The impact of morbidity on food intake in rural Kenyan children

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Keywords: morbidity, food intake, Kenya

Abstract

Objective: To quantify the effect of common illnesses on energy intake in rural Kenyan children.

Design, setting and subjects: Toddlers in rural Kenya (n = 110) were studied longitudinally from 18-30 months of age in the mid-1980s.

Outcome measures: Morbidity data were collected weekly using an illness questionnaire and physical inspection. Food intake was quantitatively assessed on two successive days each month. Food intake on days of illness was compared to food intake on days of wellness and during convalescence.

Results: Significant decreases in mean daily energy intake were seen between days of wellness vs. days of severe illness. Above usual intake was observed during convalescence. Girls showed a greater reduction in intake during illness compared to boys. Food intake reductions were greatest in children with gastrointestinal (diarrhoea) and lower respiratory tract infections, measles and other febrile illnesses. In the case of severe illness, a compensatory increase in intake during week one of the convalescence period was observed, being greater in girls (376 kcal vs. 71 kcal extra per day for boys).

Conclusion: Food intake is decreased during common acute illnesses in children and increased above their usual intake during convalescence. Food should not be withheld from sick children and feeding should be actively encouraged during illness, particularly during convalescence with the return of appetite. These data, although somewhat dated, are still applicable to toddlers in rural Africa where malnutrition and feeding practices have changed very little.

Ⓟ **Peer reviewed. (Submitted: 2012-01-31. Accepted: 2012-07-30.) © SAJCN**
S Afr J Clin Nutr 2012;25(3):142-148

Introduction

The synergism between malnutrition and infection is a leading cause of morbidity and mortality in young children in low-income countries.[1-3] Infections not only produce catabolic effects and malabsorption, but depending on the nature and severity of the infection, they are often accompanied by anorexia and reduced food intake.[4] Aside from some gross estimates and approximations,[5,6] the decline in food intake by type of illness has not been clearly delineated. It is assumed that anorexia and malabsorption are main factors that contribute to associated malnutrition. Imposed dietary restrictions, including cultural food avoidances and iatrogenic practices, such as purging the body of perceived “toxins”, may further contribute to malnutrition. Moreover, feeding a sick child may take considerably longer than feeding a well child, time that rural mothers may not have. Because of the high incidence and prevalence of mild and severe illnesses, predominantly respiratory tract infections, gastrointestinal disease and a variety of febrile illnesses, a significant negative impact on a child’s growth and nutritional status might be expected, as amply demonstrated in the literature.[7-9] However, there is lack of quantitative information on food intake changes during illness in developing countries.

The impact of acute morbidity on food intake was quantified in a sample of 110 toddlers followed longitudinally in the Kenya Nutrition Collaborative Research Support Program (NCRSP) in the mid-1980s.[10,11] To date, this is one of a few field studies that has documentation of weekly morbidity in children living at home and which quantitatively measured food intake analysed on days with and without illness and during the convalescence period. The withholding of food during illness was not a common practice in the study population.[11] The objectives of this analysis were to quantify the effect of common illnesses on energy intake and compare this intake to the intake during wellness periods, to compare which specific illness categories caused the greatest decline in intake and to analyse whether the intake during convalescence was increased above usual intakes in compensation for any illness-related decreases.

Method

Study background and sample

Geographic area

The study was conducted in a 60 km^2 area in the rural Embu district, Kenya, on the south-east slopes of Mount Kenya. The area has no electricity and few all-weather roads. The water supply is derived mainly from rivers, streams and ponds. Only a few households have access to piped water. Within the study area, there is a mission hospital, a government health centre with a small maternity and children's ward, several dispensaries for treating minor illnesses and a district hospital that is 32 km away. The health facilities are within 5-10 km of most households and are mainly reached on foot. Immunisation rates for diphtheria, pertussis, tetanus and bacille Calmette-Guérin (BCG) are > 90%, and 83% for measles, as this is an Expanded Program for Immunisation site. There were no available data on the human immunodeficiency status (HIV) status of the children and pregnant women in the study area at the time of the study.

