CHAPTER 4

ANTHROPOMETRIC STATUS

INTRODUCTION

Physical growth is regulated primarily by two factors, namely genetics and the environment[1,2]. In terms of the latter, the quantity and quality of food available are the main determinants of growth rate. In the health and related professions, anthropometry is generally used to determine the nutritional status of individuals and populations, and by implication the availability of proper food. The relative ease with which the weight and height of an individual can be determined and compared with those of a well nourished individual of similar sex and age, lends the technique of anthropometry to being widely used in the assessment of the nutritional status of individuals and populations. The technique is also useful in the prediction of morbidity and mortality, the assessment of the effects of poverty as well as in the monitoring and evaluation of intervention programmes.

Macronutrient components of foods like protein, carbohydrate and fat, which are the sole contributors to energy intake, are the principal determinants of growth rate. For this reason, the anthropometric determination of nutritional status is indicative mainly of the availability of protein and energy foods.

UNICEF has estimated that 190 million children younger than five years of age are chronically malnourished and are trapped early in life in a pattern of ill health and poor development[1]. In 1987, the United Nations sub-committee on nutrition and the World Health Organisation estimated that one-third to two-thirds of children in developing countries show some degree of growth retardation[2]. It is insufficiently appreciated that most of the excess infant mortality is due to hunger; even when the immediate cause of death is due to diarrhoea, pneumonia, measles or other infectious disease, death would have rarely occurred in a well nourished child.
Over the past two decades, a number of studies on preschool children have established the relatively high prevalence of protein-energy malnutrition (PEM) in preschool children[3,16] in the country. The percentages of under 5 year old children being underweight range from 21% in the Dias divisional council[6], 15% in Botshabelo[13] to 8% in rural South Africa[11].

Depending on its severity, the adverse effect of PEM on childhood mortality, impaired intellectual development as well as propensity to infections is well documented[17-26]. It is also widely accepted that PEM is associated with a number of micronutrient deficiencies of which vitamin A, iron and iodine are the most common, and the restitution of these micronutrients to normal levels has the most dramatic effects on general health improvement[2]. For these reasons, the anthropometric assessment of children was incorporated in this study.

METHODOLOGY

Age and Gender Determination

The date of birth was recorded from the Road to Health Card or birth certificate, wherever possible. Where this was not possible, respondent's recall was used. Gender was recorded.

Weight Determination

Using electronic scales, weight was determined on all the children. The average of two readings was used. The following method was employed:

- The scale was placed on an even, uncarpeted area and was leveled with the aid of its in-built spirit level.

- After the scale was switched on, the fieldworkers had to wait for the zero indication (0,0) as well as the stable indicator (o in the top left hand corner of the display panel) to appear.

- The children were weighed (preferably after emptying their bladders) and with the minimum of clothing:
    - diapers only for babies (dry only)
    - underclothes for older children.

- The child was placed on the scale, standing still and upright in the middle of the platform, facing the fieldworker, looking straight ahead with their feet flat and slightly apart until the reading was taken.

- After the reading was recorded in the space provided on the questionnaire, the child was removed from the scale. The weight was recorded to the nearest 100g.

- After the child stepped down from the scale, the fieldworkers had to wait for the zero reading to appear on the digital display before repeating the procedure once.

- The two readings could not vary by more than 100g. If they did, the scale had to be checked for accuracy and the procedure had to be repeated until the correct weight was obtained.

- When the child/baby was not able to stand alone on the scale, the following method was employed:
    - The first two steps above were followed.
    - The mother/caretaker was weighed first (without heavy clothing and shoes).
    - Then the zero/reset button was pressed and the fieldworkers had to wait for the zero reading (0,0) to appear on the digital display.

- The baby was then placed in the mother's arms and the reading taken and recorded.
- The mother and child were then taken off the scale, and when the zero reading appeared again on the display the procedure was repeated once.

Height Determination

Children younger than 2 years

The supine height in these children was determined by means of a measuring board, which was specially constructed for the survey.

- Two readings were taken and the measurement was repeated if the two readings varied by more than 0,5 cm.

- The measuring board was placed on an even, uncarpeted area.

- Care was taken to ensure that the measuring board was functional and the footboard had no undue loose movement.

- The child was placed on the measuring board lying on his/her back with the crown of the head touching the fixed headboard and the shoulders touching the base of the board. One fieldworker was needed to hold the child in this position.

- A second fieldworker ensured that the child's heels touched the board and the legs were straightened (knees not bent), before the footboard was slid against the soles of the child's heels. The measurement was taken on the inside of the footboard to the nearest 0,1 cm.

- The measurement was recorded in the space provided on the questionnaire and the procedure was repeated once.

Children 2 years of age and older

The standing height of these children was taken by means of a stadiometer. Two readings were taken and the measurement was repeated if the two readings varied by more than 0,5 cm.

- The stadiometer was placed on an even, uncarpeted area.

- The child's shoes were removed.

- The child was positioned as follows :

    - facing the fieldworker.

- shoulders relaxed, with shoulder blades, buttocks and heels touching the measuring board.
- arms relaxed at sides.
- legs straight and knees together; and
- feet flat, heels touching together.

