Community-based survey versus sentinel site sampling in determining the nutritional status of rural children

Implications for nutritional surveillance and the development of nutritional programmes

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A study of the anthropometric status of under-5-year-olds was conducted in the Nqutu district of KwaZulu by means of a representative community-based sample and concurrent samples from primary health care clinics, preschools and primary schools.

The first objective of this exercise was to determine the extent of acute nutritional stress in the district as an indication of the appropriateness of food relief efforts in the region. The absence of wasting and the high prevalence of stunting (37,5%) in the community-based sample suggested that the main problem is chronic socio-economic underdevelopment, rather than a severe or immediate lack of food. The fact that fewer than 20% of households are in any way reliant on domestic production for their maize requirements explains why the recent drought has not had a greater impact on the nutritional status of this vulnerable group. This study confirms that the more recent emphasis of the National Nutrition and Social Development Programme on social development is appropriate.

An equally important objective of this study was to evaluate the usefulness of clinics, preschools and schools as sites for the collection of anthropometric data and the development of nutritional programmes. This preliminary attempt to develop the methodology for district-based nutrition surveillance suggested that all these sites have limitations both in respect of data collection and community access. The implications of using these sites and the developments needed to improve their usefulness in a future nutrition surveillance system are discussed.

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The nutritional status of black South African preschool children from rural and peri-urban communities has been assessed in numerous previous cross-sectional anthropometric surveys. In studies spanning the past 10 years and conducted in different social settings,[1-6] a consistent finding has been the presence of a high prevalence of height-for-age (HFA) deficits or stunting (25 - 47%), a significant but lower prevalence of weight-for-age (WFA) deficits (5 - 14%) and a low prevalence of weight-for-height (WFH) deficits or wasting (0,5 - 3,5%). Since young children are, for biological reasons, especially vulnerable to the effects of food insufficiency, nutritional status assessments in this age group provide a useful window on the wider community. This picture of high levels of stunting with only minimal evidence of wasting suggests that the main problem in these communities is chronic undernutrition. This is likely to be a result of long-standing dietary inadequacy reflecting socio-economic deprivation, rather than acute nutritional stress caused by severe food lack or serious illness.

In 1991, following the presentation of the annual budget in which a new value-added tax was announced, the South African government made R220 million available for a nationwide poverty relief programme. This programme, which rapidly took the form of a food aid programme, was thought to be a necessary step to support the 'poorest of the poor' at a time of severe economic recession and high unemployment. Anticipated crop failures as a result of a severe drought were expected to aggravate household food insecurity further.

From the programme's inception the absence of any readily available and up-to-date nutritional data made it difficult to confirm that recent socio-economic and climatic conditions had indeed resulted in acute nutritional stress, a usual precondition for emergency food relief. Even if an acute deterioration in nutritional status was assumed on the basis of prevailing conditions, the absence of a surveillance system designed to identify specific at-risk groups made targeted nutritional interventions impossible.

This in-depth study of the nutritional status of children in the Nqutu district was undertaken as part of a broader study to determine the presence of acute nutritional stress in Natal/KwaZulu, and was intended to inform the regional relief efforts of what is now known as the National Nutrition and Social Development Programme (NNSDP).

At the same time this study was seen as an opportunity to investigate some of the methodological issues involved in setting up a national nutritional surveillance system. In this regard there was special interest in answering the following questions: (*i*) does an assessment of nutritional status at different sentinel sites in a community (e.g. clinics, preschools, schools) vary significantly from that obtained from a cross-sectional survey in the same community? (*ii*) how do the sentinel sites differ from each other both as sites for data collection and in their potential for programme implementation? (*iii*) what are the implications of these differences for nutritional surveillance and programme development? and (*iv*) what would be the most appropriate anthropometric indicator of nutritional status in a proposed surveillance system?

Methods

The study was conducted over a 6-week period between 12 October and 27 November 1992.

