Growth, feeding practices and infections in black infants

S D Delport, P J Becker, A Bergh

Objective. To investigate the growth, early feeding practices and prevalence of infections in black infants.

Design. Longitudinal study with prospective documentation of data.

Setting. Kalafong Hospital, Pretoria.

Patients. Term, appropriately grown infants with a positive rapid plasma reagin test on cord blood were enrolled. Infants who on follow-up did not have congenital syphilis were studied.

Results. At birth the mean weight-for-age Z-scores corresponded with those of the National Center of Health Statistics (NCHS) reference population and increased during the first 3 months. A fall-off in growth performance in respect of weight gain occurred from 3 months and continued until 15 months when the study was terminated. At 6 and 12 months, 86% and 81% of infants respectively were receiving breast-milk. By 3 months, 78% of infants were receiving a supplementary food. At 9 months, 40% of infants had experienced an infection during the preceding 3 months. During the study, upper airway infections comprised 74% of all episodes of infection.

Conclusions. Compared with the NCHS reference population, black infants grow adequately during the first 3 months of life. This is followed by a persistent fall-off in growth performance associated with the introduction of supplementary food.

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The first year of life remains a child's most vulnerable period for disease and death. This is borne out by the high morbidity and mortality rates in infants from developing countries. Malnutrition is a major determinant of the risk of mortality in these infants.[1-3] The second 6 months of life, in particular, carry a great risk of growth faltering and malnutrition.[1] During this time infections may be more common because of a decline in breast-milk intake and the possibly inadequate nutritional value of weaning foods.[1] The nutritional risk of infants is also influenced by unfavourable social and economic factors and the unavailability of nutritional support should growth faltering occur.[4]

Previously, weight anthropometry had shown that a progressive decline in weight gain takes place between 2 and 6 months in infants from developing countries, compared with their counterparts from a developed country such as the UK.[4] A subsequent study showed that the growth of infants from a developing country is qualitatively similar to that of British breast-fed infants.[5] It would seem that growth during the first 6 months of life is influenced by the predominant feeding practice, i.e. formula or breast-milk, and conclusions about growth patterns of these infants are in turn determined by the growth standard used.[5] These variables may result in uncertainty about what constitutes normal growth during infancy, particularly in infants from developing countries.[5] The growth standard of the National Center of Health Statistics (NCHS)[6] has been recommended for use by the World Health Organisation[7] and is the most widely used growth standard in industrialised and developing countries. The NCHS standard may not be suitable to monitor growth in infants because, during the construction of the growth curves, little emphasis was placed on growth during infancy.[6] Prospective measurements on infants were only made at 3-month intervals and the mode of feeding was analysed in only 75% of these infants.[6] The NCHS standard is commonly used to evaluate growth in indigent South African infants because a growth standard using this population as the reference population is not available. The aim of this study was to investigate on a prospective and longitudinal basis the growth and early feeding practices of and the incidence of infections in a group of indigent infants.

Patients and methods

Term, healthy, appropriately grown infants were enrolled over a 1-year period. They were born in hospital and recruited on the first postnatal day because of a positive rapid plasma reagin (RPR) test on cord blood. At the time when the study under discussion was initiated, cord blood was being screened routinely for reagin reactivity using the RPR test. A positive test led to the identification of the corresponding mother-infant pair on whom detailed serological tests for syphilis (STS) were then carried out using the RPR test, the treponema pallidum haemagglutination (TPHA) test and the fluorescent treponemal antibody-absorption (FTA-ABS) test. Asymptomatic, term, appropriately grown infants of mothers with a positive STS and in whom congenital syphilis could not be diagnosed because of equivocal STS, did not receive treatment and were followed up clinically and serologically at 1 month of age and at 3-month intervals until 15 months of age. Of these, a group of uninfected infants was studied. At birth all had positive TPHA and FTA-ABS tests but negative FTA-ABS IgM tests and their RPR titres were either negative (32) or lower (90) than the maternal titres. Infants in the latter group had a consistently decreasing RPR titre on follow-up, indicative of passively acquired immunity. A further 23 mother-infant pairs, who had false-positive RPR

Department of Paediatrics, Kalafong Hospital and University of Pretoria

S D Delport, MB ChB, MMed, MPharm Med, PhD

Centre for Epidemiological Research in Southern Africa, Medical Research Council, Pretoria

P J Becker, PhD (Present address: Bureau for Management Information, University of South Africa)

Faculty of Education, University of South Africa

A Bergh, BA Hons, BEd, PhD, SED

tests on cord blood because their subsequent RPR, TPHA and FTA-ABS tests were negative, were also enrolled.

