J. biosoc. Sci. (1998) **30**, 481–499

INFANT AND YOUNG CHILD FEEDING PRACTICES AMONG AFRICAN PASTORALISTS: THE DATOGA OF TANZANIA

DANIEL W. SELLEN*

Department of Anthropology, University College London, Gower Street, London WC1E 6BT

Summary. Breast-feeding and weaning practices were observed for a cohort of 81 children under 3 years of age in the context of a longitudinal study of social, ecological and nutritional factors affecting growth in a semi-nomadic population of pastoralists in northern Tanzania (WaDatoga of Mbulu District). The adequacy of indigenous infant and young child feeding practices was assessed in relation to current international recommendations. Objectives were to provide baseline data for future investigations of any changes in young child feeding practices which accompany population shifts towards settlement and non-pastoral modes of subsistence, and to improve understanding of the strengths and limitations of indigenous feeding practices in this type of population. It was found that while breast-feeding was universally initiated, other aspects of young child feeding practices do not meet current international recommendations. Prelacteal feeds are commonly used, supplementary feeding with non-human milks usually occurs before 4 months of age, use of solid foods normally begins later than 6 months, and breast-feeding does not continue until 2 years of age for the majority of children. The data have implications for the design of breast-feeding promotion and improved weaning food interventions among African pastoralists.

Introduction

The general advantages of exclusive, frequent and prolonged breast-feeding in terms of improved infant and young child morbidity (Feachem & Koblinsky, 1984), growth performance (Cousens *et al.*, 1993; Dewey, Heinig, Nommsen & Lonnerdal, 1990), increased child survival (Jason, Neiburg & Marks, 1984) and increased birth spacing (Thapa, Short & Potts, 1988; Winikoff, 1983) are well-documented. Adequate breast-feeding practices, as defined in recent international recommendations (Anon., 1991; Koniz-Booher *et al.*, 1990) ensure adequate dietary intakes for many infants under 6 months (Cohen *et al.*, 1994), protect against infection (Cunningham, Jelliffe & Jelliffe, 1991; Howie *et al.*, 1990), and are important factors in promoting normal

*Present address: Department of Anthropology, Emory University, Atlanta, GA 30324, USA.

developmental maturation (Stuart-Macadam & Dettwyler, 1995). The critical importance of the timing of introduction of supplementary fluids and complementary foods (Underwood & Hofvander, 1982), their nutritional quality (Brown, Creed-Kanashiro & Dewey, 1994), and the disease risks associated with their preparation and feeding has also become widely appreciated in recent years (Brown *et al.*, 1989; Rao & Kanade, 1992), while there appear to be trade offs between nutritional status and diarrhoeal incidence under some local conditions (Molbak *et al.*, 1994). In contrast to this general knowledge, specific knowledge of the patterns of traditional child feeding practices remains scant for many rural societies (Maher, 1992). Such information is essential if interventions such as breast-feeding promotion are to be effective, and the changes in child feeding practices which accompany changes in living conditions and subsistence activities are to be understood. In particular, there is an extreme paucity of studies of the weaning process among African pastoralists. Although nomadic or semi nomadic pastoral and sedentary agro-pastoral populations constitute a significant proportion of the continent's population, with estimates ranging between 11 and 24 million people (Jahnke, 1982; Sandford, 1983), in general they remain severely under-served by existing health care delivery systems, and their health and nutrition remains poorly understood.

A longitudinal study of infant and young child feeding practices was conducted in a community of Datoga pastoralists living along the eastern shore of Lake Eyasi in northern Tanzania. Subsistence is based almost entirely on family-owned herds of cattle, sheep and goats. The population is semi-nomadic, with households relocating with the herds according to the exigencies of ecological and socio-political factors. Animals provide milk or are sold at monthly markets to raise cash for purchase of grain, while meat is rarely consumed. There are no permanent roads through the area, material conditions are extremely poor, and the community is not directly served by primary health care or educational facilities. The Datoga are a numerous ethnic group (at least 300,000 people), but are economically and politically marginalized. Infant mortality approaches 20% and is high by national and international standards (Borgerhoff Mulder, 1992; Sellen, 1995); mortality remains relatively high throughout life. The major causes of mortality are not well investigated to date, but have been observed to include tetanus of the newborn and dehydration and respiratory tract infections among young children. Malaria, diarrhoea, gut parasites and tuberculosis are prevalent among adults; the illnesses most commonly treated by local flying doctors are scabies, eye infections and infected leg injuries sustained while walking in the bush. No modern forms of contraception are used and the total fertility rate of 6·9 is high relative to other pastoral groups (Borgerhoff Mulder, 1992). The goal of this paper is to describe the patterns of breast-feeding and complementary feeding and to present an assessment of the adequacy of feeding practices in relation to international guidelines. Specific hypotheses tested are that: (a) breast-feeding practices meet current international recommendations; (b) the timing of introduction and quality of complementary foods is adequate; (c) there is little variation within the population in the pattern of young child feeding. The results are discussed in comparative perspective.

Study design and methods

A community-based sample of young children (<3 years) was visited monthly to collect 24 h maternal or principal care-giver reports of their diet, make anthropometric measurements, and interview mothers about their family situation and about

experience with, attitudes towards and plans for the care and feeding of the focal child. The sampling base consisted of all Datoga households temporarily resident in three neighbouring settlement areas at some time between January 1991 and December 1992 which could be reached with measurement equipment. The criterion for inclusion was that at least one child under 3 years of age having no younger sibling was resident in at least one of the families within a household. In this study *families* were operationally defined in relation to the male parent, and therefore could be monogamous or polygynous, and *households* were defined as patrilineally related groupings of families who shared the same *homesteads* and coordinated their herding, selling and purchasing activities. During initial visits anthropometric measures were made and a battery of interviews conducted with mothers. Repeated follow-up visits were planned approximately monthly until the child reached 3 years of age, a younger sibling was born (who then became a subject) or the study period ended. In practice, follow-up success varied because of the high mobility of the members of households.