Area of study

The Nqutu magisterial district, situated in the hilly inland zone of central KwaZulu, has an estimated population of 200 000 people. This district has been the site of at least 2 previous nutritional status assessments in children under the age of 5 years. The first, performed in 1974, showed that 39% of children were stunted and 27% were significantly underweight for age (UWFA).[7] A second survey in 1983, using WFH to determine whether a severe drought during the previous year had resulted in acute nutritional stress, found no evidence of wasting.[1]

Although no district is likely to be representative of the whole region, the presence within the Nqutu district of deep rural populations typical of a large number of central KwaZulu districts, together with fairly large formal and informal townships, suggests that the findings in this district will be applicable to populations in other parts of the region and possibly other homeland areas.

Cluster survey

Kok's modification[8] of the standard World Health Organisation cluster survey method[9,10] was used for the community-based survey. This method uses the class 1 primary school population rather than the total population, both as a basis for cluster selection and to define random starting points for each cluster. Pre-conditions for its use are a primary school attendance rate in the early classes of at least 70%, and the knowledge that a significant proportion of children are not attending schools outside the district. Both these conditions were considered to be fulfilled in the Nqutu district. A detailed description of this method is provided elsewhere.[11] Stratification into urban-rural subsamples required that the usual 30 x 7 cluster sample be increased to 40 x 7.

All clusters around the central market town of Nqutu and those in the large northern township of Mondlo were categorised as *urban*. The remaining clusters were regarded as rural and further classified as *rural* (*accessible*) when the starting point was reached from a road on the public transport route, and *rural* (*inaccessible*) when the starting point was from a road that was off the public transport route.

The following data were collected for each child between the ages of 6 months and 59 months: sex, date of birth, number of clinic attendances in the previous 12 months, weight, length and mid-upper-arm circumference (MUAC). Dates of birth and the details of clinic visits were classified as *documented* if present on a Road-to-Health card (RTHC), as *reported* if provided by the biological mother and as *doubtful* if neither of the above sources applied.

In each household respondents were asked to indicate what proportion of the maize eaten by household members had been grown at home, i.e. none, less than half, more than half, or all. This question was intended to measure the extent to which the population surveyed relied on subsistence agricultural production, and to identify groups at risk of nutritional stress as a direct result of the drought.

Sentinel site sampling

A representative sample of 140 children was obtained during the same 6-week period from each of the following sentinel sites, viz. primary health care (PHC) clinics, preschools and primary schools (class 1).

A list was compiled of all the existing fixed and mobile clinics, preschools or creches, and primary schools in the Nqutu district. In each category a cumulative total of attendances or enrolments, based on figures from the previous year (for schools) and previous quarter (for preschools and clinics), enabled a sampling interval to be calculated and a sample that was proportional to its size to be drawn from each site. On the day in question we selected the children required from each site by taking the first arrivals at clinics, and by using random number tables to select children from attendance lists in the case of preschools and schools.

As in the cluster survey, sex, date of birth and measurements of weight, length and MUAC were obtained from each child. Since the age ranges of children at the different sites were not known before the study, MUACs were measured on all children, but only analysed in those between the ages of 1 and 5 years. Dates of birth or ages were obtained and recorded at clinics in the same way as for the survey. At preschools and schools ages were obtained from the school registers. Although this information is said to be obtained from RTHCs or birth certificates, the reliability of these data was not specifically validated.

Anthropometric measurements

In the community-based survey the measurements were taken by 4 teams each comprising a senior PHC nurse, a staff nurse, a health assistant and a community health worker. Data collection in the field was preceded by a 1-day training workshop during which each team member performed multiple measurements under the supervision of the field work co-ordinator (C.A.G.), followed by a trial cluster in the community under full field conditions.

All the data from the sentinel sites were collected by the field work co-ordinator and a trained assistant.

