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Nutrition in Tari

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SUMMARY

The growth of children in Tari is poorer than the growth of children in two-thirds of the highlands districts of Papua New Guinea. The important proximal determinants of these levels of growth in Tari are birthweight, food and nutrient intake and disease episodes. Birthweights in Tari are lower than in a number of other highlands centres and this is likely to be an important determinant of postnatal growth and disease, particularly for those whose birthweights are below 2500g. The overall effect of child feeding practices in Tari is that energy and protein intakes may be marginal after the first few months of life and contribute to the low levels of growth. Episodes of illness (young children experience an average of 4 episodes in the first year) decrease nutrient intake and increase nutrient requirements; this, combined with the failure to increase food intake during the convalescent period, means that the overall result of an episode of disease is a decrease in growth. There are functional consequences of this pattern of growth in Tari: low-birthweight children and those who are malnourished have a higher mortality rate than those of normal birthweight and growth, and short children have delays in achieving gross motor development milestones.

Introduction

This paper describes the way in which children of the Tari area grow, from the time they are born until they are five years old. The patterns of growth of Tari children will be described by the use of three commonly used indices of nutritional status, weight for age (W/A), length for age (L/A) and weight for length (W/L). Weight for age and length for age are calculated by expressing the observed weight and length, respectively, as a percentage of the expected value in age-specific growth standards. For weight for length, observed weight is expressed as a percentage of height-specific weight standards. The standards used here are those commonly referred to as the Harvard standards (1).

The growth of children in the Tari area is poorer than the growth of children in two-thirds of the highlands districts of Papua New Guinea (PNG). There are 30 districts in PNG in which at least 80% of the population live above 1200 metres above sea level. These include all 28 districts in the Southern Highlands, Enga, Western Highlands, Simbu and Eastern Highlands Provinces together with Goilala District in Gulf Province and Menyamya District in Morobe Province. When these districts are ranked according to estimates of the height of 18-month-old children derived from the results of the 1982/83 National Nutrition Survey (where the greatest estimates received a rank of 1) Tari District ranks number 23 out of 30 (2). Of the 539 children under 5 years of age measured in this survey 40.2% were below 90% length for age and 31.8% were below 80% weight for age (P. Heywood, unpublished data).

The growth patterns of children at Tari are similar to those seen across the highlands even though the level of growth is lower. Median L/A falls from the standard median gradually from birth to a point where, in the fifth year of life, approximately half the children are below 90% of the standards. In contrast, median W/L, which is above the standards in the first few months of life, falls sharply during the first

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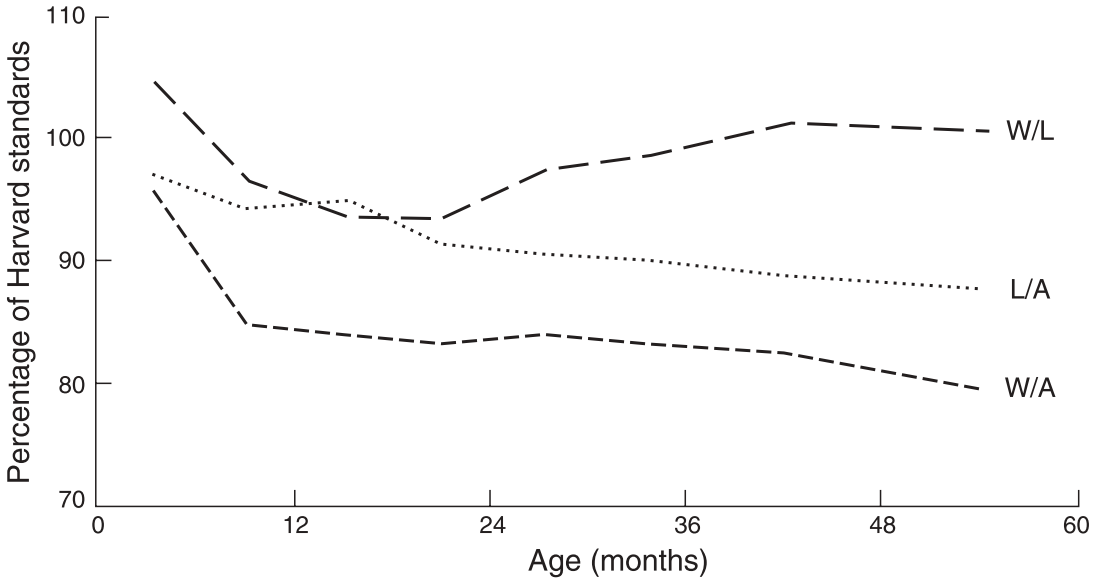