Structured questionnaires were conducted in KiSwahili by a single interviewer in the presence of local Datoga assistants who could assist with interpretation between KiSwahili and KiDatoga for those 30% of women whose competence in KiSwahili was low. Questionnaires, which included items on current childcare and feeding events and a 24 h food frequency, were designed to follow an empirically logical progression and to be short enough to maintain respondent rapport. All anthropometric measurements were taken by a single observer following standard procedures (Frisancho, 1990; Gibson, 1990; Jelliffe & Jelliffe, 1989). Recumbent length was measured to the nearest millimetre using a portable anthropometer (Model 101, Seriex Inc., New Jersey) and a flatboard. Naked weights of young children were measured to the nearest 0·1 kg either directly with a spring balance (Salter Industrial Measurement Ltd., West Midlands, UK), or by difference, the mother or care-giver standing on digital scales (AA battery-operated Soehlner Model 7701; CMS Weighing Ltd, 18 Camden High St, London) both with and without the young child in hand. Data for length, weight, age and sex were used to compare all individual children to the appropriate reference sample in the CDC/NCHS/WHO tables (Department of Health Education and Welfare, 1977a,b). The growth performance of any child at the time of measurement was expressed in terms of weight-for-age *Z* scores (WAZ) and length-for-age *Z* scores (HAZ) calculated using a computer program available from the Centers for Disease Control (Centers for Disease Control, 1989). Since no birth records exist for the population, year and month of birth of children were obtained by interviewing parents and other family members, using standard cross-checking methods developed by small population demographers (Borgerhoff Mulder, 1992; Leslie & Gage, 1989; USAID, 1979). Informants were asked to place the date of birth of each child on a local calendar of events developed by previous researchers and updated by the present author (Sellen, Sieff & Borgerhoff Mulder, 1993). For all subjects an estimated date of birth was arrived at to the nearest month by family consensus. Univariate descriptive statistics and survival estimates were obtained using the SPSS software on a personal computer (SPSS Inc., 1993).

Results

Children under 3 years were resident in 47 of 77 households (61%) contacted, and 41 of the household heads consented to an initial visit. Data on growth and feeding

Table 1. Sample characteristics

Measure	Lost to follow-up	Followed-up	Overall
Number of subject infants	41	40	81
(females, males)	(23, 18)	(14, 26)	(37, 44)
Mean birth order of infants	3·3 ± 2·0	3·8 ± 2·6	3·5 ± 2·3
[range, median]	[1–8; 3·0]	[1–10; 3·0]	[1–10; 3·0]
Mean estimated age at entry of infants (months)	15·5 ± 8·9	12·0 ± 8·3	13·7 ± 8·8
[range, median]	[1·32; 13]	[2·34; 12]	[0–34; 12]
Mean time in the study (months)		6·1 ± 6·4	3·2 ± 5·6
[range]			[1–10]
Weight-for-age score (WAZ)	1·33	1·38	−1·36
Height-for-age score (HAZ)	−1·59	−1·39	−1·54
Weight for age score (WHZ)	−0·24	−0·38	−0·38

Table 2. Anthropometric indicators of prevalence of low nutritional status among young children (0–36 months) at study entry

Indicator	Boys (n=44)	Girls (n=37)	Overall (n=81)
% stunted (< −2 SD HAZ)	27·3	43·2	34·6
% wasted (< −2 SD WHZ)	4·5	2·7	3·7
% stunted and wasted (< −2 SD WHZ and < −2 SD HAZ)	2·3	2·7	2·5
% probably undernourished	34·1	48·6	40·8

practices were collected during January–March 1991 and May–December 1992 for a total of 81 focal children drawn from 62 families organized into the 41 separate households. Mean ages at entry into the study, mean maternal marital status, mean birth orders and mean anthropometric scores did not differ significantly between children by sex (Table 1). Repeat measures were obtained for 40 infants from 21 households; 30 of these children were followed for at least 4 months, and 6 for at least 6 months. Field logistic constraints prevented any follow-up fieldwork on 41 infants from 20 households in the two most isolated communities, but data from single measures on these individuals are included here. When subjects were disaggregated by success in follow-up, the differences in the characteristics measured at entry were not statistically significant.

Anthropometric cross-classification indicated growth deficits for approximately 40% of the subjects (Table 2). The higher frequency of stunting among girls was not

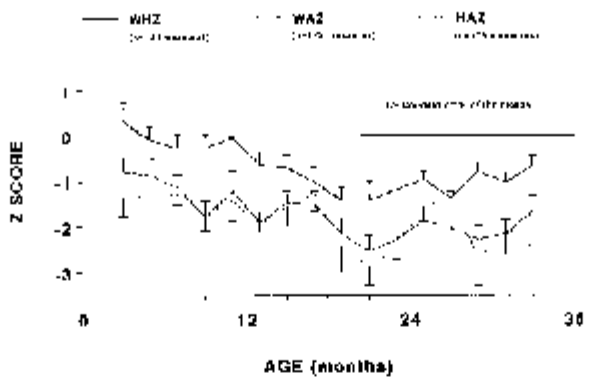

Fig. 1. Mixed longitudinal growth performance of Datoga children under 3 years of age.

statistically significant ($\chi^2 = 0{\cdot}872$, $p = 0{\cdot}351$). The mean weights of infants fell increasingly below the reference values until 11 months of age (the best-fitting binomial regression for these data being that with an inflection point at this age). Growth faltering was clear after 6 months of age (Fig. 1). After 12 months of age mean weights for age were at the 5th percentile of the reference data, and fell below it after 18 months. Lengths for age were also lower than reference values at all ages between 0 and 3 years. Standing height rather than recumbent length was recorded for 16% of measurements on children over 24 months. Additional cross-sectional survey data indicated that there was a slight, but non significant, increase in population mean weights for age until 5 years of age (attributable either to catchup growth or to mortality of individuals of very low weight).