At each follow-up visit the anthropometric measurements of the infants were conducted by one investigator (S D D). These included the weight, length and head circumference. The weights of the infants were measured with a scale that weighed them in increments of 20 g while they were naked. Length was measured in a recumbent position by means of an infant measuring board with a fixed headboard and a movable footboard. The head circumference was measured with a non-stretch tape. Measurements of weight, length and head circumference were converted to weight-for-age (WA), length-for-age (LA), weight-for-length (WL) and head circumference-for-age (HCA) Z-score values based on the NCHS growth standard and using the Epi-Info programme (Version 6, CDC, Atlanta, USA).

At each visit a structured questionnaire was administered to the mother. Closed and open-ended questions were used to enquire about the type of milk feed (breast-milk or formula), infections and the introduction of weaning foods during the period preceding the follow-up visit. The age when breast-feeding was completely stopped was recorded. A qualitative dietary evaluation was performed to assess intake of porridge, vegetables and protein-rich food. The latter was defined as food that provided a good source of protein, such as meat or eggs. The age at which the intake of supplementary food was commenced and the frequency per week of intake of protein-rich food were documented. Portion size of the supplementary food was not established and dietary calculations were not performed. It is possible that some mothers exaggerated the intake of protein-rich food. Mothers were asked about intercurrent infections in the infants during the period preceding the follow-up visit. The nature of the infection was determined from the symptoms observed by the mother. Only infections treated by health professionals were documented.

Results

One hundred and forty-five infants were enrolled over a 1-year period. Most were from urban or rural economically disadvantaged communities. One hundred and fifteen were from an urban environment to the east and west of Pretoria and 30 were from a rural setting. Thirty-three infants were lost to follow-up after initial enrolment, 15 of whom were from a rural setting. Forty-eight infants were followed up partially and were lost before 15 months elapsed. Seventy-four infants were followed up for the required 15 months. One hundred and twelve infants returned at 1 month, 96 at 3 months, 89 at 6 months, 85 at 9 months, 79 at 12 months and 74 at 15 months.

Feeding practices

Milk intake

Data related to milk intake are summarised in Table I. Breast-feeding was initiated by all mothers during the postpartum period. At 1 month, 106 of 112 infants were breast-fed, 4 received formula and 2 received formula and breast-milk. At 3 months, even though the prevalence of breast-feeding was lower, 90% of infants were still receiving breast-milk. This prevalence remained virtually unchanged until 6 months and then dropped to 81% at 9 months. At 12 months and 15 months 81% of infants were still receiving breast-milk. The prevalence of formula feeding was 4% at 1 month, increasing to 14% at 12 months and decreasing to 11% at 15 months. The prevalence of breast-feeding and formula feeding combined was less than 4% at all ages.

Table I. Milk intake

Age (mo.)	Breast-milk	Formula	Breast-milk and formula	No milk
1 (N = 112)	106	4	2	0
3 (N = 96)	86	8	2	0
6 (N = 89)	83	3	3	0
9 (N = 85)	69	12	1	3
12 (N = 79)	64	12	1	2
15 (N = 74)	59	8	2	5

Supplementary food

Exclusive breast-feeding. Breast-feeding was defined as exclusive when no additional food or milk was offered. However, the possibility that some infants received water or other herbal mixtures in addition to breast-milk was not established. At 1 month 98 of 106 infants were exclusively breast-fed. The remaining 8 infants were receiving porridge in addition to breast-milk. By 3 months only 30 of 86 infants and by 6 months only 6 of 83 infants were exclusively breast-fed.

Porridge. The preferred porridge at all ages was soft maize-meal porridge. At 1 month of age 8 of 112 infants were already receiving porridge; this figure increased to 66 of 96 infants at 3 months and 88 of 89 infants at 6 months (Table II).

Table II. Supplementary food porridge

Age (mo.)	Maize meal	Cereal	None
1 (N = 112)	5	3	104
3 (N = 96)	60	6	30
6 (N = 89)	81	7	1
9 (N = 85)	82	3	0
12 (N = 79)	77	2	0
15 (N = 74)	72	2	0

Vegetables and protein-rich food. During the first month no infant received a supplementary food other than porridge. By 3 months, 4 of 98 infants were receiving vegetables and 1 was receiving eggs. By 6 months 24 of 93 infants and by 9 months 45 of 84 infants were receiving a protein-rich food in the form of eggs or meat (Table III). By 15 months, 67 of 73 infants were receiving a protein-rich food (Table III). At 6 months 25% of the infants who were receiving a protein-rich food were receiving it on a daily basis and this figure remained unchanged for the duration of the study period.

