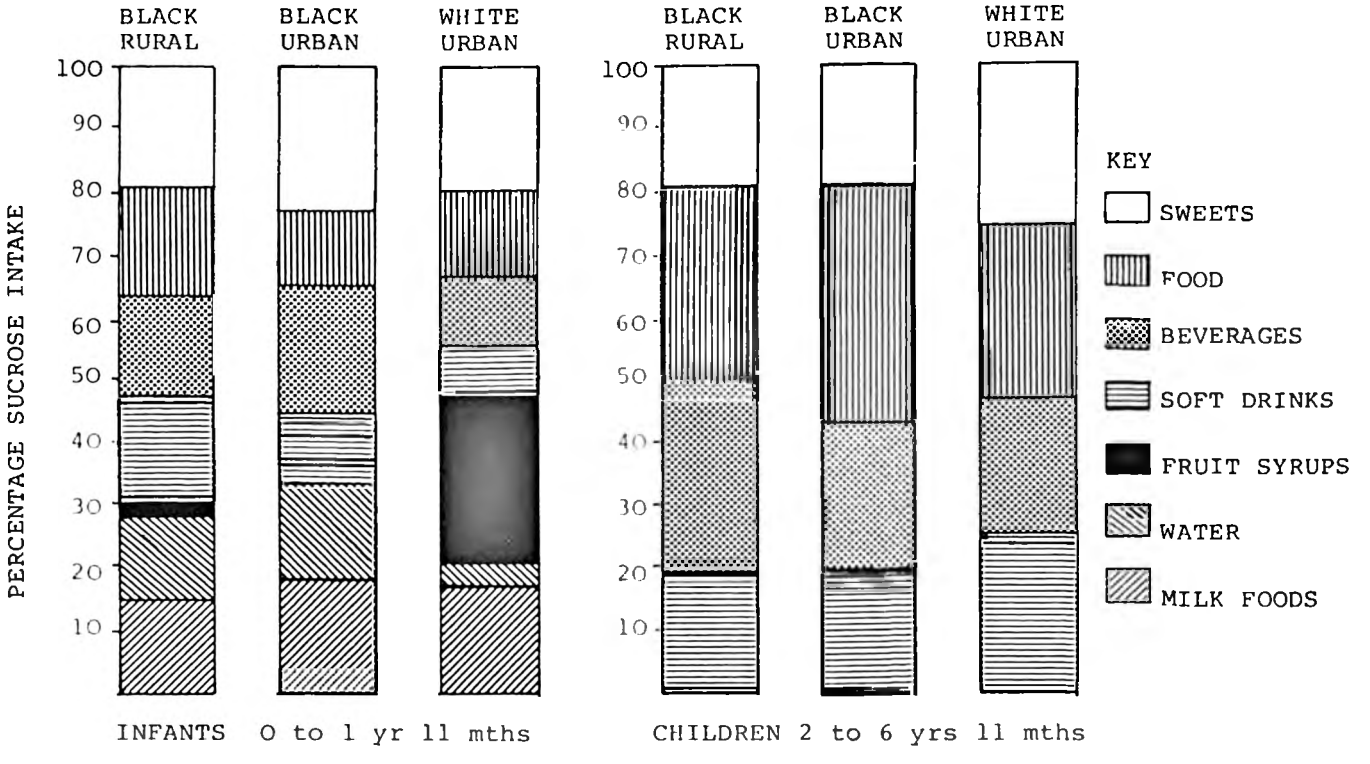

Fig. 1. Proportions of sucrose intake in infants and preschool children.

two Black groups and that in White children the intake was higher.

Caries prevalence and sucrose intake

Irrespective of the similarity or otherwise of mean daily sucrose intakes between the groups, caries prevalences varied considerably. Black children had significantly less caries ($p < 0,001$) than White children (Tables I and II). There were no significant differences within the same group between girls and boys.

Rural Black children with low sucrose intakes (1 S.D. below the mean) had a caries prevalence similar to those with high intakes (1 S.D. above the mean). It is noteworthy that, in spite of the similar caries prevalences, these rural children had markedly different sucrose intakes, with the lower comsumers having only one tenth the intake of the high consumers, 10 g/d compared with 122 g/d, respectively. Urban Black and urban White children on the other hand, consuming higher amounts of sucrose had significantly more caries than those with lower intakes (Table III). The high sucrose consumption together with the high caries prevalence which was found in both Black urban and White groups

would fit the generally accepted hypothesis of a high sucrose intake associated with a high caries score. However, rural Black children proved an exception, for which we have no ready explanation.

A socio-economic grading was noted in White children (Table IV), with a significantly lower ($p<0,01$) caries prevalence in average compared with lower groups. This was the opposite in the case of urban Black children where the average group had significantly more caries ($p<0,001$) than the lower group. Rural Black children showed no significant differences in this respect.