Altogether, 197 child-days of data on feeding and childcare practices were available for analysis. The biological mother was the respondent for 84% of the 24 h food frequency interviews, a co-wife of mother for 7% of interviews, and a close female relative for the remainder. Fifty-one (63%) of the children were breast-feeding at entry, and 60 were weaned (defined as complete cessation of breast-feeding) before the end of the study or lost to follow-up. There were two cases of twins, one in which both had survived and another in which a twin had died prior to the census. Since feeding data on the two living twins were identical, only one was included in the analysis. Additional retrospective data on the timing of feeding events were also available for seven 3-year-olds studied during a randomized pilot study and these were pooled for some analyses to boost sample sizes.

Initiation of breast-feeding was universal, but usually followed a post-partum delay of 2–3 days (Fig. 2). Most recent mothers ($n = 44$) reported using prelacteal feeds. Neonates were reportedly fed only water, which was usually boiled or heated in some way prior to feeding. In a few cases diluted goat or cow's milk, or sugared cow's milk, were fed (Table 3). A mixture of water and hot ash was given ritually in a minority of cases where labour had been particularly difficult. All mothers interviewed had a clear notion of non mature human milk or colostrum as distinct from mature milk, and most expressed negative attitudes towards it. Although colostrum is not taboo by tradition, 79% of mothers ($n = 34$) reported that they discarded their milk in the immediate post-partum period. A variety of justifications were given, the most common of which

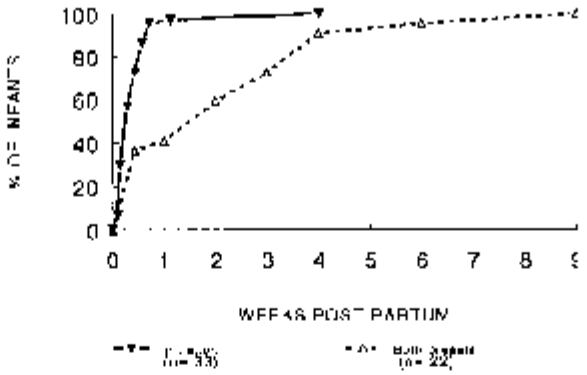

Fig. 2. Pattern of post-partum initiation of breast-feeding among the Eyeal Datoga.

Table 3. Prelacteal breast milk alternatives reportedly fed during the first 3 days post-partum*

Type of preparation	Proportion of infants for which practice reported (%)	Preparation involved boiling (%)	Preparation involved no boiling (%)	Boiling treatment not clarified (%)
None	7 (3)		—	—
Water	66 (29)	72 (21)	100 (60)	7 (2)
Water—non-human milk	21 (9)	33 (3)	66 (6)	—
Cows milk + sugar	2 (1)	0	100 (1)	
Water + ash	4 (2)	100 (2)	0	
Total	44	63 (26)	32 (13)	5 (2)

*Mean age at first breast-feeding for this sample of infants was 3·4±5 days; median 2·0; range 0–30

was a belief that the colostrum would give the infant digestive problems, because early milk was thought to be 'too heavy' for the infant's stomach ($n=19$, 56%). Others believed the child would become more generally sick, invoking perceived undesirable qualities of the early milk ('rotten' or 'dirty', 6%; 'too watery', 6%). Mothers clearly exercised their own judgment over whether to delay the initiation of breast-feeding, as evidenced by those who did not discard their early milk ($n=9$, 21%), or did so only because of sore breasts and blood in the milk ($n=1$) or because a previous child fed colostrum had died ($n=1$). A minority (12%, $n=4$) reported that the child would not suckle when first offered the breast, with the result that mothers self-expressed the colostrum. Most mothers monitored their infant's appetite and breast milk intake carefully during the first month, and claimed to recall the approximate age in weeks at which both breasts were used at a single feeding. Almost all children were receiving mother's milk by the end of the first week of life (Fig. 2; the two exceptions involved illness of the mother after childbirth).

Table 4. Milestones in the feeding process

Weaning milestone	Prospective data collection: monthly 24 h recalls (months)	Retrospective data collection: maternal report of events preceding first visit (months)	Breslow	*p*
Introduction of non-human milks	3·6 (0·5, 6·5) $n=14$	1·0 (0·2, 1·8) $n=35$	2·95	0·0860
Introduction of maize solids	10·6 (9·5, 11·7) $n=34$	10·6 (8·2, 13·0) $n=41$	2·85	0·0912
Cessation of breast-feeding	21·9 (20·6, 23·2) $n=50$	18·2 (15·3, 21·2) $n=38$	7·02	0·0081

Numbers in table are median (95% confidence interval) and sample size.

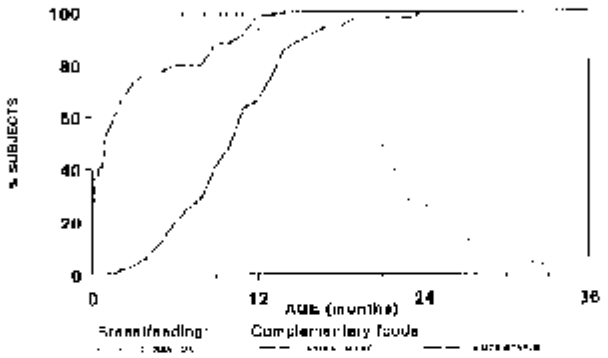

Fig. 3. General pattern of infant and young-child feeding among the Eyasi Datoga.

Supplementary foods fed to infants and young children included fresh and soured goat or cow's milk, maize-meal gruel and the principal adult staple, stiff maize-meal porridge prepared by adding ground maize kernels to boiling water (KiSwahili, *ugali*; KiDatoga, *ghamita*). Kaplan–Meier survival analysis of young child weaning practices for all children measured at least once in the study showed that the median ages of introduction of non-human milks, introduction of grain-based solids, and cessation of breast-feeding were 2, 11 and 20 months respectively. The results indicated that maternal recall of the timing of weaning milestones may be rather accurate. When the observations collected prospectively (by repeated 24 h recall of specific feeding practices) or retrospectively (by maternal recollection of feeding changes) were analysed separately, the differences in the median survival times and shape of the survival curves for the data on the weaning milestones were not appreciable (Table 4). Since sample sizes were small, prospective and retrospective data were pooled to derive population estimates of the general pattern of weaning (Fig. 3).