Sample

Of the 1 059 households in the study area, a sample of 290 households, that consisted of a biological mother and father with children of designated ages, was enrolled in the larger NCRSP study.[10,11] Two hundred and forty-seven households of the 290 that were enrolled completed the main study. One hundred and twenty of these 247 had toddlers. These toddlers were each followed from 18-30 months of age and comprised the analytical sample for this study. Toddlers with chronic physical or developmental problems were not included in the study sample. All study families belonged to the Embu tribe and lived on one- to two-acre farms, grew subsistence crops, mainly maize and beans and a few cash crops, and kept a small number of livestock for consumption: mainly goats for milk products and occasionally chickens. Most families resided in small one- to two-room houses that were constructed of mud and wood frames, with dirt floors and thatched roofs, and less frequently tin roofs. Many were without latrines. The mean household size was seven people.

Table I: Comparison of analytical sample with total study sample for illness and wellness

	Analytical sample number of illness episodes	Total sample number of illness episodes	% illness episodes captured in analytical sample*
Male			
Illness: total	217	696	31.2
Mild	198		
Severe	19		
Wellness	256	448	57.1
Female			
Illness: total	282	922	30.6
Mild	261		
Severe	21		
Wellness	287	520	55.2

* Illness captured on days with measured food intake

Complete data were available for 110 of the 120 toddlers (57 boys and 53 girls). The total number of illness episodes that coincided with days of quantitatively measured food intake are presented in Table I. Compared to the total number of days with illness episodes for the entire toddler sample, the sample with illness and concomitant food intake measurements represented 30.8% with mild and severe episodes and 56.1% with wellness episodes.

Method

Morbidity

Methods for morbidity data collection have been described in detail in a previous publications and reports.[10] In brief, information on morbidity was collected during weekly visits using an illness questionnaire and physical inspection carried out by enumerators who were trained and supervised by the project nurse and physicians. The caregiver, usually the mother, was asked to describe any signs or symptoms of illness that the child had experienced in the past seven days using her own words. Illnesses were then recorded using a checklist organised by broad illness categories, listing relevant specific signs and symptoms. If the child was sick, a physical examination was carried out using a standard list of signs and symptoms by the enumerator. Any observations that were relevant to the reported illness were recorded. The start and end dates of illness signs and symptoms, the informant, the facility, consulted healthcare provider and type of treatment received, if any, based on inspection of the child's clinic card, were included.

Continuing illnesses were followed within the subsequent days to determine their end dates or whether they were ongoing. In cases of puzzling illnesses or potential or actual serious illness, the supervising nurse and/or physician revisited the child in the next few days and determined whether immediate intervention or referral were needed. As a quality control measure, five per cent of the morbidity interviews were repeated several hours later on the same day by a supervising nurse, with 95% agreement on the general category of reported illness. A nurse accompanied each of the enumerators once per week to observe their performance, validate their findings and indentify needed additional training.

Morbidity information collected by the enumerator for each weekly visit was coded onto a weekly summary of morbidity, according to diagnostic categories, by the physician or nurses in consultation with the enumerator. Illnesses were classified into one of 15 general categories, such as diseases of the skin, ears, mouth, throat, respiratory tract and gastrointestinal tract and communicable diseases. Each general category was further divided into specific conditions, where possible. For example, communicable diseases included measles, mumps and pertussis. The specific disease category was determined from reported and observed signs and symptoms that were recorded on the weekly forms, from information from clinics and hospital visits and from laboratory tests, treatments and diagnoses. In coding, the most clinically unifying diagnosis was determined by the physician and nurses. Each illness episode was coded as mild or severe, based on predetermined criteria.[12,13] Start and end dates of the illness were recorded, permitting calculations of illness duration, convalescence and wellness periods.

Diarrhoea was defined as ≥ 3 watery stools per 24 hours. Mild diarrhoea was defined as watery, non-bloody stools without fever, vomiting or dehydration. Mild febrile illness was defined as oral temperature < 101°F. Upper respiratory tract disease was considered to be mild. The severe illness category consisted of communicable diseases, e.g. measles and pertussis, lower respiratory tract illness (pneumonia), severe diarrhoea (≥ 10 stools/day and/or few stools with vomiting and dehydration), high fevers (≥ 101°F) and clinical or proven malaria and meningitis.

All toddlers were followed longitudinally for a 12-month period, starting with the day they reached 18 months of age and ending with the day they reached 30 months. If two episodes of seemingly unrelated illness (mild or severe) were reported on the same day, these were counted separately. Each illness was coded. Wellness periods were defined as the periods in which no illnesses were reported or observed. Following a given illness, the subject would need to have had two consecutive illness-free days to be counted as well. In this way, each day during the observation period could be designated as a day of either illness or wellness. Convalescence was defined as the two weeks immediately following the end of a clinical morbidity episode. Therefore, convalescence was a period within the wellness period in which compensatory eating was noted to have taken place.