- With the child looking straight ahead (Frankfurt plane), the headpiece was slid down until it touched the crown of the head.
- The reading was taken to the nearest 0,1cm.
- The measurement was recorded in the space provided on the questionnaire and repeated once.

Criteria Used for the Assessment of Anthropometric Status

The data were compared with those of the National Center of Health Statistics of the USA[27] using Epi Info version 6.02[28]. Ages were re-calculated as "biologic" ages, i.e. dividing the year into 12 equal segments. For each child, a z-score (i.e. the number of standard deviations (SDs) from the reference population median) was calculated for weight-for-height, weight-for-age and height-for-age. If the z-score for weight-for-age or height-for-age was less than -6SDs or greater than +6SDs, or if the z-score for weight-for-height was less than -4SDs or greater than +6SDs, then the record was first verified for accuracy of data entry. Where an error had occurred on data entry, this was corrected; where no error could be detected, the indicator with such an extreme z-score was set to missing and, therefore, excluded from the analysis. The number of records with such extreme z-scores was 293 for weight-for-height, 13 for weight-for-age and 291 for height-for-age.

For just under 10% of the sample, the age of the child was given rather than the date of birth. For half of these, the age in complete years was provided rather than years and months. In order to assess the effect of including this latter group in the analysis, the three anthropometric indicators were compared using all available results and then excluding this group. The results, when excluding and including this group were respectively: weight-for-height 2,6 and 2,7; weight-for-age 9,3 and 9,5; height-for-age 23,5 and 23,5. The good agreement of these results led to the decision to include all available data in the analysis.

RESULTS

At the national level, the average percentage of preschool children falling under -2SDs weight-for-height was 3%, whereas only 0,4% of the children were below -3SDs (Table 4.1). Free State, North West, Northern Province and Eastern Cape had the highest percentages of children under -2SDs weight-for-height, with the lowest figures in KwaZulu/Natal and Gauteng (Fig 4.1). These findings indicate that wasting is not a serious problem in preschool children in South Africa.

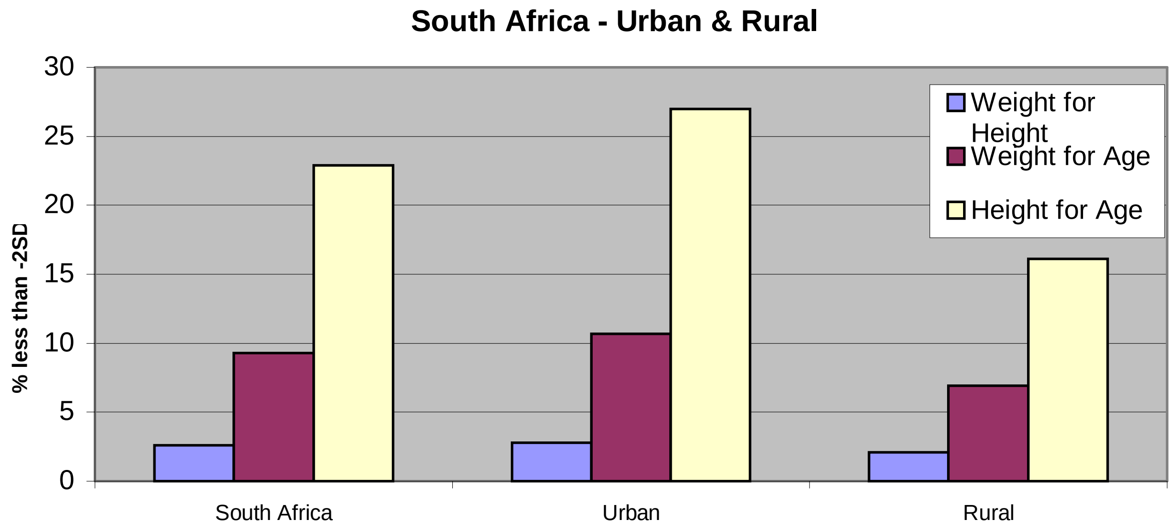
Northern Cape, Free State, North West, Northern Province and Eastern Cape had the highest percentages of children below -2SDs weight-for-age with Gauteng and KwaZulu/Natal having the lowest values (Table 4.1; Fig 4.1). The average value for South Africa was 9%. The percentage of children below -3SDs weight-for-age was 1%.

Table 4.1. Anthropemetric status by area of residence

Percentage of children aged 6 to 71 months who are classified as undernourished according to the anthropometric indices of nutritional status: weight-for-weight, weight-for-age and height for age, South Africa, 1994