Table 5. Pattern of introduction of various weaning foods into the diets of Datoga infants and young children

Age at the end of the study or loss to follow-up (months)	*n*	% known to be receiving foods from 24 h recalls						
		Water	Maize gruel	Fresh/curdled non-human milks	Clarified butter	Ghee	Meat	Other*
0–5·9	7	29	14	71	0	14	0	0
6–8·9	12	50	33	100	8	25	9	18
9–11·9	8	50	63	100	13	25	0	0
12–17·9	16	63	63	100	44	50	25	19
18–23·9	15	87	60	100	40	53	47	33
24–36·9	21	95	76	100	60	70	65	45
Total infants	78							77

*Other foods included eggs, chicken, beans, stewed leafy green vegetables and mixed dishes of maize and beans.

A large majority (approximately 90%) of young children were breast-fed for more than a year, although a few were weaned from the breast during the first year because of maternal illness. Almost all children were fully weaned before 3 years of age. Most children in the sample were receiving non-human milks as a breast milk supplement or substitute by 12 months of age. In contrast, a majority (approximately 80%) were not introduced to solid foods until after 6 months of age, and some individuals not until after 2 years of age. There was much variation in the timing of introduction of solids and cessation of breast-feeding among children in the sample. Introduction of solids ranged between 2 months and 27 months of age, but occurred between 9 and 21 months for 70% of the sample. Similarly, although a majority of children (approximately 70%) stopped breast-feeding during the second year of life, the range was between 4 and 33 months. There was a non-statistically significant tendency for boys to be introduced to solid foods at later ages than girls and to be weaned at earlier ages.

The pattern of introduction of other types of food was estimated prospectively by examining the series of 24 h food frequency reports on each child in relation to age and calculating the proportions of children known to have received a particular food before the end of the study period (Table 5). This confirmed that non-human milks were the most commonly given liquid supplement from an early age, and were in many cases consistently given instead of water. Although only half of children under 1 year of age were drinking water at study end, 70% of infants were already being supplemented with non-human milks by 6 months of age. Few children under 9 months were fed maize gruel, and curdled milks were not commonly fed until the second year of life. Many children of all ages were fed small amounts of ghee, and increasing proportions of children received clarified butter and meat after 9 months of age. Meat had not been introduced into the diets of most infants under 1 year of age. In the few exceptions meat was usually introduced not in the boiled or roasted form consumed by adults, but

as dried biltongs, which were regarded by mothers as better for infants to taste and smell. Among 2 year olds, it was often introduced in soups in response to sickness.

To gain a better understanding of the variety and potential quality of young child diets, changes in the frequency of feeding of each type of food were examined by age after pooling all days sampled for children within the same 3- or 6-month age range (Table 6). First, the proportion of days a specific food was offered after it had been introduced into an individual child's diet was estimated, and second, the daily number of feedings (i.e. servings) which included that food on those days was estimated. It was found that no type of food was fed on every day after it had been introduced. In the case of both fresh and curdled non-human milks, this was in part because none was available on approximately 10% of days sampled. Fresh non-human milks and maize meal porridge were by far the most frequently fed complementary foods in terms of percentage of days served. Once introduced, fresh non-human milks were fed to children of all ages on approximately 80% of all days. In contrast, the proportion of days on which stiff maize-meal porridge was fed after introduction showed a more gradual increase with age. It was fed almost daily to 1- and 2-year-olds. Thus, in practice, the diet is highly monotonous.

Fresh non-human milks were fed the most frequently on a daily basis (between three and four feedings), and this was true across all age groups. The milk was boiled prior to a little less than 30% of feedings. Although milk was often served mixed with a separately prepared supply of maize-meal gruel, this was usually cold when the milk was added. The daily frequency of consumption of maize-meal porridge averaged approximately two servings per day, but children in the 9–18 month age range received on average almost one less serving of maize-meal per day than either younger or older children. Gruel was the third most commonly served food in terms of proportion of days prepared, and was regarded as a beverage, filler and breast-milk alternative. Consequently, it was fed at high daily frequencies to infants under 1 year of age, and less frequently to older children. Curdled milks were consumed more often by children over 1 year of age, and half of all servings were mixed in with servings of fresh milk. Clarified butter, ghee and meat were fed on less than 30% of the days after they were first introduced into an individual child's diet. Ghee was more frequently fed to infants, and was often fed on its own. Clarified butter and meat were more commonly fed to toddlers, and were usually accompanied by maize-meal porridge.

Mothers of non-exclusively breast-fed children ($n = 36$) were questioned about preferred styles of young child feeding. More than 75% ($n = 28$) of these mothers reported that at each feeding they first offered the breast before other foods. A majority of mothers fed complementary foods by hand ($n = 24$, 66·7%). Gourds or plastic cups were sometimes used to feed liquids to older children ($n = 9$, 25·0%), and some mothers occasionally used a spoon to feed ghee to infants ($n = 3$, 8·3%). No mother was observed to bottle feed, and informants suggested a bottle feeding rate of 'one in a hundred' among the wider population.

Discussion

Health professionals need specific knowledge about weaning practices to help them avoid making inaccurate assumptions that so-called 'traditional' practices are somehow ideal or naturally adaptive, or, more commonly, that they are completely at odds with the recommendations of Western medicine. Both the nutritional consequences and the

Table 6. Reported daily food consumption frequencies for Datoga in

Type of food *KiSwahili/KiDatoga* term (description in English)	Age class (months)				
	0–2·9	3–5·9	6–8·9	9–11·9	12–19·
Maziwa mabichi/shangshengiyoy (fresh non-human milks)[a]					
No. post-introduction child-days sampled	5	23	32	18	43
% of days served[a]	66·7	82·6	85·7	94·4	88·4
No. servings per day	4	3·4±0·9	3·5±0·8	3·6±0·5	2·7±_
Serving frequency sample size[b]	2	16	13	9	27
% of servings boiled[c]	75·0	57·1	36·8	6·7	17·1
% of servings mixed into *ugi*	100	77·8	72·7	57·1	70·4
Maziwa maciungu/sadjeng (curdled non-human milks)[c]					
No. post-introduction child-days sampled	0	17	19	38	42
% of days served[a]		11·8	15·8	33·3	40·5
No. servings per day		2	4	3·7±0·6	2·3±1
Serving frequency sample size[b]	—	2	1	3	10
% of servings combined with fresh milks	—	0	0	0	58·3