Weights were measured to the nearest 0,1 kg with Salter hanging scales in the survey and at the clinics, and platform 'bathroom' scales at the preschools and primary schools. Scales were calibrated each morning against a known weight. Infants and toddlers were weighed unclothed and older children were weighed in underwear only. A portable plywood board, mounted on a right-angled base and fitted with a metal tape measure and sliding headboard, was used to measure recumbent length in children less than 2 years of age and the upright height of children 2 years or older. Standard technique was used and lengths recorded to the nearest 0,1 cm. Plastic tape measures were used to measure MUAC and these were also recorded to the nearest 0,1 cm.

Data analysis

Z-scores for the three anthropometric indices, viz. WFA, HFA and WFH, were calculated using Anthro[12] public domain software designed by the Centers for Disease Control. Z-scores are recommended by the WHO for monitoring groups of children for public health and research purposes.[13] Since Z-scores are comparable across ages and indices, a particular score reflects an equivalent deviation from the median for children of any age, in respect of HFA or WFH as well as WFA.[14]

The chi-square test was used for the comparison of anthropometric indices between the community-based sample and each of the sentinel site samples in turn. Pearson's correlation coefficient was calculated for the association between MUAC and WFH.

Results

The final sample size, gender breakdown and mean ages for the survey and each of the sentinel sites are shown in Table I. The larger preschool sample is explained by the fact that 2 unlisted preschools were discovered after data collection had already commenced, and rather than redraw the whole sample we simply added the extra preschools to the sample.

Table I. Sex and mean age by sampling site

Site	No.	Male No.	Male %	Female No.	Female %	Mean Age (SD) (months)
Survey	300	135	45,0	165	55,0	37,1 (22,0 - 52,2)
Clinic	138	66	47,8	72	52,2	14,0 (5,5 - 22,5)
Preschool	171	90	52,6	81	47,4	64,3 (53,3 - 75,3)
School	133	67	50,4	66	49,6	92,1 (77,3 - 106,9)
Total	742	358	48,2	384	51,8	47,9 (18,7 - 77,1)

A small number of children, for whom details of age or sex were not available or in whom anthropometric indices with significantly outlying Z-scores (greater than 6,0 or less than –6,0) were recorded, were excluded from all further calculations based on anthropometric indices. This explains the difference between the final sample sizes and those presented in the data analysis.

Table II. WFA by sampling site

Age (months)	Survey No.	Survey No Z-score < –2,0	Survey %	Clinics No.	Clinics No Z-score < –2,0	Clinics %	Preschools No.	Preschools No Z-score < –2,0	Preschools %	Schools No.	Schools No Z-score < –2,0	Schools %	Total No.	Total No Z-score < –2,0	Total %
6,0 - 11,99	1	0	0	62	6	9,7	0			0			63	6	9,5
12,0 - 23,99	67	7	10,5	58	11	18,9	0			0			125	18	14,4
24,0 - 47,99	138	10	7,3	13	2	15,4	8	0	0	0			159	12	47,6
48,0 - 71,99	85	5	5,9	0			95	12	12,6	3	0	0	183	17	9,3
72,0 - 95,99	0			0			38	5	13,2	83	16	19,3	122	21	17,2
≥ 96,0	0			0			0			37	10	27,0	37	10	27,0
Total	291	22	7,56	133	19	14,3	141	17	12,1	123	26	3,8	689	84	12,2
95% CI		(4,52; 10,60)			(8,28; 20,1)			(4,46;19,7)			(13,94; 28,34)			(9,75; 14,63)	
P-value					0,032			0,126			< 0,0001			0,001	