	Northern Cape	Western Cape	Eastern Cape	KwaZulu Natal	Eastern Transvaal	Northern Province	Gauteng	North West	Free State	South Africa	Rural	Urban
Weight-for-height												
Number of children	925	930	1486	1256	1199	1379	823	1574	1347	10819	6062	4757
Percent < -2SD	2.5	1.3	3.2	0.7	1.7	3.8	1.2	4.5	4.5	2.6	2.8	2.1
95% confidence interval	1.2;3.8	0.6;2.1	2.1;4.4	0.2;1.2	0.9;2.4	2.9;4.7	0.4;2.0	3.3;5.7	2.7;6.3	2.2;2.9	2.3;3.4	1.5;2.7
Percent < -3SD	0.1	0.0	0.6	0.1	0.4	0.5	0.0	0.6	0.8	0.4	0.4	0.3
Weight-for-age												
Number of children	944	842	1540	1277	1277	1457	837	1644	1420	1238	6343	4895
Percent < -2SD	15.6	7.0	11.4	4.2	7.3	12.6	5.6	13.2	13.6	9.3	10.7	6.9
95% confidence interval	12.0;19.2	4.2;9.8	9.4;13.4	3.2;5.2	5.4;9.1	9.9;15.2	3.9;7.4	11.1;15.4	11.0;16.3	8.5;10.1	9.6;11.9	6.0;7.9
Percent < -3SD	1.1	0.7	2.2	0.2	1.0	2.6	0.6	1.6	2.4	1.4	1.8	0.8
Height-for-age												
Number of children	928	831	1502	1273	1195	1377	825	1586	1354	10871	6094	4777
Percent < -2SD	22.8	11.6	28.8	15.6	20.4	34.2	11.5	24.7	28.7	22.9	27.0	16.1
95% confidence interval	18.0;27.6	7.6;15.5	23.8;33.8	13.3;16.0	6.1;24.6	0.0;38.4	9.4;13.7	21.3;28.1	24.3;33.0	21.4;24.5	24.8;29.3	14.4;17.8
Percent < -3SD	5.9	2.3	8.4	3.5	6.0	12.6	2.2	7.1	8.6	6.6	8.4	3.8

Figure 4.1. Anthropometric status by area of residence



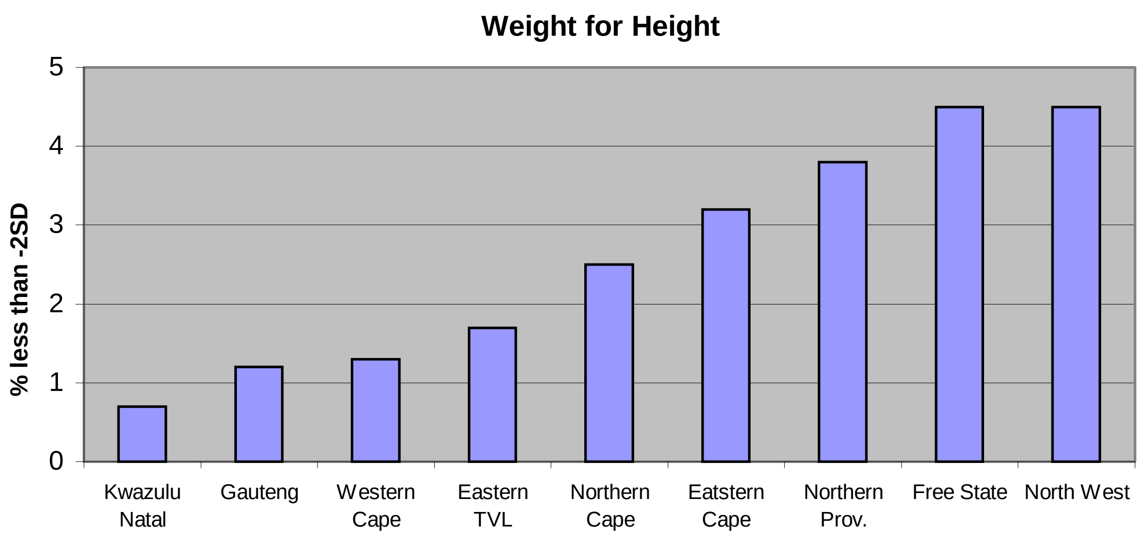
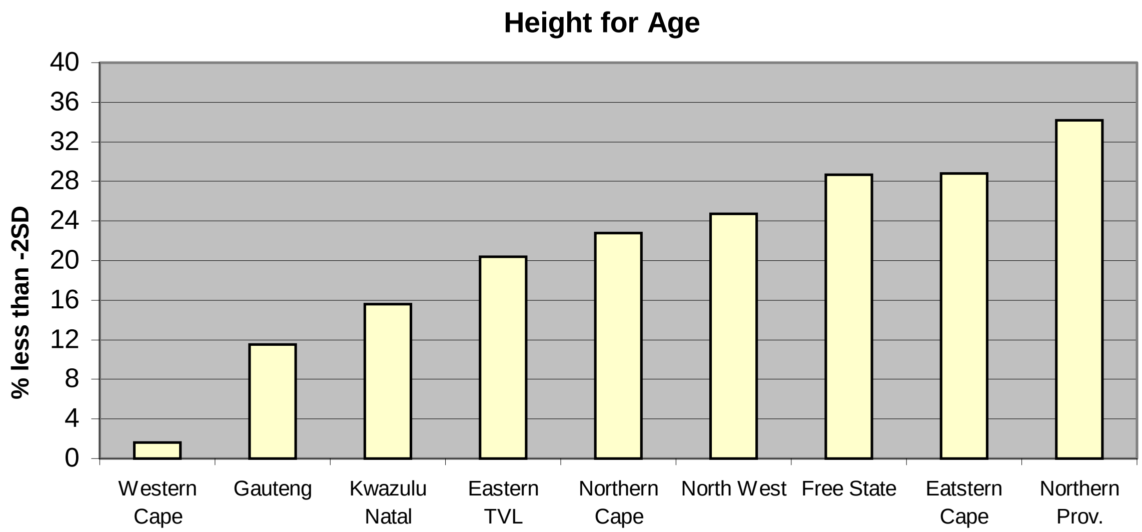