Figure 1. Median weight for age (W/A), length for age (L/A) and weight for length (W/L) of Tari children from the first to the fifth year of life as percentages of the Harvard standards by age (1). From unpublished data of P. Heywood and D. Smith.

year and reaches its lowest point, approximately 93% of the standard, between 12 and 18 months of age. From this age the median W/L recovers slowly to approximately 100% of the standard between 3 and 4 years of age. The combined effect of this pattern is a steep fall in W/A during the first year of life followed by a more gradual decline in subsequent years to a median value of approximately 80% of the standard in the fifth year (Figure 1).

Factors influencing the nutritional status of Huli children

The major factors contributing to this pattern and level of growth in the first five years of life are birthweight, food and nutrient intake and morbidity.

Birthweight

All analysis of birthweight is based on live, single births. For more details on the sources of the data see Allen (3). Data for 4699 Huli births occurring over the period 1957-1977 have been analyzed by Heywood (4). Because of the low numbers of supervised deliveries in the early years of this period, the data for 1957 to 1962 have been combined. Figure 2 shows the mean birthweight and the prevalence of low birthweight (less than 2500 g) between 1957 and 1977. The annual means are remarkably constant over the period with an overall mean of 2.91 kg. Similarly, the prevalence of low-weight births remained constant over this time, at a level of approximately 15%. Males were 62 g heavier than females at birth and birthweight increased with parity. The average difference in birthweight between first and second, and second and third liveborn children was 109 g and 59 g, respectively.

Although these results cannot be directly compared with subsequent data sets extracted from the Tari Birth Registers there is a suggestion that the mean birthweight at Tari has increased by around 100 g since the 1960s. The proportion of births which are below 2.5 kg has similarly decreased. The mean weight of 1222 births between 1980 and 1982 was 3.01 kg (5) and 3.04 kg for 4767 births between 1979 and 1986 (3). Between 1979 and 1986, low-weight births averaged 7%, males were on average 69 g heavier than females, and parity was a significant determinant of birthweight. Second births were on average 66 g heavier than first births and third births 62 g heavier than second births. No discernible linear increase or decrease in birthweight occurred over the period 1979 to 1986.