Table III. HFA by sampling site

Age (months)	Survey No.	Survey No Z-score < –2,0	Survey %	Clinics No.	Clinics No Z-score < –2,0	Clinics %	Preschools No.	Preschools No Z-score < –2,0	Preschools %	Schools No.	Schools No Z-score < –2,0	Schools %	Total No.	Total No Z-score < –2,0	Total %
6,0 - 11,99	1	0	0	62	5	8,1	0			0			63	5	7,9
12,0 - 23,99	67	27	40,3	58	17	29,3	0			0			125	44	35,2
24,0 - 47,99	138	48	34,8	13	2	15,4	8	2	25	0			159	52	32,7
48,0 - 71,99	85	32	37,7	0			95	13	13,7	3	0	0	183	45	24,6
72,0 - 95,99	0			0			38	11	28,9	83	17	20,5	122	29	23,8
≥ 96,0	0			0			0			37	12	32,4	37	12	32,4
Total	291	107	36,8	133	24	18,0	141	26	18,4	123	29	23,6	689	187	27,1
95% CI		(31,23; 42,31)			(12,06; 25,26)			(12,04; 24,84)			(16,08; 31,08)			(23,84; 30,44)	
P-value					< 0,0001			< 0,0001			0,009			< 0,0001	

Table IV. WFH by sampling site

Age (months)	Survey No.	Survey No Z-score < –2,0	Survey %	Clinics No.	Clinics No Z-score < –2,0	Clinics %	Preschools No.	Preschools No Z-score < –2,0	Preschools %	Schools No.	Schools No Z-score < –2,0	Schools %	Total No.	Total No Z-score < –2,0	Total %
6,0 - 11,99	1	0	0	62	2	3,2	0			0			63	2	3,2
12,0 - 23,99	67	0	0	58	1	1,7	0			0			125	1	0,8
24,0 - 47,99	138	0	0	13	0	0	8	0	0	0			159	0	0
48,0 - 71,99	85	0	0	0			95	9	9,5	3	0	0	183	9	4,9
72,0 - 95,99	0			0			38	2	5,3	83	7	8,4	122	9	7,4
≥ 96,0	0			0			0			37	2	5,4	37	2	5,4
Total	291	0	0	133	3	2,2	141	11	7,8	123	9	7,3	689	23	3,34
95% CI		(0; 0)			(0; 4,74)			(3,37; 12,23)			(2,72; 11,92)			(2,0; 4,68)	
P-value					0,031			< 0,0001			< 0,0001			< 0,0001	

In the community-based sample, dates of birth or ages were documented in 63,3% of children and obtained from mothers following a careful interview in a further 27,7% of cases. Only in the remaining 9% were ages considered doubtful. In the clinic sample 97,1% of dates of birth or ages were documented. Attendance at clinics in the previous 12 months, assessed in the community-based sample only, was either documented or reported by the mother in 87,7% of cases.

The percentage of children with Z-scores of less than –2,0 for WFA in the survey was compared with the corresponding percentage at clinics, schools and preschools. While clinics and preschools had a substantially higher percentage of children who were underweight than did the survey, it was only in the school children that this difference achieved significance (Table II). Similar comparisons in respect of other anthropometric indices showed a highly significant difference between the survey and each of the sentinel sites in the case of HFA (Table III) and, in the case of WFH (Table IV), a significant difference between the survey and schools and preschools.

The stratification of anthropometric status in the community-based sample into urban, rural accessible and rural inaccessible groups reveals very little difference in WFA deficits between these strata, but shows that there is a progressive increase in stunting rates from urban, to rural accessible, to rural inaccessible groups (Table V).