Figure 4.1. Anthropometric status by area of residence (continued)



In terms of a national average for height-for-age, 23% of children were under -2SDs indicating that stunting is a major problem in South Africa (Table 4.1). In the Northern Province 13% of the children were below -3SDs of the expected height-for-age, which is indicative of severe stunting (Fig. 4.1). The national average percentage for stunting (23%) is more than twice the value for being underweight (9%). Rural areas had a higher percentage of children below -2SDs weight-for-age (11%) than the urban areas (7%) (Table 4.1). A similar pattern was seen for height-for-age and, to a lesser extent, weight-for-height (Table 4.1; Fig. 4.1). These observations support previous findings that rural communities are nutritionally at a greater disadvantage than those in the urban areas. The percentages of children below -2 or -3SDs weight-for-height, weight-for-age and height-for-age did not vary significantly with age, except for the 6-11 month old children who had a lower prevalence for low weight-for-age and height-for-age (Table 4.2; Fig. 4.2).

Table 4.2. Anthropometric status by age group

Percentage of children aged 6 to 71 months who are classified as undernourished according to the anthropometric indices of nutritional status: weight-for-weight, weight-for-age and height for age, South Africa, 1994

	6-11 months	12-23 months	24-35 months	36-47 months	49-59 months	60-71 months
Weight-for-height						
Number of children	939	2027	2189	2142	1994	1528
Percent < -2SD	3.3	3.6	2.1	1.6	2.3	3.0
95% confidence interval	2.0;4.5	2.7;4.5	1.4;2.7	1.1;2.2	1.7;3.0	2.1;4.0
Percent < -3SD	0.3	0.6	0.4	0.3	0.1	0.5
Weight-for-age						
Number of children	1010	2129	2247	2198	2064	1590
Percent < -2SD	7.1	9.0	10.2	9.0	9.7	9.9
95% confidence interval	5.1;9.2	7.5;10.5	8.6;11.9	7.7;10.3	8.2;11.2	8.1;11.8
Percent < -3SD	1.2	1.7	1.8	1.0	1.2	1.5
Height-for-age						
Number of children	954	2048	2201	2144	1991	1533
Percent < -2SD	16.7	23.4	22.8	23.8	24.0	23.8
95% confidence interval	13.8;19.6	21.0;25.9	20.4;25.1	21.6;26.1	21.4;26.5	20.9;26.7
Percent < -3SD	4.0	6.8	6.7	7.2	6.7	7.3

Figure 4.2. Anthropometric status by age group

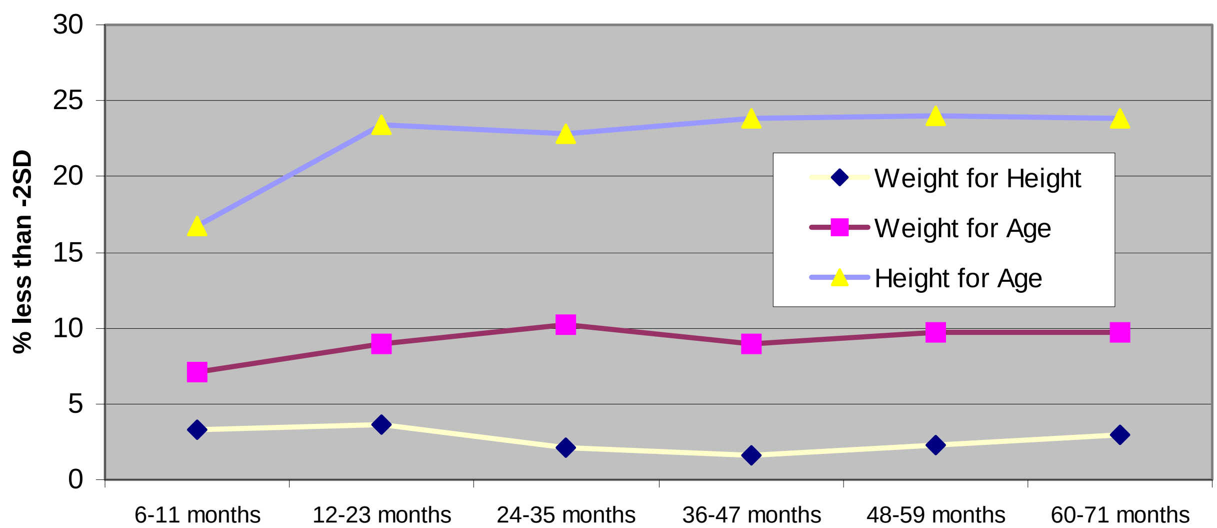
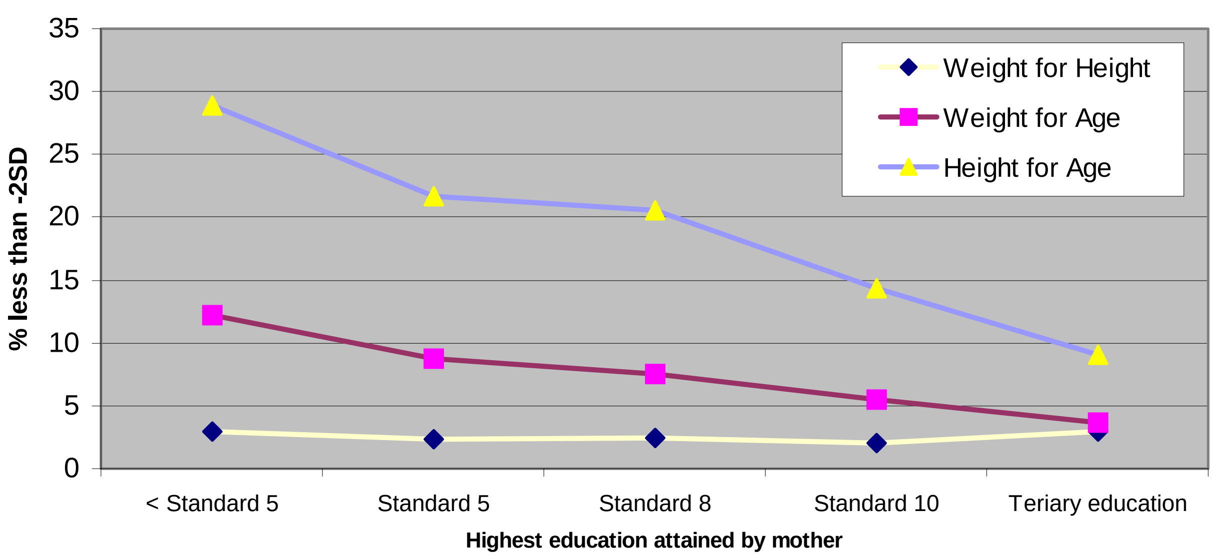