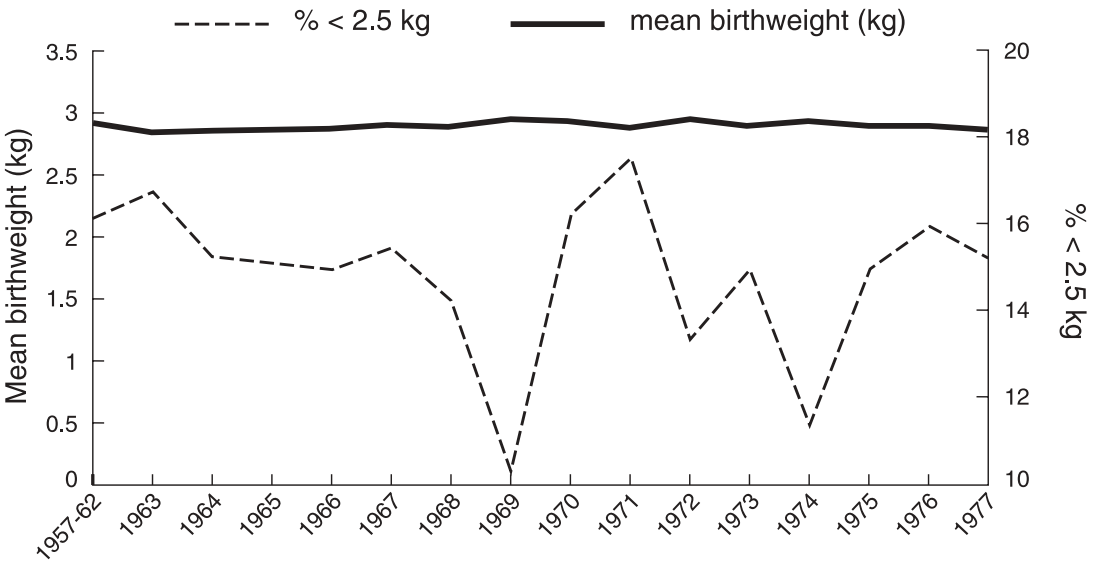

Figure 2. Prevalence of low birthweight (less than 2.5 kg) and mean birthweight (kg) from 1957 to 1977 in Tari.

Whether birthweights at Tari vary significantly in a regular seasonal pattern remains an open question. The 1957-1977 analysis found that the most significant 'seasonal' variation occurred when months were grouped February, March, April; May, June, July; August, September, October; and November, December, January. This combination of months is the least significant combination in the 1979-1986 data. The lack of any discernible 'seasonal' pattern in the 1979-1982 data suggests that the patterns which appear in the two other data runs are not real, but are the result of longer-term and less regular variation in birthweights. These variations over time are examined by Allen (3).

There are few other comparable data sets from rural highland areas. At Embi-Pumberel Health Centre on the Nembi Plateau south of Nipa and about 50 km southeast of Tari, the mean birthweight of 833 children born at the centre or brought to the clinic within 24 hours of birth between January 1979 and March 1986 was 2.84 kg (6:41), significantly lower than in Tari. In contrast, at Mingende Health Subcentre in Simbu Province the mean of 2437 birthweights recorded between 1970 and 1980 was 3.22 kg, significantly higher than in Tari (7), and for 1343 births to village women at Goroka Hospital between 1964 and 1973 the mean birthweight was 3.15 kg, also significantly higher than in Tari (8).

Birthweight has been shown to be an important determinant of postnatal growth in other countries (9) and is likely to be a significant factor affecting differences between children within Tari and between Tari and other parts of the highlands.

Food and nutrient intake

As in most other highland areas, sweet potato (*Ipomoea batatas*) is the staple food at Tari. More than thirty other food crops including taro (*Colocasia esculenta*) and bananas (*Musa* spp.) and a wide variety of green leaves are also grown (10). The proportion of families consuming various foods at the time of the National Nutrition Survey (June-July 1983) is shown in Table 1 (11). Sweet potato is dominant in the diet but important supplementary foods, at least at that time of the year, were bananas, green leaves and legumes. The low proportion of people consuming imported rice or flour (4.7%) and tinned meat and fish (7.7%) is consistent with the low level of cash income in the area at the time. There is little seasonality in the frequency of consumption of sweet potato and greens, but there is variation in the types of greens eaten at different times of the year (D. Lehmann, unpublished report 1983).

This food pattern, characterized by reliance on sweet potato as the main staple and a very

TABLE 1

FOODS EATEN BY FAMILY ON PREVIOUS DAY, IN TARI, 1983

Food	N	%
Banana	47	10.6
Tapioc	4	0.9
Sweet potato	392	88.5
Taro	5	1.1
Chinese taro	2	0.5
Sago	44	9.9
Rice/flour	21	4.7
Tinned or frozen fish/meat	34	7.7
Bush meat	10	2.3
Fresh fish	4	0.9
Greens	165	37.2
Legumes	49	11.1

Notes:

(i) Percentages refer to all families who responded to the question in the district

(ii) Families are likely to have consumed more than one of these foods during the previous day, therefore the percentages do not add up to 100%

Adapted from the Southern Highlands Provincial Tabulations of the 1982/83 National Nutrition Survey (11)

low consumption of animal foods, is characteristic of traditional diets in most of the highlands. Studies in other parts of the highlands before there was significant cash income indicate that sweet potato contributed approximately three-quarters of total energy intake and half of total protein intake (12, 13).

Traditionally breastfeeding was universal and it has been believed that the introduction of solids usually occurred late in the first year of life. It now appears that at least half the children are receiving some solids in the first three months of life and practically all children are consuming supplementary foods by the time they are 6 months of age (P. Heywood, unpublished data). The most commonly used supplementary foods are banana, sweet potato, pumpkin and eggs (A. Heywood, unpublished data).