Table V. Anthropometric indices by urban or rural strata

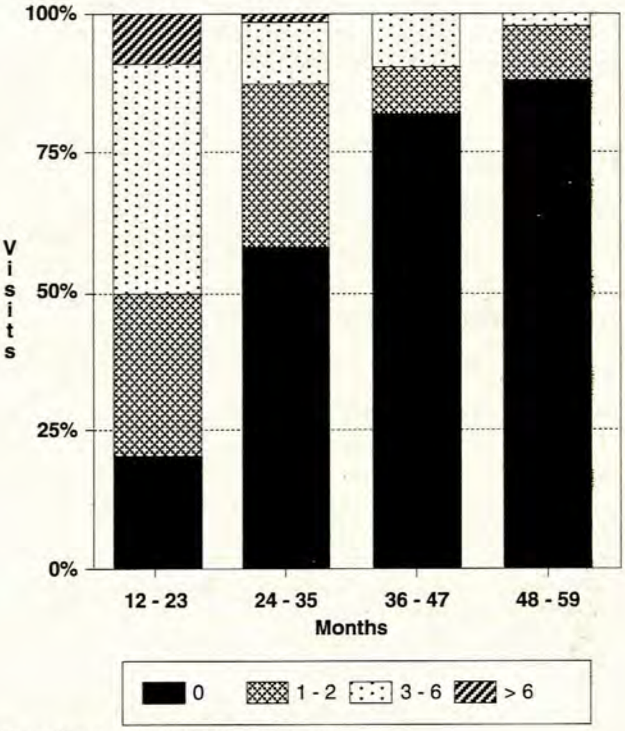
Anthropometric indices	Z-scores less than –2,0					
	Urban (*N* = 49)		Rural accessible (*N* = 182)		Rural inaccessible (*N* = 60)	
	No.	%	No.	%	No.	%
WFA	4	8,2	14	7,7	4	6,7
HFA	14	28,6	64	35,2	29	48,3
WFH	0	0	0	0	0	0

One hundred and sixty of 174 households sampled during the community-based survey provided information about domestic maize production and the proportion of maize from this source consumed by the household each year. Of households thus sampled, 81,2% were completely dependent on bought maize (Table VI).

Table VI. Household maize consumption

Proportion of maize that comes from domestic production	Households No.	%
None	130	81,2
< half	7	4,4
> half	20	12,5
All	3	1,9
Total	160	100

Clinic attendance in the 12 months preceding the survey was analysed by year of age from the community-based sample (Fig.1). This shows that 80% of children aged 12 - 23 months attended a PHC clinic on one or more occasions during this period but that there was a dramatic fall-off in attendance thereafter. When 3 or more visits were used as the cut-off point, only 50% of children in the 12 - 23-month group, 12% in the 24 - 35-month group, 10% in the 36 - 47-month group and 2% in the 48 - 59-month group were included.



Based on community-based survey

Fig. 1. Clinic visits in under-5s by year of age.

WFH was compared with MUAC in 353 children from the combined sample between the ages of 1 and 5 years (Fig. 2). A Pearson's correlation coefficient of 0,43 suggested only a moderate correlation between these two measurements of wasting. Although WFHs with Z-scores of <–2,0 µm and MUACs of <13,5 cm identified similar proportions of the sample (1,13% and 2,83%, respectively) as wasted, different children were identified with the two measures.

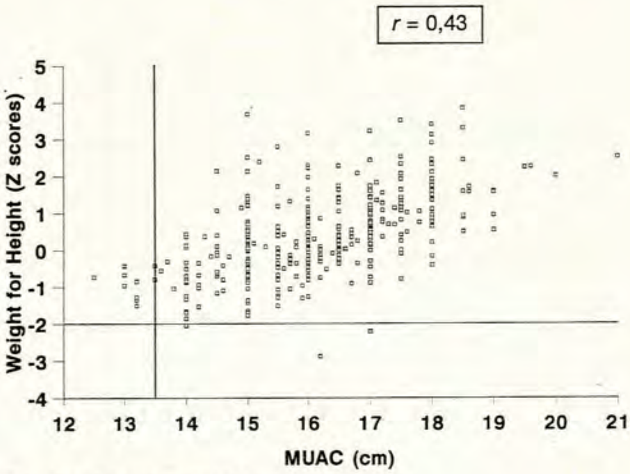


Fig. 2. WFH versus MUAC.