Table 4.2. Anthropometric status by socioeconomic factors

Percentage of children aged 6 to 71 months who are classified as undernourished according to the anthropometric indices of nutritional status: weight-for-weight, weight-for-age and height for age, South Africa, 1994

	Type of housing			Highest education attained by mother				
	Formal	Traditional	Informal	< Standard 5	Standard 5	Standard 8	Standard 10	Tertiary Education
Weight-for-height								
Number of children	6997	2335	1282	4133	2752	2061	1142	432
Percent < -2SD	2.5	2.5	3.1	3.0	2.3	2.4	2.0	3.0
95% confidence interval	2.1;3.0	1.8;3.2	1.9;4.3	2.4;3.5	1.6;3.1	1.6;3.1	1.1;2.8	1.1;5.0
Percent < -3SD	0.3	1.8	0.5	0.4	0.4	0.2	0.3	1.0
Weight-for-age								
Number of children	7240	2446	1332	4291	2854	2145	1186	454
Percent < -2SD	8.5	10.4	10.6	12.2	7.5	7.5	5.5	3.7
95% confidence interval	7.6;9.3	8.9;11.9	8.0;13.2	11.0;13.5	6.1;8.8	6.1;8.8	3.8;7.2	1.9;5.4
Percent < -3SD	1.1	1.8	2.2	1.8	1.3	1.1	1.4	1.0
Height-for-age								
Number of children	7012	2370	1279	4156	2760	2076	1144	434
Percent < -2SD	19.8	27.9	26.1	28.9	21.7	20.6	14.3	9.1
95% confidence interval	18.3;21.4	24.5;31.4	22.4;29.8	26.7;31.1	19.7;23.7	18.2;22.9	11.6;17.0	5.6;12.6
Percent < -3SD	5.6	8.3	7.4	8.9	5.9	5.5	4.2	1.4

Figure 4.3. Anthropometric status by maternal education



The prevalence of wasting was similar across all types of housing (Table 4.3) and levels of maternal education (Table 4.3; Fig. 4.3). However, the prevalence of being underweight tended to be higher in children living in informal housing and was the lowest for children whose mothers were well educated. Significantly though, the prevalence of stunting was the highest in children living in traditional or informal housing and had poorly educated mothers.

DISCUSSION

In the present study, anthropometrically, a low [(<5%)29] prevalence of wasting, a low [(<10%)29] prevalence of being underweight and a medium [(20,0-29,9%)29] prevalence of stunting have been documented at the national level.

Nutritional status, however, varied considerably between urban and rural populations and among provinces. The prevalence of wasting, although low [(<5%)29], varied from 0,7% in KwaZulu/Natal to 4% in North West and Free State; the prevalence of being underweight varied from a low [(<10%)29] of 4% in KwaZulu/Natal to a medium [(10,0-19,9)29] of 16% in Northern Cape, almost a fourfold difference. Similarly, there was almost a threefold difference in the prevalence of stunting between Gauteng (11%) and Northern Province (34%), the latter being a high [(30,0-39,9%)29] prevalence. Previous studies[6,13] of preschool children have reported a prevalence of 16% and 29% for underweight and stunting, respectively, compared to 11% and 29% in this study; furthermore, in the Free State the previously reported prevalence of 15% underweight and of 36% stunting in preschool children is also similar to the present findings (14% and 29% respectively). Furthermore, the study by the Regional Health Organisation of Southern Africa (RHOSA) on rural children reported a prevalence of 8% underweight and of 25% stunting in preschool children[11]. These values are in reasonable agreement with the average values of 9% underweight and of 23% stunting found in the present study. The present findings, therefore, indicate that malnutrition continues to be a significant problem in the country, especially in the rural areas.