Table III. Supplementary food — protein-rich

	Meat/eggs	
Age (mo.)	Yes	No
1 (*N* = 112)	0	112
3 (*N* = 96)	1	95
6 (*N* = 89)	24	65
9 (*N* = 85)	45	40
12 (*N* = 79)	53	26
15 (*N* = 74)	67	7

Infections

The number of infants who experienced infections at various ages are shown in Table IV. Infections were rare during the first month of life, with 3 of 112 infants having experienced an infection. The number of infants experiencing an infection increased progressively from 14 of 96 infants at 3 months to 32 of 85 infants at 9 months. At 12 and 15 months 20 of 79 infants and 20 of 74 infants respectively had experienced infections.

Table IV. Infections

	Infections	
Age (mo.)	Yes	No
1 (*N* = 112)	3	109
3 (*N* = 96)	14	82
6 (*N* = 89)	24	65
9 (*N* = 85)	32	53
12 (*N* = 79)	20	59
15 (*N* = 74)	20	54

Fig. 1 depicts the nature of the infection documented for the group as a whole during the study period. Of 113 occurrences of infection, the majority were upper respiratory infections. Diarrhoeal disease was the second most common infection but occurred infrequently.

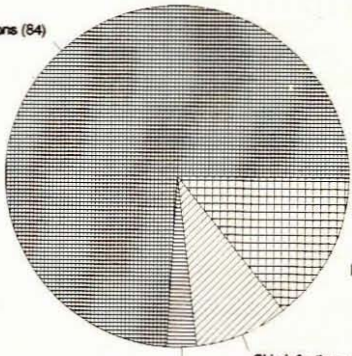

Fig. 1. Nature of infections (*N* = 113).

Health care was sought from general practitioners in the majority of cases (Fig. 2). Apart from 8 admissions to a short-stay ward of a hospital, no infant required admission to a hospital ward.

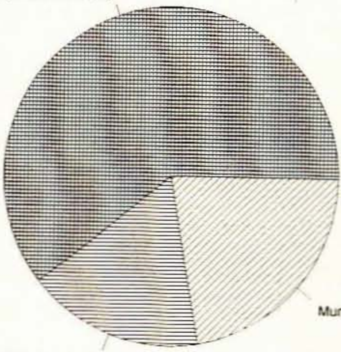

Fig. 2. Health care providers (113 occasions).

Table V. Weights and lengths (mean ± SD) of infants (birth to 15 months)

	Weight (kg)		Length (cm)	
Age	Boys	Girls	Boys	Girls
Birth	3.23 ± 0.45 (*N* = 45)	3.16 ± 0.39 (*N* = 48)	49.12 ± 1.62 (*N* = 43)	48.35 ± 1.64 (*N* = 47)
1 month	4.54 ± 0.60 (*N* = 43)	4.35 ± 0.53 (*N* = 45)	53.53 ± 1.84 (*N* = 43)	53.13 ± 1.31 (*N* = 45)
3 months	6.51 ± 1.11 (*N* = 32)	6.35 ± 0.84 (*N* = 39)	60.15 ± 2.60 (*N* = 32)	59.56 ± 1.80 (*N* = 39)
6 months	8.15 ± 1.25 (*N* = 36)	7.68 ± 0.77 (*N* = 43)	66.20 ± 2.80 (*N* = 36)	64.70 ± 2.99 (*N* = 43)
9 months	9.10 ± 1.33 (*N* = 36)	8.46 ± 0.98 (*N* = 30)	80.18 ± 2.52 (*N* = 36)	69.02 ± 1.80 (*N* = 30)
12 months	9.90 ± 1.50 (*N* = 32)	9.17 ± 0.92 (*N* = 36)	73.47 ± 2.75 (*N* = 32)	71.87 ± 2.20 (*N* = 36)
15 months	10.24 ± 1.42 (*N* = 37)	9.81 ± 0.98 (*N* = 30)	76.06 ± 2.73 (*N* = 37)	75.81 ± 2.77 (*N* = 29)

Growth

The mean weight and length of the infants by age and sex are presented in Table V. The anthropometric indices of WA, LA, WL and HCA are expressed as Z-scores for boys and girls and presented in Figs 3 and 4.