Food intake

Food intake was assessed on two successive days monthly. Trained enumerators measured and weighed recipe ingredients, meal portions, leftovers and snacks that were given to the toddler from 07h00-18h00. The mother was interviewed on the subsequent mornings for recall about foods that the toddler had consumed after 18h00 the previous day and before 07h00 the following morning. Food composition tables, based on biochemical analyses of predominantly local foods and relevant published food tables,[14] were used to determine the nutrient composition of the consumed foods. The mean daily energy intake that coincided with a day of illness or wellness or convalescence was used in the analyses. Food intake measurements by the enumerator were observed by the supervisor monthly on a five per cent subsample for quality control purposes.

To determine whether decreased energy intake during an illness episode was compensated for by a greater than usual intake during the convalescence period, comparisons were made between food intake during an illness, during convalescence (for two weeks) and during wellness periods. The above analyses were cross-sectional since food intake data on any given child during the illness and convalescence periods were not frequent enough to permit a longitudinal within-child analysis. Two assumptions were made regarding food intake: that food intake was constant for each day over the entire period of the illness and that intake was constant over the first 14 days of the convalescence period.

Statistical methods

Cross-sectional analyses were carried out using paired intake on days of wellness, days of illness and days of convalescence for each child and according to each illness category. A general linear model programme correction for unequal sample size was applied. Measures repeated over time for each subject were averaged to obtain an estimate of the subject's mean intake for each type of illness, convalescence and wellness episodes. Weighted means and standard deviations were then computed across subjects for each gender group to obtain least squares estimates of the true group means. The weightings were proportional to the number of estimates of between-subjects variability. Tests of statistical significance between mean food intake for each illness state (mild or severe compared to wellness) were computed using the general linear model with a categorical fixed effect for each illness type and a random effect for each child. The random effect removed the within-child variation in intake to allow comparable estimates of the illness and wellness food intakes.

Results

Energy intake

The overall mean daily energy intake, averaged over the 18th -30th month for each child, was 868 ± 874 kcal for boys and 840 ± 1 033 kcal for girls. This intake was ~83.5% and ~88% of the Food and Agriculture Organization/World Health Organization (WHO)/ United Nations University daily energy recommendations for boys and girls, respectively.[15] The diet was low in fat, with 14.8% of kcal derived from fat and 16% of kcal derived from animal sources, predominantly cow's and, to a lesser extent, goat's milk. Maize was the main staple that was eaten. Occasional millet, sorghum and beans were the primary sources of energy and protein. There were some dark green vegetables in the stews. Little or no breast milk was consumed after 18 months.

Anthropometric nutritional status

The children in this study were generally stunted (height-for-age z scores -1.9 ± 1.1 for boys and -1.9 ± 0.9 for girls) and underweight for age (weight-for-age z scores -1.43 ± 0.1 for boys and -1.52 ± 1.0 for girls), compared to the formerly used WHO-adopted National Center for Health Statistics reference data.[16] Linear growth was relatively more retarded than weight. No children with overt marasmus or kwashiorkor were found among the sample.

Morbidity

The leading categories of morbidity in this subsample of children were acute upper respiratory tract infections, which included bronchitis, tonsillitis, pharyngitis and laryngitis; skin and eye infections; stomatitis; diarrhoeal disease; and fever and clinical malaria (see Table II). Spleen enlargement, a reflection of endemic malaria, was present on physical examination in 13% of the sample. No deaths occurred in the toddler group during the year of observation.

Thee average child in the study was illness free 63.9% of the time and ill 36.1% of the time. Ninety per cent of illnesses were considered to be mild and 10% were considered to be severe. Girls were observed or reported to be sick slightly more often than boys (38.9% for girls compared to 33.1% for boys). However, the prevalence of severe illness in girls was double that of boys (4.6% vs. 2.4%) (Table III). As seen with prevalence, girls had a slightly higher incidence of

Table II: Proportionate morbidity for toddlers (18-30 months): new episodes over one year