In 1994, a national study in children starting school involving 364 magisterial districts, 3 347 primary schools and 97 790 children, 9,0% of children were underweight and 13% stunted[30]. The study included 12% of children who were younger than 6 years of age, 30% between 6 and 7 years and 31% between 7 and 8 years of age; these age groups partly overlap with those of the present study. The prevalence of being underweight or wasted in both studies (< -2SDs) is very similar (9% underweight and 3% wasted in this present study vs 9% and 3% respectively), whereas the prevalence of stunting (< -2SDs) is almost double in the present study (23% vs 13% in the school survey). Within the obvious time and age group limitations of such a comparison, it would appear that the prevalence of malnutrition in the country continues to be unacceptably high and is indeed a cause of grave concern. Although the very young (6-11 months) appear to be less severely affected by stunting than the older children (>12 months), nevertheless, of equally grave concern, is the increase (Table 4.2) in the prevalence of being stunted with age, a finding that has important implications in terms of formulating and implementing intervention programmes.

Table 4.4. Comparison of PEM of some countries in Africa, South America and Asia[1]

	GNP per capita (US$ 1991)	Percent Underweight (0-4 years)	Percent stunting (2-5 years)		GNP per capita (US$ 1991)	Percent Underweight (0-4 years)	Percent stunting (2-5 years)
Tanzania	100	29	58	Nicaragua	460	11	22
Ethiopia	120	48	63	Lesotho	560	16	23
Uganda	170	23	51	Egypt	610	10	32
Bhutan	180	38	56	Bolivia	650	13	51
Burundi	210	38	60	Zimbabwe	650	12	31
Bangladesh	220	66	65	Guatemala	930	34	68
Malawi	230	27	62	El Salvador	1080	15	36
India	330	63	65	Namibia	1460	26	28
Nigeria	340	36	54	Botswana	2530	15	-
Pakistan	400	40	60	**South Africa**	**2560**	**9**	**23**
Ghana	400	27	39	Brazil	2940	7	16
Zambia	420	25	47				

In comparative terms (Table 4.4)1, preschool South African children appear to have a more favourable nutritional status than children elsewhere in Africa, Central and South America and in the Indian peninsula. However, although the average South African prevalence of anthropometric indices appears favourable, it is certainly no cause for complacency; it is indeed a cause of grave concern and it calls for immediate action, especially in those areas where the prevalence of stunting exceeds 20%, i.e. in six of the nine provinces. The latter, together with the presence of deficiencies of vitamin A, iron (and possibly iodine), represents a very considerable risk of infection, morbidity and mortality in the population studied. As such, the improvement of the nutritional status and health care services for preschool children should undoubtedly be seen as a national priority and afforded the full benefits of the government's Reconstruction and Development Programme.

The prevalence of stunting is known to reflect socioeconomic standards. It is also known that the most adverse impact of undernutrition on the growth of children occurs in the 6-24 month old age group[31,32]. The prevalence of stunting can be significantly reduced, but by no means eliminated[33-36], with improvements in socioeconomic conditions and better and more accessible health care facilities. This suggests that the country is likely to be faced with the problem of stunting for some significant number of years in the future; as such, appropriate intervention programmes are clearly needed to address this problem on an urgent basis. In this regard, socioeconomic development is of paramount importance[31-36]; improvement of nutritional status is also significantly, if not equally, important[37,38]. Importantly though, food supplementation schemes are most likely to have maximal benefit, in terms of reversing stunting, when they are provided during the period of maximum growth deficits, namely to the very young children; for instance, each 100

Kcal/day in supplementary feeding during the first year of life is reported to be associated with approximately 9 mm in additional length gain as compared with 5 mm, 4 mm and no impact of linear growth at all when the same supplement is given during the second, third or fourth year of life, respectively[37]. Similarly[38], in a more severely malnourished population, each 170 Kcal/day supplementary feeding is associated with an additional growth of 2,8, 1,7 and 1,1 cm in 1-2, 2-4 and 4-5 year old children, respectively.

It is insufficiently appreciated that the composition of the supplementary foods is as important as providing such foods[39]. Although adequate energy intake is important, its role is often overemphasised[40]; indeed, neither energy nor any of the known nutrients, on their own, have been shown to affect linear growth consistently[20]. Within the context of developing countries, it is generally accepted that an inadequate energy intake is likely to be associated with inadequate intake of other nutrients, especially micronutrients, as well as with poor dietary quality[39]. Recent evidence from a multinational (Mexico, Kenya and Egypt) longitudinal study[20] indicates that although stunting occurred soon after birth in all three countries, as it has also been shown to be the case in the present study, energy deficiency was a problem only in Kenya; all three populations studied, however, had poor dietary quality and multiple micronutrient deficiencies. The inclusion of those micronutrients known, in the case of deficiency, to adversely affect linear growth, therefore, should be included in any supplementary foods.