Discussion

This survey of nutritional status in black South African under-5s has again shown that, in spite of extreme socio-economic and climatic adversity, there is a relatively low prevalence of wasting and therefore little evidence of significant acute nutritional stress in this population. The main problem continues to be one of stunting which, at a level of 37,5%, suggests severe and long-standing socio-economic underdevelopment. Stunting rates were found to be significantly higher in rural than in urban children and this differential was particularly obvious in children from inaccessible rural areas. In the absence of wasting, the percentage of children who are underweight-for-age (UWFA) should be more or less equivalent to the percentage of children who are 'underheight'-for-age (UHFA).[15] The fact that much lower degrees of UWFA than UHFA have been recorded suggests that the children in the Nqutu district are relatively overweight for height. This picture, which has also emerged from many previous South African studies, has never been explained and requires further elucidation. It also has implications for the use of WFA as an indicator of nutritional status.

Wasting rates of 7,8% and 7,2%, respectively, have identified accessible groups for immediate nutritional support at preschools and schools. The reason for a higher wasting rate at these two sentinel sites than in the community-based survey or at clinics is not immediately clear.

The substantial differences in the anthropometric indices obtained in the community-based survey, compared with those obtained from each of the sentinel sites, confirm that sentinel site samples, for a number of possible reasons, are not truly representative and therefore of limited value in a one-off assessment of the nutritional status of a population.

A comparison of the mean ages of children sampled at each of the sentinel sites reveals that these sites capture children from very different age groups and that none of them has satisfactory access to children between the ages of 2 years and 4 years, when protein energy malnutrition is likely to be most prevalent. This disparity in age is one possible cause of the difference in anthropometric status between survey and sentinel site samples.

The fact that the people in this district are minimally reliant on domestic food production for their basic nutritional needs suggests that the recent drought is unlikely to have had a direct or rapid adverse effect on nutritional status. This may not be the case in districts where people are known to be more dependent on local food production; separate assessments are needed in those areas.

Nutritional surveillance is a system of routine data collection to monitor changes in nutritional indicators over time, to give warning of impending crises, to identify at-risk populations and to monitor the effectiveness or ineffectiveness of existing programmes and policies.[16] Different types of data may be used for these varied applications but the essential features are that the data are collected over time, as in repeated cross-sectional surveys or in regular reporting of clinic-based WFA data, and that the data collection and analysis are linked to decision-making.

Cross-sectional surveys have the advantage of producing carefully controlled and thus accurate data over a short period of time, but they are complex and expensive exercises, often cause disruption by taking staff away from other activities, are usually planned centrally and therefore deprive peripheral workers of the opportunity to evaluate their own work, and need to be repeated on a regular basis if they are to produce trend data.

Although sentinel site data are unlikely to provide the true prevalence of undernutrition in the community, this is less of a problem if a trend rather than an absolute prevalence is required. Since these data are collected continuously, arrangements can be made to report more or less frequently, thereby producing short-, medium- or long-term trends, depending on the needs of the programme. This focus on sentinel sites also offers a structural link between data collection and implementation by involving people working at the sentinel sites in the collection of data necessary for an informed programmatic response.

In view of the numerous benefits offered by sentinel site data for continuous monitoring, a more detailed comparison of different sentinel sites is required, both in terms of the accuracy with which they reflect the size and nature of the problem, and the access to nutritional and social development programmes that they provide for at-risk populations.

PHC clinics appear to be natural sites for both data collection and programme implementation and thus appropriate units at which to develop a nutritional surveillance system. These data can be used to generate trends simply by including the percentage of children who are below the defined cut-off point in the quarterly clinic statistical returns. Another, and perhaps more useful, alternative is for clinic staff to keep a separate RTHC or so-called master card, on which the indices of all children seen that month are plotted, to provide a graphic month-by-month comparison of the anthropometric status of all clinic attenders.