Ugali/ghamir (maize-meal porridge)									
No. post-introduction child-days sampled	0	12	15	14	42	30	44	166	0·0
% of days served*	—	8·3	46·7	78·6	90·5	96·7	100	82·5	
No. servings per day		3·0	2·5 ± 1·0	1·6 ± 0·5	1·8 ± 0·8	2·6 ± 0·7	2·6 ± 0·8		
Serving frequency sample size†	—	1	6	9	34	23	27		
Ugi/weri-wegi (maize-meal pap/gruel)									
No. post-introduction child-days sampled	4	25	23	22	41	30	45	198	4·0
% of days served*	25·0	40·0	47·8	72·7	65·9	56·7	68·9	58·1	
No. servings per day		3·6 ± 1·1	3·4 ± 0·7	3·2 ± 0·9	2·1 ± 0·7	3·8 ± 1·0	3·0 ± 0·9		
Serving frequency sample size†	0	8	9	14	27	16	27		
Siagi iumi/mareta (clarified butter)									
No. post-introduction child-days sampled	3	11	15	13	34	26	40	149	
% of days served*	0	9·1	6·7	7·7	20·6	11·5	40·0	21·5	
— Inaredash (ghee/dripping)									
No. post-introduction child-days sampled	4	11	15	14	38	26	40	155	
% of days served*	50·0	18·2	26·7	14·3	26·3	30·8	30·0	29·7	
Nyama/various words (meat)									
No. post-introduction child-days sampled	3	18	16	15	37	28	38	162	
% of days served*	0	0	0	6·7	40·5	21·4	50·0	27·8	

Table 6. *Continued*

Type of food *KiSwahili/KiDatoga* term (description in English)	Age class (months) 0–2·9	3–5·9	6–8·9	9–11·9	12–19·9
Maziibeg (water)					
No. post-introduction child-days sampled	3	20	19	21	44
% of sample days served[a]	33·3	25·0	31·6	28·6	59·1
% of water serving days boiling reported	0	14·3	0	0	0
Total child-days sampled	6	26	24	22	44

[a]Based on 24 h recall of care-giver; only data on infants already introduced to each food
infant refused to eat because of illness are included.
[b]Denotes number of child-days for which serving frequencies could be calculated from re
[c]Includes both fresh cow's milk (*nkangakengyeg* proper) and goat's milk (*anoga*), which are
[d]Includes instances where the milk was added to porridge or pap before churning or sour
[e]Operationally defined as heating raw milk until it bubbles or adding to porridge or pap
taken off the boil.

determinants of observed population feeding patterns must be fully understood before improvements can be suggested. In general, it is important to evaluate the relative importance of food beliefs, food availability and parental time constraints in structuring existing practices. In the special case of pastoralists, the extent to which protein and micronutrient-rich milk and meat are used as weaning foods, and any implications for the maintenance of breast-feeding, need to be evaluated.

An adaptationist perspective on human cultural practices might lead us to expect that young child feeding practices in traditional societies which have remained largely unaffected by recent ideological influences from urban areas will be adequate for promoting child growth and well-being. Given the specific environment in which Datoga children must be raised, and the constraints operating on mothers, it is possible that aspects of the observed pattern of child feeding do in fact promote infant health, growth and survival. However, a careful evaluation of the data does not suggest that this is likely for most aspects of Datoga feeding practices.

International recommendations are that all children under 2 years should be continuously breast-fed, and that all infants under 4–6 months of age should be exclusively breast-fed (Anon., 1991; Koniz-Booher *et al.*, 1990). When compared with these recommendations the results indicate that breast-feeding practices among the Datoga are not, on average, adequate. Calculation of the breast-feeding indicators suggested by the World Health Organization (WHO/CDC, 1991) reinforces this conclusion. Although breast-feeding was universally initiated for the sample of children recruited into this study, the use of prelacteal feeds means that the breast feeding of neonates was most often predominant rather than exclusive. The widespread use of non-human milks as feeding supplements for infants under 6 months of age also shows that supplementary feeding is the norm from an earlier age than is recommended. Thus the rate of predominant breast-feeding (i.e. breast feeding combined with the supplementary feeding of liquid foods such as milk) is approximately 75% of all infants under 4 months, well above the recommended 0%. Conversely, few solid foods are given to children before the introduction of maize-based dishes, and the median time of introduction of maize porridge is rather later than the recommended 6 months. The timely complementary feeding rate (based on introduction of maize porridge) of approximately 25% of 6–9 month olds is well below the recommended 100%.

The pattern of growth faltering in the under 3 year-olds is consistent with the hypothesis that feeding practices are associated with inadequate nutrient intakes and high infection rates. Slow child growth, delayed adolescence and small achieved adult body weights are commonly observed in African pastoral populations (Galvin, Coppock & Leslie, 1994; Sellen, 1996; Shell-Duncan, 1995), and the variance in growth performance found among Datoga children of all ages is established from a young age (Sellen, 1995). The widespread use of pre-lacteal feeds, which are contaminated and do not provide the nutritional benefits of breast milk, is likely to have adverse effects on child health and growth performance. Although one study recently found that the practice of discarding colostrum had no long-term effects on growth and survival of a large sample of children under 3 years from a population in Guinea Bissau with overall mortality rates very similar to those prevailing among the Datoga, it did not control for any associated use of prelacteal feeds (Gunnlaugsson, Clotilde da Silva & Smedman, 1993). Very early introduction of non-human milks is common, and is

unlikely to have beneficial effects in infants under 6 months of age relative to exclusive breast-feeding. While sample sizes for this study were too small to evaluate the long-term effects of early supplementation on morbidity and survival, negative effects of non-exclusive breast-feeding are recorded for many other rural populations (Brown *et al.*, 1989; Shahidullah, 1994). Unmodified non-human milks may not provide optimal nutrient balance, especially for the malnourished (Brown *et al.*, 1994).