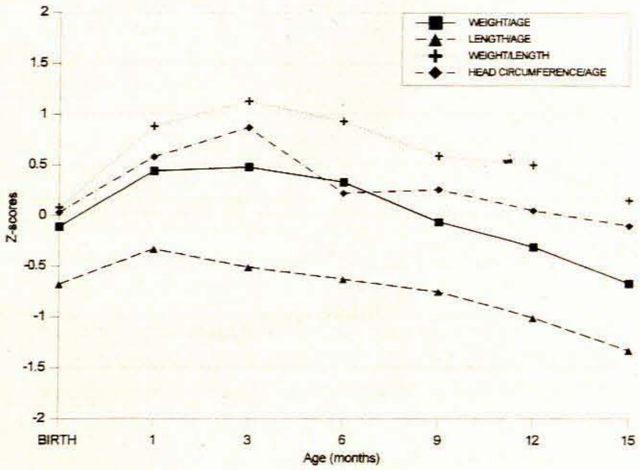

Fig. 3. Mean Z-scores (boys).

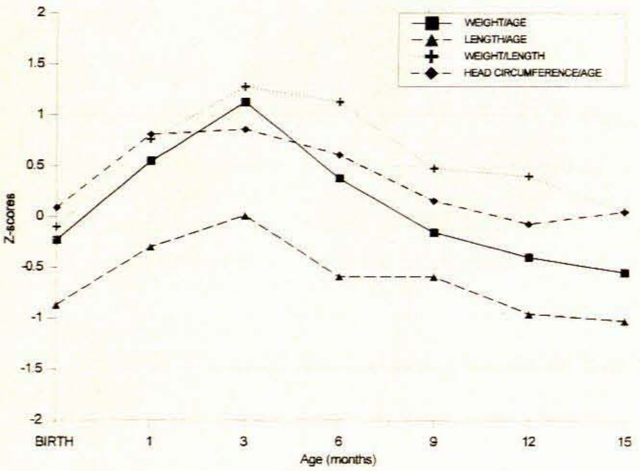

Fig. 4. Mean Z-scores (girls).

Length-for-age Z-scores

The mean Z-scores for male and female infants at birth were below the means for the reference population (Figs 3 and 4). The Z-scores for the boys increased until 1 month and then decreased until 15 months of age (Fig. 3). The Z-scores of the girls increased until 3 months and then also showed a decreasing trend until 15 months (Fig. 4). The mean Z-scores of the boys and girls remained below the mean of the reference population for the duration of the study.

Weight-for-age Z-scores

At birth the mean Z-scores of the boys and girls corresponded to the mean of the reference population and then increased in both groups until 3 months (Figs 3 and 4). A decreasing trend was then evident in both groups until 15 months when the mean Z-scores were below the mean of the reference population (Figs 3 and 4).

Weight-for-length Z-scores

At birth the mean WL Z-scores of the boys and girls were more than the mean for the reference population and remained more than the reference population for the duration of the study, namely 15 months (Figs 3 and 4).

Head circumference-for-age Z-scores

At birth the mean HCA Z-scores of the boys and girls corresponded to the mean values of the reference population and then showed an increasing trend until 3 months of age (Figs 3 and 4). A decreasing trend was then evident until 15 months when the mean Z-scores for the boys and girls again corresponded to the mean values of the reference population (Figs 3 and 4).

Discussion

This study obtained information on the growth, feeding and health of indigent children during the first year of life — a period generally regarded as critical. The results showed that breast-feeding was common, with 86% of infants receiving breast-milk at 6 months and 81% at 12 months. These figures are considerably higher than those for white and coloured population groups in South Africa.[8] At 6 and 12 months, 29% and 6% of white infants respectively are breast-fed while 61% and 39% of coloured infants are breast-fed at 6 and 12 months respectively.[8] In this study, prolonged exclusive breast-feeding was uncommon. By 3 months only 32% of infants were being breast-fed exclusively and this figure is probably an overestimate since the intake of water in addition to breast-milk during the first 3 months was not established.