How much of these supplementary foods is being consumed has not been determined. Orr-Ewing et al. (14) showed that although supplementary foods were introduced early by the Amele of Madang Province their total contribution to energy intake was still only minimal at 12 months of age. It is likely that the situation in Tari is similar. Further, with the exception of eggs, the most commonly used foods have low concentrations of both energy and protein.

There have been no studies of the amount of breastmilk consumed by young children at Tari. Earlier studies in other parts of the country indicated that breastmilk consumption was low. However, a more recent study in the lowlands using the newer deuterium oxide (heavy water) dilution method indicated that intakes may be considerably higher than previously believed (14).

Thus, although there are very few data on child feeding in Tari, what data there are, together with information from other parts of the country, indicate that breastfeeding is practically universal and the amount of breastmilk consumed may be higher than was thought to be the case. Supplementary foods are introduced early but the actual amounts consumed may be quite low, even at 12 months of age, and the energy and protein concentrations of foods used are low.

This pattern of child feeding and the actual foods used mean that both protein and energy intakes of young children may be marginal after the first few months of life, particularly during illness and in the convalescent period following an illness.

Observations indicate that breastfeeding is prolonged, and the most common reason for cessation is a subsequent pregnancy. Although consumption in the later stages of lactation is probably low, breastmilk may still be an important source of high-quality protein. As the diet of older children is probably similar in composition to that of adults, with low concentrations of energy and protein, the limiting factor in nutrient intake is likely to be the ability of the child to consume the relatively large volumes of food needed to meet basic nutrient requirements.

Morbidity

The pattern of morbidity or sickness in young children has been studied by Lehmann (15). As expected, the youngest children have the greatest burden of illness. During the first year of life a child is likely to have at least 4 illness episodes. During the second, third and fourth years the average number of episodes was 3, 2 and 1, respectively. Acute lower respiratory tract infection (ALRI or pneumonia) was the most significant cause of morbidity, accounting for 70% of all illness episodes in children under 6 months of age and half of all illness in children 1-4 years (16,17). Gastroenteritis (diarrhoea and vomiting), which was lowest in the first 6 months of life and most frequent in children aged 6 months to 2 years, accounted for 8% to 16% of all episodes. The importance of episodes designated as fevers increased with age, accounting for 10% of episodes in children under 6 months and increasing to 27% in the fourth year. The cause of these fevers is unknown but malaria may account for a significant proportion of them.

There has been no investigation in Tari of the effect of these illness episodes on growth. However, work in Africa (18) has shown that of the common childhood illnesses, episodes of gastroenteritis and malaria have significant effects on weight and height while episodes of respiratory disease have little effect. Thus, the overall effect of morbidity on growth might be expected to be least in the first 6 months of life when the rates of gastroenteritis and fever are lowest and to be greatest between 6 months and 2 years when the rate for gastroenteritis is greatest and that for fever is increasing. Nevertheless, it should be stressed that the amount of morbidity due to gastroenteritis in Tari is considerably less than that seen in parts of Asia and South America.

This effect is certainly consistent with the age pattern for W/A and W/L which shows decreases in the first year. However, the most rapid decrease in both these indices begins much earlier, suggesting that other factors, such as inadequate intake of energy and/or protein, may be involved initially and that morbidity is an added factor, particularly between 6 and 24 months.

Even so, if catch-up growth following each episode of morbidity were complete there would be no overall detrimental effect of morbidity on growth. Requirements for energy and particularly protein are increased during catch-up growth. In Tari there appears to be little, if any, attempt by mothers to increase the amount of food eaten by children during the convalescent period and those foods which are commonly fed to children have low concentrations of both energy and protein. Thus, whilst morbidity would be expected to have an effect on growth its effect would not be expected to be as great as in other situations where rates of gastroenteritis are higher. At the same time the intake of energy and/or protein may fail to meet requirements. Early in life this may be due to low intake of breastmilk and the small amounts of supplementary foods consumed. Later the situation will be exacerbated by increased nutrient requirements for catch-up growth and inadequate feeding practices in the period following an episode of illness.