The relatively delayed introduction of solid complementary foods might be interpreted as an adaptation for maximizing young child nutritional quality in a socioecological environment offering an extremely limited range of weaning food alternatives. However, the nutrient densities of stiff maize porridges used by east African pastoralists are often too low to meet the needs of young children (Selinus *et al.*, 1971), and the Datoga do not germinate or ferment the maize before cooking (as in neighbouring populations, maize has replaced sorghum and finger millet since the colonial period). While the use of boiled cow-fat (ghee) and clarified butterfat for feeding infants and 1-year-olds, respectively, has the potential to improve the calorie and fat-soluble vitamin content of complementary foods, it was found that, once introduced, these foods were not fed as frequently as maize meal.

It is difficult to assess the adequacy of breast-feeding duration without internal comparisons of subsequent growth and survival, since current recommendations concerning the optimal minimal duration of breast-feeding are vague. On average breast-feeding is not of particularly long duration in comparison with other rural African populations. The population displays a breast-feeding pattern with a slow decline in the first year and a quite rapid decline in the second year. The 1-year and 2-year continued breast-feeding rates were approximately 75% and 20% respectively. While this general pattern is typical of the national patterns observed in most east African countries examined in the recent Demographic and Health Surveys (Perez Escamilla, 1993), the median duration of breast-feeding (estimated at 21 months after adjustment for truncation bias using survival analysis) falls towards the low end of the range found typical of the rural population in east and central Africa (range 19–24 months). It is very similar to that reported for other sub-Saharan pastoralists, such as the Ngisonyoka Turkana pastoralists of northern Kenya (18·2 ± 2·6 SE and 20·4 ± 1·2 SE, based on truncated and untruncated cohorts, respectively: Gray, 1994), and various sections of the Fulani pastoralists of Mali (22, 20 and 17 months estimated from demographic data using the incidence/prevalence method: Hill & Thiam, 1987), but much greater than the value of 12·5 months reported for a Negev Bedouin population participating in a planned settlement scheme in Israel (Nagpan *et al.*, 1991).

The validity of the results may be questioned because of the small sample size, frequent loss to follow-up and a reliance on retrospective reports. In particular, the high rates of loss to follow-up, leading to frequent right-censoring of prospective observations, and the use of retrospective data may have introduced biases in estimates of the general temporal pattern of the weaning process. If highly mobile households differed in unmeasured ways from the households which migrated less frequently, the children measured only once may have been exposed to different care and feeding practices than those observed longitudinally. If mother's reports were inaccurate, then the use of retrospective data was not justified. Since the data from more mobile households will have been more likely to be recalled these biases might interact.

In fact, there was little evidence that either sampling or recall bias were sufficient to invalidate the study. First, there were few indications that young child feeding practices varied markedly with degree of household mobility within the community. No systematic baseline differences were identified between the individuals lost to follow-up and those who remained in the study (Table 1). Second, the fact that more boys were recruited into the study and a higher proportion of boys were successfully followed up could not be attributed to sample bias or preferential reporting of the presence of young boys in households because the sampling period ensured that all households in the area were exhaustively censused and that all those with small children were contacted. Although the sample was biased towards more sedentary households, there was also no difference in the young-child sex ratio of households that consented to take part in the study and those that did not. Third, when the sample was stratified by approach for data collection, estimated population-level descriptors for the process of weaning derived from maternal recall showed good agreement with those derived from longitudinal observation (Table 4). This was probably due to both the cultural context, in which most mothers were very comfortable with recognizing weaning milestones and eloquent in describing the circumstances in which they occurred, and the study design, by which maternal reports focused only on the weaning history of a youngest child born on average just over a year prior to first interview. Retrospective reports suggested an earlier introduction of non-human milks and cessation of breast-feeding than the prospective data, but the difference was only statistically significant for the latter. Even this result did not necessarily indicate inaccuracy of maternal recall because it could also be attributed to truncation bias in the retrospective data. Estimates from recall will always be down-biased because children fully weaned at the time of first visit were more likely to have been children who were weaned earlier than the average. Importantly, the retrospective reports were not heaped in a particular month, a particular season, or at a particular period of time prior to interview and exclusion of 10 retrospective reports for which there was a suspicion that different milestones may have been conflated had no effect on the general results. The finding that cross-sectional retrospective data and longitudinal data were broadly consistent was encouraging given the enormous difficulties of reducing sampling errors when investigating semi-nomadic pastoral populations (Sellen, 1996). Errors introduced by small sample size were of as much concern as recall bias. Pooling seemed justified given that the milestones were chosen for analysis only to provide an impression of the general scheduling of the gradual process of weaning. Although pooling of the data for analysis will also have resulted in some downward bias (reducing accuracy) it probably reduced the errors associated with small sample size and follow-up bias (improving precision).

In sum, these limited data serve as a useful index of general patterns until further studies on larger samples and with longer follow-up periods are implemented. Further research is clearly needed before a proper assessment of the adequacy of complementary feeding practices among the Datoga can be made. For example, the present study provided no data on the actual caloric values of the weaning foods prepared, the bio-availability of micronutrients in milk and animal fats either before or after treatment by boiling, or the potential appetite-diminishing effect of a diet with limited organo-leptic diversity. Nevertheless, the descriptive data are of value in

focusing attention on some key knowledge gaps for both the Datoga and other African pastoral populations.