During the first 3 months breast-feeding mainly coincided with a greater-than-average growth performance with regard to weight gain. The mean WA Z-scores at birth corresponded with the mean WA Z-scores of the reference population but were 1.1 for the girls and 0.5 for the boys at 3 months. These were the highest Z-scores in relation to the reference population recorded during the study period. From 3 months, a fall-off in growth performance in boys and girls with regard to weight gain occurred and continued until 15 months when the mean Z-scores were just more than 0.5 SD below the mean of the reference population. It has been suggested that the NCHS standard is not appropriate for evaluating the growth performance of breast-fed infants because physical growth in these infants may be slightly less than the average NCHS standard but still optimal for predominantly breast-fed infants.[9,10]

Morbidity experience indicated that during the first 3 months, only 3% of 1-month-old infants and 14% of 3-month-old infants had experienced an infection. However, by 6 months, 26% of infants had experienced an infection. The prevalence of infections peaked at 40% at 9 months and the majority were upper respiratory tract infections. The latter two findings were not unexpected.[11] Lower respiratory tract infections and diarrhoeal disease, the major killer disease of infants, caused only 17% of the infections.

Supplementary food was introduced at an early age — in the majority of cases just before the age of 3 months. This practice leads infants to decrease the volume of breast-milk intake.[12] The reason is that breast-fed infants self-regulate their total energy intake and, when supplementary foods are introduced, the breast-milk intake is decreased and its beneficial properties diluted,[12] its anti-infective properties in particular.[13] If it is assumed that human milk peaks at 850 ml/day, exclusive breast-feeding will cover the needs of an infant growing on the 50th weight centile until 4 months and up to 6 months in a healthy child tracking the 25th centile.[14] Mothers should therefore be encouraged to increase the period of exclusive breast-feeding to a minimum of 4 months.

The mean LA Z-scores at birth were lower than the mean for the reference population, indicating that these infants were marginally shorter than the reference population, probably due to a genetic influence. The mean LA Z-scores increased towards the mean of the reference population until 1 month for boys and 3 months for girls, and then showed a trend away from the mean of the reference population for the remainder of the study period to end at almost 1.5 SD below the mean of the reference population at 15 months (boys and girls).

The WL Z-scores showed a similar trend as the WA Z-scores but with higher average mean Z-scores than the latter because of the relatively low LA Z-scores. At 15 months the WL Z-scores coincided with the mean Z-scores of the reference population in contrast to the WA Z-scores which were 0.5 deviation below the mean of the reference population at 15 months.

The recommendation by the World Health Organisation for the use of the NCHS standard for growth is based on the belief that the genetic potential for growth is similar in all well-nourished children.[illegible] The NCHS growth standard may, however, not be applicable to local population groups and infants in particular. When reference population data are being used, a distinction must be made between the concept of a reference and that of a standard or target.[15] The target for one population would not be the same as the target for another, and the question of what is a realistic goal in a particular situation then becomes important.[15] For example, it might be reasonable to set the target for length as 95% of the reference population instead of 100%.[15]

However, percentile growth standards for screening children should be derived from the population or subpopulation to which the children belong.[16] It may be inappropriate to use standards derived from an economically privileged group.[16] Only comparison of the growth of a child with the growth of similar children in a similar environment can determine whether the child in question is growing poorly or well for that environment.[16]

The accurate monitoring of growth during infancy is of the essence, and is possible in practice because infants are accessed regularly during clinic visits for immunisation. The rate of growth during infancy is rapid and a decrease in growth rate is the earliest indication of nutritional failure.[17] A minimum of two measurements should enable a health worker to make a crude assessment of whether the infant's weight gain has been satisfactory.[17] This method is simple but lacks sensitivity in infants who are growing below the 3rd centile of the reference population and who are at high risk for nutritional failure.[17] In these infants increments in weight are more reliable and should be determined.[17,18]

An unexpected finding was the pattern of growth of the infants' head circumference. At birth the mean Z-scores for boys and girls coincided with the mean Z-scores of the reference population. Until 3 months the Z-scores paralleled the higher WA Z-scores and then, like the WA Z-scores, showed a decreasing trend until 15 months of age, ending at a mean Z-score of –0.5 for boys and girls. It is unclear whether the decreasing Z-scores were the consequence of an inadequate diet.

Optimal growth of economically disadvantaged infants during the first 6 months requires exclusive breast-feeding for the first 4 - 6 months.[13] In order to achieve this goal, appropriate antenatal and continuing postnatal educational programmes need to be available. If growth faltering does occur during infancy, a balanced food supplement should be available to facilitate nutritional rehabilitation.

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