Walker (1975) found that in spite of similar sucrose intakes in White (134 g/d) compared with Black (90 g/d) urban school pupils of 16 - 17 years, the groups had widely different mean caries scores (DMFT 10,0 and 2,1 respectively). In a study made on Californian university students, Collins, Jensen and Becks (1942) found a group of caries-free individuals with a high sucrose intake and another carious group with a very low intake. They suggested that this feature alone did not explain the absence or presence of dental caries.

In our study the good dental condition of young preschool children in time declined, and prevalence of caries increased with age. This decline in dental health was very marked in White children; occurred from the age of 4 years in urban Black, but was less marked in rural Black children (Table II). The rather poor dental situation of older preschool Black children was unexpected, and is in marked contrast to the Black high school pupils who have excellent teeth (Retief, Cleaton-Jones and Walker 1975). In contrast to the 100 per cent caries-free prevalence reported by Sheiham (1967) for Black Nigerian children aged up to 4 years, two thirds or less of South African Black children of 1 - 4 years were free from caries. However, a recent study of Nigerian children (Henshaw and Adenubi, 1977) of 0 - 9 years showed a lesser proportion of caries-free children in both country and town areas, namely 79,3 per cent and 61,2 per cent respectively, compared with the previous Nigerian survey. The latter proportions were similar to those of South African Black preschool children studied, namely 60,9 per cent in the country and 51,6 per cent in town.

White South African children of 1 - 4 years had far less freedom from caries (Cleaton-Jones *et al*, 1978), but their scores were superior to those of London children (Winter *et al*, 1971) of the same age; however, at five years caries-free prevalences had fallen to about one quarter, a proportion closely similar to that of British children (Beal and James 1970). Black urban 5 year old children had not maintained the greater freedom from caries which rural children had done, but were similar in this respect to White children.

Rampant caries and sucrose intake

Rampant caries was common in White children with their high sucrose intakes, less common in urban Blacks with lower intakes, and lowest in rural Black children with the lowest intakes. The picture presented is similar to that of the caries experience, except in rural Black children where high sucrose eaters had significantly higher rampant caries prevalences – double that of the low sucrose eaters – in contrast to the similar caries prevalences in these two groups. Once again it would appear from the rampant caries prevalences found in this study, that there is a measure of support for the 'high sucrose high caries' hypothesis, even in the rural Black children.

There was little if any socio-economic gradient in rampant caries in contrast to that of the caries prevalences.

Labial caries and sucrose intake

The most remarkable and entirely unexpected finding was the high labial caries prevalence in rural Black children who lived mostly in poor circumstances (only a small proportion were better-off). This type of caries was evident in high proportions soon after eruption and was already high at one year of age in contrast to White children who had a low prevalence at the same age. Even more striking was the absence of labial caries in urban Black children under 3 years (Table II).

These rural children had prevalences of labial caries not significantly different from Whites in spite of much lower daily sucrose intakes. On the other hand, urban Blacks, who were generally better-off than their rural counterparts, had higher sucrose intakes than rural children, but had a very low prevalence of labial caries. This was a significantly lower prevalence than that found in both the White group ($p<0,001$) and their rural counterparts ($p<0,01$). The similarity of the prevalence of labial caries in rural Black and White infants and its absence in urban Black infants is made even more remarkable by the fact that only White infants were given fruit syrup concentrates. Furthermore, total bottle sucrose intakes were high in White and in Black urban, but low in Black rural groups. The amounts of vitamin syrups given by local clinic sisters were not assessed but, as noted in Part I, played little if any role in the Black rural group, because of poor or no attendance at well-baby clinics; in the case of the Black urban and White groups this may be otherwise. This would emphasise the marked labial caries differences between Black rural and urban groups.

CONCLUSIONS

This study has indicated that (i) prevalences of caries and rampant caries in the deciduous dentition of urban Black and urban White children appeared to be associated with total sucrose intake. Labial caries in all groups and particularly in Black rural children was not apparently associated with total mean daily sucrose intake; (ii) caries prevalences were not related to socio-economic level; in urban Blacks the better-off children had higher prevalences than the poorer; in White children poorer groups had the higher prevalences of caries, rampant caries and labial caries, but in Black rural children prevalences did not show a consistent pattern; and (iii) labial caries prevalence in rural Black children was as high as that of Whites, whereas Black urban infants surprisingly had no labial caries before 3 years of age.

Factors involved in dental caries in the deciduous dentition urgently need clarification. Does the deciduous dentition have a different caries pattern to that of the permanent dentition? Attention is drawn especially to the contradictory situation of a low sucrose intake and a high labial caries prevalence in Black rural children,

and an equally high prevalence in While children with their far higher sucrose consumption. As mean total sucrose intake is not the main cariogenic factor, frequencies of intake could perhaps provide a more definite lead. Sucrose intake patterns and particularly amounts derived from sources such as feeding bottles, soft drinks, fruit syrups, sweets and confectionery, are being analysed and will be reported elsewhere.

ACKNOWLEDGEMENTS

This study was supported by a grant from the South African Sugar Association.

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