	% of episodes		% of time	
	Boys (n = 53)	Girls (n = 57)	Boys (n = 53)	Girls (n = 57)
Respiratory tract infections				
Upper	45.5	41.2	52.8	49.5
Lower	0.3	1.2	0.2	1.4
Otitis media	0.1	1.5	0.1	1.5
Gastrointestinal tract diseases				
Diarrhoea	7.8	8.6	4.0	3.9
Upper gastrointestinal tract (nausea and vomiting)	4.0	4.5	2.5	2.0
Oral cavity diseases				
Stomatitis and sore tongue	0.9	1.3	0.7	0.9
Dental	0.1	0	0.1	0
Fever				
Fever only	6.3	3.6	2.8	1.3
Clinical malaria	3.7	3.5	2.1	1.3
Eye infections	17	18.8	19.2	19.6
Skin infections	2.0	2.9	2.5	3.2
Urinary tract infections	0.1	0.2	0.1	0.2
Other	12.2	12.7	12.9	15.0

Table III: Toddlers' illness prevalence for one year (from 18-30 months of age)

Groups	% of episodes*		Days per year	
	Mean	SD	Mean	SD
Male and female toddlers combined (n = 110)				
Illness	36.1	20.4	132.0	74.0
Severe	3.5	6.0	13.0	22.0
Mild	32.5	20.7	119.0	76.0
Male toddlers (n = 53)				
Illness	33.1	19.5	121.0	71.0
Severe	2.4	4.0	9.0	14.0
Mild	30.7	19.8	112.0	72.0
Female toddlers (n = 57)				
Illness	38.9	20.9	142.0	76.0
Severe	4.6	7.3	17.0	27.0
Mild	34.3	21.5	125.0	79.0

* Observation period for toddlers was one year (18 months-30 months of age).
SD: standard deviation

illness than boys and a longer mean duration (30.1 vs. 14.5 days on average for severe illnesses).

Mean food intake on days of wellness and illness

Mean energy intakes on days of wellness vs. days of illness (mild and severe) and for mild vs. severe illness are presented in Table IV. Statistically significant differences in mean daily energy intake were seen between days of wellness vs. days with severe illness and between days with mild vs. severe illness. Small differences between mild illness and wellness intake were present, but not statistically significant. Girls not only experienced double the number of severe illness episodes of longer mean duration (Table III), but also showed a greater reduction in intake during illness compared to the boys.

Reduction of energy intake for specific disease categories

Person-averaged daily kcal intake per illness category was compared to each child's own mean wellness intake. Negligible or no decrements in energy intake were seen with eye and skin infections, mild diarrhoea, low-grade febrile illnesses (< 101°F) and stomatitis. For the group as a whole, illnesses that were consistently accompanied by large, statistically significant decreases (p-value < 0.05) in food intake were symptomatic gastrointestinal complaints, such as abdominal pain, vomiting and severe diarrhoea, upper and lower respiratory tract infections, measles and febrile illnesses (> 101°F), which mainly included otitis media and clinical malaria (see Table V).

Significantly decreased energy intake was found in children with pneumonia, measles and malaria for boys and girls combined (see Table V). Although large decreases in food intake were seen with malaria (see Table V), these decreases were not statistically significant given the small number of illnesses that coincided with days of food intake data collection and the large intra-person variances in food intake. Among boys, only symptomatic gastrointestinal disease and vomiting were associated with significant decreases in energy intake compared to their wellness food intake. Among girls, diarrhoeal disease, measles and lower respiratory tract infection, in particular, were associated with large and statistically significant decreases in food intake.

Food intake during the illness and convalescence periods compared to wellness intake

Boys decreased their intake during severe illnesses by 220 kcal/day when compared to their days of wellness (see Table IV). Given that the mean duration of a severe illness in boys was 14.5 days, boys missed out on an average of 3 190 kcal per severe illness (mean decrease in severe illness was 220 kcal/day x 14.5 days duration). For the first week of convalescence, boys ingested 71 kcal/day below wellness levels, from 795-866 kcal/day. During the second week of convalescence, boys increased their intake by 151 kcal/day above wellness levels. At the end of the two weeks of convalescence, the male child had a mean deficit of 2 630 kcal/day due to severe illness (assuming unrealistically that no other illness intervened). Therefore, an additional 188 kcal/day for approximately two weeks would be required for recovery of the energy lost due to a severe illness.