RECOMMENDATIONS

The findings of the present national study indicate that one in ten of all preschool children is underweight and almost one in four is stunted. This translates into approximately 660 000 preschool children being identifiably malnourished and 1 520 000 being stunted because of long-term malnutrition.

SAVACG offers its assistance in the implementation of those recommendations for which it has the relevant expertise and infrastructure. In terms of the recommendations made in this chapter, SAVACG can assist with recommendations 4.1.1, 4.1.3, 4.1.4, 4.2.3, 4.2.5, 4.2.6 and 4.2.7.

4.1 Short-term

4.1.1 Stunting should be addressed within the proposed framework of the Nutrition Committee[41] regarding an integrated nutrition strategy for South Africa which must be compatible with the ethos and principles of the government's Reconstruction and Development Programme for socioeconomic upliftment. Essentially, the strategy includes:

- i) health facility-based nutrition programmes,
- ii) community-based nutrition programmes,
- iii) nutrition promotion, communication and advocacy,
- iv) national nutrition surveillance for growth monitoring,
- v) legislation, policy and regulations to improve nutrition, and
- vi) human resource development. These aspects will not, therefore, be repeated or expanded upon in the rest of the report.

4.1.2 The findings of the present study clearly identify the preschool child, especially the very young (< 2 years of age), as a prime target group for nutritional intervention, and the mother for nutrition education. At present, both these aims should be concurrently achieved within the existing health facility-based and community-based nutrition programmes.

4.1.3 The supplementary foods that are currently, or will be, provided should not simply concentrate on energy content but also on dietary quality and micronutrient composition.

4.1.4 All children with anthropometric parameters that fall below -2SDs should be targeted.

4.2 Medium- and Long-term

4.2.1 In the longer-term, the provision of supplementary foods is seen as an interim measure. The need for continued supplementary feeding must be weighed against socioeconomic development. As the latter increases, the former should be phased out.

4.2.2 Due consideration should be given to creating creche facilities within the community and at the work place, especially in provinces with a high prevalence of stunting and in disadvantaged communities within provinces which have a high prevalence. Income generating activities could be linked to these structures.

4.2.3 Similarly, health facility-based rehabilitation centers should be established for the intensive treatment, supervision and follow-up of severely malnourished children. The mothers of malnourished children, apart from being educated, can also concurrently engage in income generating activities.

4.2.4 The financial aspects of recommendations 4.2.2 and 4.2.3 should be interpreted and viewed in the light of the current budget for and cost-effectiveness of the Primary School Nutrition Programme.

4.2.5 The Directorate of Nutrition should enable both universities and research organisations to conduct research on the monitoring and evaluation of any such schemes that are implemented. In this regard, particular attention should be given to the long-term benefits afforded to children by such schemes.

4.2.6 The Directorate of Nutrition should establish a Consultative Group, such as SAVACG, specifically mandated to monitor growth as well as the prevention, identification and treatment of malnutrition.

4.2.7 An anthropometric assessment of preschool children should be repeated in three years with a view to assessing progress achieved.

REFERENCES

1. Grant JP. The state of the world's children 1994. UNICEF Oxford University Press. Panel 5: 16-19. 1994.

2. Scrimshaw NS. The challenge of global malnutrition to the food industry. Food Technol. February 1993; 60-71.

3. Richardson BP. Growth patterns of South African children: An overview. S Afr J Sci. 1978; 74: 246-249.

4. Margo G, Baroni Y, Wells G, et al. Protein energy malnutrition and nutritional anaemia in preschool children in rural KwaZulu. S Afr Med J. 1978; 53: 21-26.

5. Wyndham CH. Impact of nutritional deficiency on mortality in children age 0-4 years in South Africa. S Afr Med J. 1983; 79: 218-221.

6. Krynauw JD, Fincham RJ, Kotze JP. An anthropometric survey of the nutritional status of black preschool children in the Dias Divisional Council area. S Afr Med J. 1983; 64: 1095-1098.

7. Lazarus T, Bhana K. Protein-energy malnutrition and associated variables among Indian preschool children in a selected area of Natal. S Afr Med J. 1984; 65: 381-384.

8. IJsselmuiden CB. Nutritional status of children under the age of 5 years in northern Gazankulu. S Afr Med J. 1984; 65: 346-347.

9. Van der Westhuizen J. Biochemical evaluation of black preschool children in Northern Transvaal. S Afr Med J. 1986; 70: 146-148.

10. Hugo-Hamman CT, Kibel MA, Michie CA. Preschool children in a Cape Town township. S Afr Med J. 1987; 72: 353-355.

11. Department of Health. First RHOSA nutrition study. Anthropometric assessment of nutritional status of black under fives in rural RSA. Epidem. Comments. 1987; 14: 1-37.

12. Jacobs M, Joubert G, Hoffman M. Anthropometric assessment of children in Mamre. S Afr Med J. 1988; 74: 341-343.

13. Kotze JP, De Hoop ME, Van Middelkoop A, Van Der Walt E. Voedingstatusopname van voorskoolse swart kinders in Botshabelo. Food Review. Febr/March, 1988; 87-89.