First, although animal products may be an excellent source of nutrients, these data suggest that the wide availability and use of non-human milks and the paucity of vegetable foods and available meat result in earlier supplementation and later complementation than would be recommended. The use of non-human milks is likely to be a response not simply to its increased availability in a pastoral society, but to severe constraints on women's time allocation due to the nature of women's labour. A common context for feeding of non-human milks involved the leaving of infants with allo-carers while the mother was involved in work activities, such as collecting water and fuel-wood, which kept her away from the homestead for large periods of the day. The proportion of days on which this occurs depends on season, location of the homestead, and labour arrangements within households. Mothers expressed very positive views about the value of breast milk relative to cows milk and other foods, and always stated it was a more appropriate food for weanlings. Therefore it is likely that mothers must trade off breast-feeding adequacy to meet competing demands, and that feeding practices are more strongly related to maternal preferences and socioeconomic circumstances than to household or seasonal availability of weaning foods. Similarly, continued supplementation with non-human milks rather than alternative weaning foods appears to be a response to the severely limited choice of semi-solid weaning foods available. The specific determinants of individual feeding and care-giver practices deserve further investigation, since these trade-offs are apparently not the same for all mothers. Large variations in feeding practices were observed within the population, with some children receiving more appropriate treatment than others.

Second, in providing baseline data on current young child practices among a semi-nomadic community this study highlights a need to study the impact of socioeconomic transitions on the trade-offs influencing feeding practices. The various economic and political pressures to which the Eyasi Datoga and similar populations are currently exposed may ultimately lead to large changes in subsistence, mobility and income. It would be useful to be able to predict the consequences for child nutrition, but without further studies, what these might be can only be speculated. Feeding practices would be expected to change with permanent settlement or shifts in subsistence practices. If settlement or a shift away from pastoral livelihoods were accompanied by a re-structuring of women's work to include activities which did not entail the frequent separation of mothers and young children one might predict that continued breast-feeding rates and duration would increase. Such re-structuring might be possible if sources of fuel and water became more accessible. If such transitions were also associated with an increased availability of more appropriate weaning foods, and a reduction in infection rates, the growth performance of weanlings would undoubtedly improve. However, since there is currently a lack of comparative evidence on the compatibility of agricultural or market tasks among recently settled east African pastoral women, and only very limited data showing that weaning diets or child health tend to improve with such changes (Brainard, 1991; Little, Gray & Leslie, 1993), it cannot be assumed that such changes would not lead to less adequate feeding practices.

Conclusions

Weaning practices among the Eyasi Datoga, a community representative of other semi-nomadic African pastoralists, do not meet current international recommendations. The timing of introduction and quality of complementary foods may be inappropriate. The wide availability and use of non-human milks and the paucity of vegetable foods available to this community appear to encourage supplementation which is too early, and complementation which is too late, according to current recommendations. These may contribute to the poor growth performance of young children. Thus, the data reveal aspects of indigenous feeding practices which should be encouraged in any maternal child health initiatives (universal initiation, extended partial breast feeding) and aspects which might justify modification (reduction in use of prelacteal feeds, later introduction of supplementary feeds, development of culturally appropriate improved weaning foods).

Acknowledgments

This work was supported in part by grants from the LSB Leakey Foundation, the Royal Anthropological Institute of Great Britain, The Leverhulme Trust, the Wenner–Gren Foundation for Anthropological Research and the University of California at Davis. Analysis was carried out at the Program in International Nutrition, Department of Nutrition, The University of California, Davis. The author also thanks Monique Borgerhoff Mulder and Kathryn Dewey for comments on earlier drafts.

References

ABDS. (1991) Innocenti declaration on the protection, promotion and support of breast-feeding. *Ecol. Food Nutr.* **26**, 271–273.

BORGERHOFF MULDER, M. (1992) Demography of pastoralists: Preliminary data on the Datoga of Tanzania. *Hum. Ecol.* **20**, 383–405.

BRAINARD, J. (1991) *Health and Development in a Rural Kenyan Community*. Peter Lang, New York.

BROWN, K., BLACK, R., LOPEZ DE ROMANA, G. & CREED DE KANASHIRO, H. (1989) Infant-feeding practices and their relationships with diarrheal and other diseases in Huascar (Lima), Peru. *Pediat.* **83**, 31–40.

BROWN, K., CREED-KANASHIRO, H. & DEWEY, K. (1994) *Optimal Complementary Feeding Practices to Prevent Childhood Malnutrition in Developing Countries*. Paper presented at Cornell/UNICEF Colloquium on Care and Nutrition for the Young Child, Aurora, NY.

CENTERS FOR DISEASE CONTROL (1989) *EPI-INFO*. Centers for Disease Control and Prevention, Atlanta.

COHEN, R., BROWN, K., CANAHUATI, J., RIVERA, K. & DEWEY, K. (1994) Effects of age of introduction of complementary foods on infant breast milk intake, total energy intake, and growth: a randomised intervention study in Honduras. *Lancet* **344**, 288–293.

COUSENS, S., NACRO, B., CURTIS, V., KANKI, B., TALL, F., TRAORE, E., DIALLO, I. & MERTENS, T. (1993) Prolonged breast-feeding: no association with increased risk of clinical malnutrition in young children in Burkina Faso. *Bull. Wld Hlth Org.* **71**, 713–722.

CUNNINGHAM, A., JELLIFFE, D. & JELLIFFE, E. (1991) Breast-feeding and health in the 1980s: A global epidemiologic review. *J. Pediat.* **118**, 659–666.

Department of Health, Education and Welfare (1977a) *NCHS Growth Curves of Children, Birth–18 years, United States*. Series 11, Vol. 165. DHEW Publication No. (P.H.S.) 78-1650, Washington.

Department of Health Education and Welfare. (1977b) *NCHS Tables of Growth, Birth–18 years, United States*. Series **11**, Vol. 124. Washington.

Dewey, K., Heinig, M., Nommsen, L. & Lonnerdal, B. (1990) Growth patterns of breast-fed infants during the first year of life: the DARLING study. In: *Breastfeeding, Nutrition, Infection and Infant Growth in Developing and Emerging Countries*, pp. 269–282. Edited by S. A. Atkinson, L. A. Hanson & R. K. Chandra. ARTS Biomedical Publishers and Distributors, St John's, Newfoundland, Canada.

Fjaestem, R. & Kostinsky, M. (1984) Interventions for the control of diarrhoeal diseases among young children: promotion of breast-feeding. *Bull. Wld Hlth Org.* **62**, 271–291.

Frisancho, A. (1990) *Anthropometric Standards for the Assessment of Growth and Nutritional Status*. The University of Michigan Press, Ann Arbor.