During severe illnesses, girls decreased their intake by 247 kcal/day when compared to their wellness intake (see Table IV). Given that the mean duration of severe illness in girls was double that of boys (30.1 vs. 14.5 days), the mean loss per severe illness was 7 435 kcal (mean decrease in severe illness was 247 kcal/day x 30.1 days duration). For the first week in convalescence, girls ingested an extra 376 kcal/day above wellness levels, from 844-

Table IV: Comparison between food intake (kcal/day) during wellness and mild and severe illness episodes (weighted kcal/day)

	Boys and girls combined			Boys			Girls		
	N1	N2	Mean ± SD	N1	N2	Mean ± SD	N1	N2	Mean ± SD
Wellness	110	1 572	855* ± 713	53	795	866* ± 687	57	777	844* ± 740
Illness									
Mild	102	1 161	848* ± 830	47	512	883* ± 797	55	649	819* ± 852
Severe	33	93	612 ± 449	12	28	646 ± 415	21	65	597 ± 474

NI: number of toddlers, N2: number of observations, * Significantly different compared to intake during severe illness, p-value < 0.001-0.002, SD: standard deviation

Table V: Reduction in daily energy intake (kcal/day) by illnesses categories compared to intake on days of wellness

Illness	Male		Female		p-value**
	N	Mean ± SD*	N	Mean ± SD*	
Upper respiratory tract infection	43	-27 ± 35	51	-62 ± 237	0.002
Lower respiratory tract infection	0	-	4	-520 ± 167	0.03
Fever	7	-132 ± 311	5	-52 ± 332	0.02
Clinical malaria	5	-243 ± 319	4	-264 ± 401	0.10
Diarrhoea	10	142 ± 614***	12	-243 ± 317	0.09
Measles	0	-	3	-232 ± 440	0.03
Vomiting and abdominal pain	5	-224 ± 281	12	-285 ± 301	0.02

N: number of illness observations (one per person), * Illness-associated decrease (kcal/day), ** p-values associated with differences between wellness and sickness intake in girls and boys combined, *** Increase in intake

Table VI: Energy intake (kcal/day) during convalescence from mild and severe illness: measured in first week and during remainder of convalescence (weighted means)

	Boys and girls combined			Boys			Girls		
	N1	N2	Mean ± SD	N1	N2	Mean ± SD	N1	N2	Mean ± SD
Mild illness									
First week	90	177	797 ± 332	42	83	848 ± 321	48	94	751 ± 332
Second week	107	513	871 ± 479	53	274	868 ± 461	54	239	874 ± 500
Severe illness									
First week	11	13	959 ± 443	8	8	795 ± 371	3	5	1 220 ± 472
Second week	17	35	941 ± 271	7	15	1 017 ± 299	10	20	883 ± 233

N1: number of individuals, n2: number of observations, SD: standard deviation

1 220 kcal/day. During the second week of convalescence, girls increased their intake by only 39 kcal/day above wellness intake. Despite the sizeable compensatory intake during the first week of convalescence, girls still had a deficit of 4 530 kcal per severe illness at the end of convalescence, nearly double the deficit that was seen in the boys. Girls would need an additional 200 kcal/day for nearly four weeks or 400 kcal/day for two weeks to fully regain energy that was lost during a severe illness. There was no compensatory increase in intake during the convalescence period for mild illness (see Table VI).

Discussion

This study of mild to moderately malnourished children using simultaneously collected longitudinal food intake and morbidity measurements enabled the estimation of the impact of mild and severe disease on energy intake. Subsequent long-term effects of illness on linear growth have been noted previously.[9] The full range of illnesses was studied in contrast to those studies that focused mainly on diarrhoeal diseases. Because food intake was documented in a quantitative fashion during periods of wellness, illness and convalescence in a free-living population, any compensatory energy intake during convalescence was able to be observed.

Consistently large daily food intake deficits were seen for lower respiratory tract infection and upper gastrointestinal tract symptoms, such as vomiting with abdominal pain, and with fever and diarrhoea. Advantage was taken of the longitudinal within-child data. Wellness, illness and convalescence food intakes were averaged for each child. This allowed each child to serve as its own control for confounders, such as home environment, season, type of diet and age and gender. This produces greater validity than cross-sectional studies.

Over the first week of the convalescence phase, it appeared that in the case of mild illness, the slight, if any, decreases in intake gradually returned to wellness levels. In the case of severe illness, in the first week of the convalescence period in girls and the second week in boys, a steep increase in intake was seen that exceeded the usual wellness intake and then gradually declined to wellness levels. However, when taking into account the duration of the illness during which the decreased intake occurred, there was still not sufficient additional energy intake during convalescence to compensate for the estimated loss of intake during the serious illness. Thus, the cumulative effect was a net loss of energy over time. Nevertheless, this study was not designed as a balance study and these analyses were only crude approximations. These analyses were also perhaps overestimations since we assumed that the food intake deficits were equal on each day of illness and the increased intakes were equal on each day of convalescence.