Functional consequences of the growth pattern in children

Do these patterns of growth seen in children at Tari have negative consequences for the health of Huli children? In Tari there have been three studies of the functional effects of malnutrition: of the risk of infant mortality associated with varying levels of birthweight, of the relationship between level of postnatal growth and risk of death, and of the effect of level of growth on gross motor development (eg, sitting up, crawling, walking).

Risk of death and birthweight

The risk of death in the first year of life was related to birthweight in a study by Heywood and Lehmann (5). Between 1979 and 1982 there were 3500 births of which 48% were supervised. The infant mortality rate amongst those children whose delivery was supervised was 67/1000 and amongst those with unsupervised delivery was significantly higher (86/1000), especially in the early neonatal period. Of those whose delivery was supervised, birthweight had a significant effect on infant mortality with a particularly sharp rise for children weighing less than 2.0 kg at

birth, 50% of whom had died in the 12 months following birth.

Risk of death and nutritional status

The relationship between attained growth at various ages and risk of death has also been studied in Tari (19). Nutritional status was assessed in 1232 children who were between 6 and 30 months of age. These children were assigned to cohorts according to W/A, L/A and W/L and the deaths in each cohort were monitored for two years.

A gradual increase in the mortality rate occurred with lower levels of W/A and a steep rise for children less than 60%. As L/A fell, there was a gradual rise in mortality and a sharp increase for those children less than 85%. For W/L there was a smooth and accelerating rise in mortality as the level of W/L decreased, with mortality reaching its highest level in those under 80% (Figure 3).

When these results are compared with those of the only other similar study in the literature, that of Chen et al. (20), which was carried out in Bangladesh, the mortality rate in PNG is higher at similar levels of W/A and W/L than in Bangladesh. A mortality rate of 100 per 1000 children (or 10%) is reached at a W/A of 70% of the standard in Tari compared to 55% in Bangladesh. For W/L a mortality rate of 100 is reached at approximately 85% in Tari and 70% in Bangladesh.

Thus, there are clear increases in the risk of death associated with lower levels of nutritional status in Tari children. Important functional consequences of malnutrition do exist.