Galvin, K., Coppock, D. & Leslie, P. (1994) Diet, nutrition and the pastoral strategy. In: *African Pastoralist Systems. An Integrated Approach*. pp. 113–132. Edited by E. Fratkin, K. Galvin & E. Roth. Lynne Rienner Publishers, Boulder.

Gibson, R. (1990) *Principles of Nutritional Assessment*. Oxford University Press, New York.

Gray, S. (1994) Comparison of effects of breast-feeding practices on birth-spacing in three societies: Nomadic Turkana, Gainj, and Quechua. *J. biosoc. Sci.* **26**, 69–90.

Gunnlaugsson, G., Clotilde da Silva, M. & Smedman, L. (1993) Age at breast feeding and postneonatal growth and survival. *Archs Dis. Childhood* **69**, 134–137.

Hill, A. & Thiam, A. (1987) *Marriage, inheritance and fertility amongst the Mulim Fulani*. Paper presented at The Cultural Roots of African fertility regimes, Ife-Ife, Nigeria.

Howie, P., Forsyth, J., Ogston, S., Clark, A. & Florey, C. (1990) Protective effect of breast feeding against infection. *Br. med. J.* **300**, 11–16.

Jahnke, H. (1982) *Livestock Production Systems and Livestock Development in Tropical Africa*. Kieler Wissenschaftsverlag Vauk, Kiele.

Jason, J., Neiburg, P. & Marks, J. (1984) Mortality and infectious diseases associated with infant feeding practices in developing countries. *Pediat.* **74**, 702–727.

Jelliffe, D. & Jelliffe, E. (1989) *Community Nutritional Assessment with Special Reference to Less Technically Developed Countries*. Oxford University Press, New York.

Kontz-Bodher, P., Pisiman, C., Parlato, M. & Roberts, A. (1990) *Answering Key Questions: Recommendations from the Expert Meeting on Optimal Infant Feeding Practices*. Bureau for Science and Technology, Office of Nutrition, USAID.

Leslie, P. & Gage, T. (1989) Demography and human population biology: problems and progress. In: *Human Population Biology. A Transdisciplinary Science*, pp. 15–44. Edited by M. Little & J. Haas. Oxford University Press, New York.

Little, M. A., Gray, S. J. & Leslie, P. W. (1993) Growth of nomadic and settled Turkana infants of north west Kenya. *Am. J. phys. Anthrop.* **92**, 273–289.

Maher, V. (1992) *The Anthropology of Breast-Feeding: Natural Law or Social Construct*. (Cross-Cultural Perspectives on Women) Berg, Oxford/Providence.

Molbak, K., Gottschau, A., Aaby, P., Hoiyng, N., Ingholt, L. & da Silva, A. (1994) Prolonged breast feeding, diarrhoeal disease, and survival of children in Guinea-Bissau. *Br. med. J.* **308**, 1403–1406.

Naggan, L., Forman, M. R., Sabov, B., Lewando-Hundt, G., Zangwill, L., Chang, D. & Berendes, H. W. (1991) The Bedouin infant feeding study: study design and factors influencing the duration of breast feeding. *Paediat. Perinatal Epidemiol.* **5**, 428–444.

Perez-Escamilla, R. (1993) Update on the breastfeeding situation in Africa. *Nutr. Res.* **13**, 597–609.

RAO, S. & KARADE, A. (1992) Prolonged breast-feeding and malnutrition among rural Indian children below 3 years of age. *Eur. J. clin. Nutr.* **46**, 187–195.

SANDFORD, S. (1983) *Management of Pastoral Development in the Third World.* John Wiley and Sons, London.

SELINUS, R., GOBEZIE, A., KNUTSSON, K. & VAHLQUIST, B. (1971) Dietary studies in Ethiopia: dietary pattern among the Rift Valley Arsi Galla. *Am. J. clin. Nutr.* **24**, 365–377.

SELLEN, D. (1995) *The Sociaecology of Young Child Growth among the Datoga Pastoralists of Northern Tanzania.* PhD thesis, University of California, Davis.

SELLEN, D. (1996) Nutritional status of sub-Saharan African pastoralists: A review of the literature. *Nomadic Peoples*, **39**, 101–134.

SELLEN, D., SIEFF, D. & BORGERHOFF MULDER, M. (1993) *Human Ecology, Subsistence, and Reproduction of Pastoralists in the Lake Eyasi area of Arusha Region, Tanzania.* Tanzania National Research Council, Dar es Salaam, Tanzania.

SHAHIDULLAH, M. (1994) Breast-feeding and child survival in Matlab, Bangladesh. *J. biosoc. Sci.* **26**, 143–154.

SHELL-DUNCAN, B. (1995) Impact of seasonal variation in food availability and disease stress on the health status of nomadic Turkana children: A longitudinal analysis of morbidity, immunity and nutritional status. *Am. J. hum. Biol.* **7**, 339–355.

SPSS INC. (1993) *SPSS Proprietary Software, Release 6.0.* SPSS Inc., Chicago, IL.

STUART MACADAM, P. & DETTWYLER, K. (1995) *Breastfeeding: Biocultural Perspectives.* Foundations of Human Behavior. Aldine de Gruyter, New York.

THAPA, S., SHORT, R. & POTTS, M. (1988) Breastfeeding, birth spacing and their effects on child survival. *Nature* **335**, 679–682.

UNDERWOOD, B. & HENDRATMER, Y. (1982) Appropriate timing for complementary feeding of the breast-fed infant. A review. *Acta paediatr. scand. Suppl.* **294**, 6–32.

USAID (1979) *Basic Field Surveys of Nutritional Status of Young Children.* Monograph No. 1 Office of Nutrition, USAID, Washington.

WHO/CDC (1991) *Report of the WHO Working Group on Infant Feeding. Key Breast feeding Indicators and Specific Methodologies for their Measurement.* WHO/CDC/UNICEF/USAID/DHS.

WINIKOFF, B. (1983) The effects of birth spacing on child and maternal health. *Stud. Fam. Plann.* **14**, 231–245.