WFA assessments are already performed on all children as part of routine growth monitoring at clinics, and the staff are well versed in the relatively simple tasks of weighing and plotting. The high percentage of RTHC carriage in children attending clinics means that reliable ages are usually available. WFA is a composite measure of all tissues and therefore reflects both wasting and stunting. While rapid deterioration in WFA status over a short period invariably indicates wasting, a more gradual change over a longer period may indicate either stunting, wasting or a combination of the two, and it will be necessary to distinguish between these different processes if coherent interventions are to follow. It is suggested that the additional measurement of MUAC in all children aged 1 - 5 years at 6-monthly intervals will provide specific evidence of the extent of wasting and help to interpret the longer-term WFA trends. Although this study has only shown a moderate correlation between WFH and MUAC in individual children, the identification of similar proportions of children as wasted, by the two methods, justifies the use of MUAC as a broad intuitive measure of wasting and circumvents the more complex task of height measurement. This finding accords with several other studies and recommendations.[17,18]

Since stunting is a marker of chronic underdevelopment and poverty, improvements in HFA status will take many years. It is therefore suggested that HFA measurements not be included in a sentinel site surveillance system and that stunting be monitored in periodic community-based cross-sectional surveys.

A mean age of 15 months among clinic attenders and the demonstration in the community-based survey that there is a rapid fall-off in clinic attendance after the age of 2 years suggest that nutritional programmes based at the clinics are unlikely to reach most children over the age of 2 years. If the clinics are to function as sites for both nutritional surveillance and interventions, coverage of the under-5s in their catchment areas will need to be improved.

Although preschools should theoretically offer access to the 2 - 5-year age group, the finding in this study of a mean age of 64 months at preschools indicates that the preschools in the Nqutu district cater for a much older age group. Furthermore, the small number of preschools, their relatively small enrolments and their concentration in the more urbanised parts of the district suggest that they are particularly unrepresentative and provide limited coverage even within their narrow age band. The fact that dates of birth, transcribed from birth certificates and RTHCs, are available for most children from the preschool register, suggests that ages are accurate and that age-dependent anthropometric indices can therefore be used. The use of preschools as sites for nutritional surveillance and interventions will require the development of a more extensive network of preschools, the extension of their coverage to a younger age group, the formalisation of their relationship to the health sector and the assistance of personnel in their tasks of data collection and programme development.

Supplementary feeding programmes have been used elsewhere to develop a network of feeding points for preschool children in which mothers and other community members have been involved in the identification of at-risk children through simple anthropometric measurements, the feeding of children and the development of gardens around the feeding points.[19] Such an organisational structure could be used to develop a more permanent preschool network with the institutional capacity for long-term nutritional surveillance.

Primary schools offer a high coverage in the 6 - 8-year age group, a well-developed and well-distributed network of schools throughout the district, and the potential capacity to handle anthropometric surveillance and the supervision of nutritional programmes. Although ages are available from the school register, a spot check in a previous survey suggested that birth certificates and RTHCs on which these ages are based, had in many cases been obtained long after birth to satisfy school entry requirements.[20] There is therefore some doubt about the validity of age-dependent anthropometric indices in this group.

Primary schools share with the other sentinel sites an inability to access preschool children directly. School-based nutritional activities must either settle for surveillance and interventions confined to this captive population, e.g. school feeding or nutrition education programmes, or the use of school-based anthropometric trends as a proxy for the nutritional status in preschoolers, to launch an outreach initiative of some kind to under-5s. Experience from elsewhere[21] again suggests that primary schools may be successfully used in the screening of the community for nutritionally at-risk children and in bringing these children to their schools or other centres where nutritional programmes are being run — so-called 'child-to-child' programmes.

The recent movement of the State into the area of nutritional support and social development has highlighted the need for systematic data collection to guide this process and the necessity for data collection to be closely linked to programme implementation. Against this background this paper has attempted to explore the relative place of community-based surveys versus sentinel sites in the provision of informational support for these programmes.

The finding that there is little evidence of acute nutritional stress in the Nqutu district indicates that the recent shift in focus by the NNSDP from food aid to social development is not only appropriate in terms of its emphasis on the process of empowerment, but correctly identifies poverty, with its complex antecedents, as the target for its attention.

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