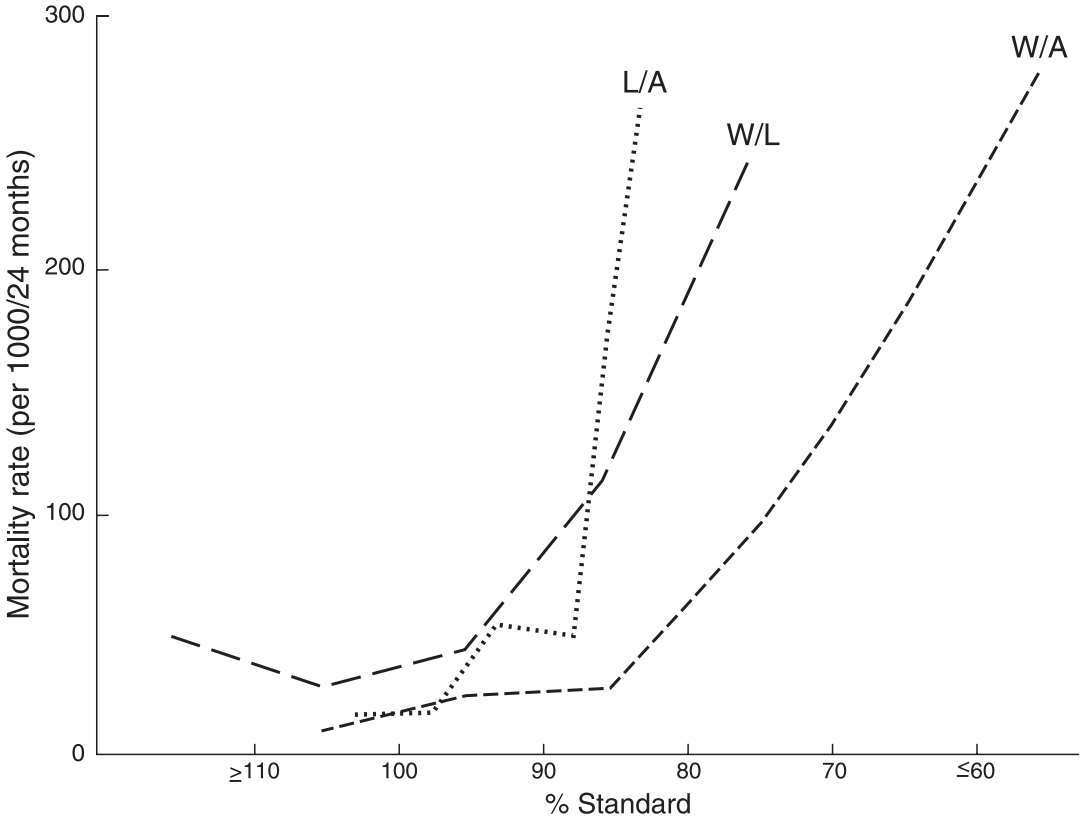

Figure 3. Prospective mortality rate by nutritional status in children in Tari. Children were 6-29 months of age at the beginning of the study and mortality was determined within the next 2 years. Nutritional status was assessed by comparison with the Harvard growth standards (1). W/A, weight for age; L/A, length for age; W/L, weight for length.

Gross motor development and nutritional status

One other functional consequence of the level and pattern of growth in Tari has been studied by A. Heywood et al. (21) who, in a cross-sectional study, assessed gross motor development in young children and the effect of nutritional status. In general, the age at which a given gross motor development stage was reached in Tari was later than North American standards, the extent of the delay being greatest for the later milestones, such as walking. W/A and W/L did not have any effect on whether or not a milestone had been reached. L/A, however, was shown to have a significant effect, the lower the L/A the lower the probability of a child having achieved a given development stage by a certain age.

Prospects for the future

Improvement in the nutritional status of children in Tari will depend on changes in all the factors influencing growth.

Increased consumption of energy and protein, particularly during the first year of life, will be necessary for the improved growth of many children. If catch-up growth is to occur, special attention is needed in all children to increase food intake in the period immediately following an episode of illness, a time when both energy and protein requirements are significantly increased.

A reduction in the burden of illness in young children will also have a beneficial effect on growth. This is particularly true in the case of gastroenteritis. It should be remembered, however, that the possible gains in growth may not be as large as in other developing countries because the rate of gastroenteritis in young children in Tari is relatively low. Reduction in the levels of respiratory disease should also have a significant effect on growth. Although individual episodes have not been shown to have an effect on growth the cumulative effect on general health may be important. The pneumococcal vaccine trials described by Riley (17) have been shown to be effective in preventing deaths and, to a limited extent, reducing the severity and frequency of illness. At the moment this vaccine is too expensive to be used in the general health services and it may be a long time before its routine use in Papua New Guinea becomes possible.

An increase in birthweight would be expected to lead to improved postnatal growth. As maternal height appears to be an important factor influencing birthweight, increases will in part depend on improved nutrition of females in the years before childbearing begins as well as during pregnancy.

If the experience in Simbu Province is repeated at Tari, some of these changes are likely to occur as a result of general economic development. The growth of Simbu children improved significantly in the 25 years between 1956 and 1981 (7) and this was associated with participation in the cash economy, changes in food habits and attendant increases in energy and protein intakes, and improved health services, as well as increased birthweight and a continuing trend in the height of adult females. Perhaps of particular importance was the finding in 1981 in Simbu that the children of mothers who spoke tok pisin (Melanesian Pidgin) had significantly higher nutritional status than the children of mothers who did not. It is likely that women who speak tok pisin have more education and are more receptive to and better understand health education messages, including those messages aimed at changing child feeding practices.

In Tari the level of economic development is currently much lower than in many other areas of the highlands and the educational status of women is very poor. Of the mothers of children included in the National Nutrition Survey in 1982/83 98% had no formal education and less than 4% spoke tok pisin (11). Many of the changes outlined above which may lead to an improvement in growth, such as improved sanitation and changes in feeding practices, with respect to children generally and following illness in particular, are dependent upon mothers, who are almost solely responsible for the care of young children.

Improved education of women, including knowledge of tok pisin, may be an important prerequisite for the understanding and implementation of health education messages in Tari. In many cases money will help too,

but the role of women and their ability to understand and act upon health education messages is critical to the success of any attempt to improve their own health status and that of their children.

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