14. Le Roux IM, Le Roux PJ. Survey of the health and nutrition status of a squatter community in Khayelitsha. S Afr Med J. 1991; 79: 500-503.

15. Ramphele MA, Heap M, Trollip DK. Health status of hostel dwellers. Part III. Nutritional Status of children 0-5 years. S Afr Med J. 1991; 79: 7605-7609.

16. Byarugaba J. The impact of urbanisation on the health of black preschool children in the Umtata district, Transkei, 1990. S Afr Med J. 1991; 79: 444-448.

17. Kielman AA, McCord C. Weight for age as an index of risk of death in children. Lancet. 1978; i: 1247-1254.

18. Chen LC, Chowdhury A, Huffman SL. Anthropometric assessment of energy-protein malnutrition and subsequent risk of mortality among preschool aged children. Am J Clin Nutr. 1980; 33: 1836-1845.

19. Keywood P. The functional significance of malnutrition: growth and prospective risk of death in the highlands of Papua New Guinea. J Food Nutr. 1982; 39: 13-19.

20. Allen LH. The Nutrition CRSP: What is marginal malnutrition, and does it affect human function? Nutr Rev. 1993; 51: 255-267.

21. Pelletier DL, Frongillo EA, Habicht JP. Epidemiologic evidence for a potentiating effect of malnutrition on child mortality. Am J Public Health. 1993; 33: 1130-1133.

22. Stoch MB. Effect of undernutrition during infancy on subsequent brain growth and intellectual development. S Afr Med J. 1967; 41: 1027-1030.

23. Dobbing J. Infant nutrition and later achievement. Nutr Rev. 1984; 42: 1-7.

24. Monckeberg F, Tisler S, Tono S, et al. Malnutrition and mental development. Am J Clin Nutr. 1972; 25: 773-779.

25. Wagstaff L, Reinach SG, Richardson BD, et al. Anthropometrically determined nutritional status and the school performance of black urban primary school children. Hum Nutr Clin Nutr. 1987; 41(C): 227-286.

26. Van Rensburg CF, Booysens J, Gatheran P, et al. The relationship between scholastic progress and nutritional status. Part I. A study of 488 school beginners. S Afr Med J. 1977; 52: 644-649.

27. National Center for Health Statistics. NCHS Growth curves for children. Birth - 18 years. US Department of Health , Education and Welfare. Public Health Services. Hyattsville Med. DHEW Publication No (PHS) 78-1650. 1977.

28. Dean AG, Dean JA, Coulombier D, et al. Epi Info, Version 6: a word processing, database, and statistics program for epidemiology on microcomputers. Centre for Disease Control and Prevention. Atlanta, Georgia. USA. 1994.

29. Gorstein J, Sullivan R, Yip M, et al. Issues in the assessment of nutritional status using anthropometry. Bull WHO. 1994; 72: 273-283.

30. Kotze JP, De Hoop ME, Taljaard CF. Anthropometric survey in primary schools in the RSA. Department of Health. Pretoria. 1994.

31. Karlberg J, Jalil F, Lindblad BS. Longitudinal analysis of infantile growth in an urban area of Lahore, Pakistan. Acta Paediatr Scand. 1988; 77: 392-401.

32. Jalil F, Karlberg J, Hanson LA, Lindblad BS. Growth disturbances in an urban area in Lahore, Pakistan related to feeding patterns, infections and age, sex, socioeconomic factors and seasons. Acta Paediatr Scand. 1989; suppl 350: 44-54.

33. Zheng BJ, Lo SKF, Tam JS, et al. Prospective study of community-acquired rotavirus infection. J Clin Microbiol. 1989; 27: 2083-2090.

34. Zheng BJ, Tam SL, Lam BCC, et al. The effect of maternal antibodies on neonatal rotavirus infection. J Paediatr Infect Dis. 1991; 10: 865-868.

35. Tam JSL, Zheng BJ, Yeung CY, et al. Distinct populations of rotaviruses circulating among neonates and older infants. J Clin Microbiol. 1990; 28: 1033-1038.

36. Lam BCC, Tam J, Ng MH, et al. The protective role of neonatal rotavirus infection: A prospective longitudinal study. Hong Kong J Paediatr. 1992; 9: 166-171.

37. Schroeder DG, Martorell R, Rivera J, et al. Age differences in the impact of nutritional supplementation on growth. J Nutr. 1995; 125: 1051S-1059S.

38. Gopalan G, Swaminathan VK, Krisma Kumari VK, et al. Effect of calorie supplementation on growth of undernourished children. Am J Clin Nutr. 1973; 26: 563-566.

39. Allen LH, Black AK, Backstrand JR, et al. An analytical approach for exploring the importance of dietary quality versus quantity in the growth of Mexican children. Food Nutr Bull. 1991; 13: 95-104.

40. Lampl M, Johnson FE, Malcolm MA. The effects of protein supplementation on the growth and skeletal maturation of New Guinean school children. Ann Hum Biol. 1978; 5: 217-219.

41. Report of the Nutrition Committee to the Minister of Health: An integrated nutrition strategy for South Africa. Department of Health. Pretoria. 1994.