With regard to gender differences, there appeared to be a subtle, relative neglect of girls in Embu, perhaps leading to a greater incidence of more severe illness in girls than in boys. Perhaps the milder illnesses in girls were treated less carefully than those in boys and developed into severe illness. With regard to food intake, food may have been given preferentially to boys and more food may have been withheld from the girls during illness. Such a gender difference was noted in analyses of seven- to nine-year-old children in the same Kenya NCRSP study, and was seen to be statistically significant.[10,11] Age and gender have been noted as determinants of food distribution and dietary intake within families in other cultures in Bangladesh,[8] Guatemala[17] and India.[18] Another typical response to illness is to withhold food from an ill child, whether or not the child is anorexic. This was not observed to any large extent in Embu. Feeding a sick toddler can be very time-consuming. More studies are needed in the area of differential treatment of girls vs. boys to reach any definite conclusions. The larger compensatory convalescence food intake in girls may reflect the greater illness-associated deficit.

Potential consequences of energy deficit associated with serious illness

The total estimated energy deficit in kcal per severe illness for boys was shown to be 3 190 kcal. There was only a modest compensatory energy increase of 71 kcal/day in week one of convalescence and 151 kcal/day in week two. Girls, even with the additional 376 kcal/day in week one of convalescence, recovered only approximately one-third of the 7 435-kcal deficit that had resulted from a severe illness during the two-week convalescence period. A deficit in expected weight gain, based on an incidence of 1.8 episodes of severe illness per boy per year and 2.2 episodes of severe illness per girl per year, is projected if foregone kcal are converted into lost body mass. If it is assumed that if 3 500 kcal equals 0.45 kg of body mass, boys are at risk of not gaining 0.73 kg per year due to severe illness, and girls are at risk of not gaining 1.45 kg per year for the same reason. Although mild illnesses are associated with relatively small, if any, energy deficits, given the relatively great frequency of these illnesses, the energy loss may contribute to a deficit in weight gain as well.

Studies in several countries have documented decreased food intake during diarrhoea.[19-22] However, to our knowledge, our study is the only one that has documented food intake in a quantitative fashion during wellness, during acute illnesses other than diarrhoea or during the convalescence period in a free-living population. It appears that an important mechanism for the adverse effects of infection on nutritional status may be mediated, in considerable part, through decreased food intake associated with severe infectious disease episodes and lack of sufficient compensatory food intake in the convalescence period. The cumulative effect over one year could be considerable and result in significant deprivation of energy intake and adverse effect on growth.

Conclusion

Although the data for this study were collected some 20 years ago, we believe that the presented information is as relevant and current today as it was at the time of the data collection. Our research team continued working in the same study area until 2002 and, since then, in other areas of rural Kenya. The nutrition situation has not improved among rural children.[23] There have been economic hardships, increasing land pressure, recurring droughts and food insecurity. We have seen few changes in the morbidity patterns and quality of diet in the local population. Publication of these findings was delayed, as immediate funding became available for a series of ambitious and time-consuming randomised, controlled feeding intervention studies. The findings reported in this study were presented at several international nutrition meetings with published abstracts. However, we believe that the dearth of published research on this topic and the current relevance of the results warrant even delayed publication.

In conclusion, the large and significant decrease in food intake, particularly during severe acute illnesses in children, is underappreciated. Thus, the feeding of sick children, at least during the convalescence phase, is extremely important, particularly upon return of their appetite. Not only should food not be withheld from sick children, but feeding should also be actively encouraged in the absence of vomiting. Poor diet quality, micronutrient deficiencies and nutrient losses induced by infection,[24] especially diarrhoea, are no doubt present, but have not been considered in detail in this study.

Acknowledgements

We acknowledge Susan Weinberg Andersson for supervising the food intake data collection and analysing these data. We also wish to thank Maria Pia Chaparro for editorial and bibliographic assistance. This study was funded by the United States Agency for International Development Grant (# DAN-1309-G-SS-1070-00) under the Collaborative Research Support Program on Food Intake and Human Function.

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