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Intra-Household Correlations of Nutritional Status in Rural Ethiopia

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Background. It is commonly believed that households are relatively homogeneous with respect to nutritional status and occurrence of diseases. We therefore examined how anthropometric measurements are correlated between different household members in famine-prone Ethiopian communities.
Methods. We studied 1147 people in the Elka village in the Rift Valley.
Results. The results show that the correlations between the state of nutrition among household individuals are weak. Thus, anthropometric indices of young children, older children and adult men are an inefficient means of screening for maternal malnutrition. The low sensitivity and high specificity suggest that intra-household members may not fully share risk factors for malnutrition.
Conclusions. We question the commonly held view on the use of childhood nutritional indicators as proxies of household nutritional risks. Our study may have practical implications for screening programmes and interventions during famines. There is no short cut to separate screening of population subgroups.
Keywords: Ethiopia, malnutrion, families, famine

Malnutrition and sickness represent the main health problems in developing countries and often result from causes on the individual, household or community level.[1,2] The joint influences of nutritional or biological factors and social deprivation usually decide the health of individuals or groups of people. Thus, it is commonly believed that households are relatively homogeneous with respect to nutritional status and occurrence of diseases.[2]

Ethiopia never fully recovered from the great famine of the early 1970s. By the mid-1980s another drought and famine of major proportions affected large parts of the country.[3] Famine vulnerability and survival strategies varied considerably at the community and household levels, enabling some people to survive the food shortages better than others.[3] Some of the survival strategies employed by farmers included reduced food consumption and dietary changes; the consumption of famine foods (such as roots, grass seeds, wild berries, and fruits); the sale of household goods, personal belongings, livestock, and land. If all failed, then families tended to move to relief shelters, the women and children usually departing first, the men staying behind, hoping to cultivate in the event of rain.

Because food insecurity usually affects large parts of the population it is justified to study the state of nutrition of both families and communities. This is important in subsistence farming communities, in particular where drought and social unrest often result in food shortage and malnutrition. The issue of health and nutrition is thus not only of academic interest but also operationally of great public health relevance.

Anthropometric measurements are often used to assess nutritional status in an individual or in communities.[4] If a strong correlation between different nutritional indices exists within a household, measurements of an individual in the household can be used to predict the occurrence of malnutrition among other family members. During the famines in Ethiopia in the 1980s identification of malnourished children were used to predict the occurrence of malnutrition in households.[5,6]

The objective of this article is to examine how anthropometric measurements are correlated between different household members in famine-prone Ethiopian communities. Thus we want to estimate if an indicator of a particular group of individuals (i.e. children) can be used to make inferences about other household members (i.e. mothers).

MATERIALS AND METHODS

Study Area

This study is part of a larger investigation on the associations between health and nutrition in drought-prone areas of Ethiopia.[7,8] It was carried out in Elka na

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Mataramofa (Elka) in the central part of the rift Valley. This is a semi-arid savannah which has repeatedly been affected by drought and famines.

Elka, located 15 km north of the town of Zwai, is a typical rural village in the Ethiopian rift valley. The rift valley cuts through Ethiopia from north to south, and the central part, known as the Lakes' Region, is mainly inhabited by the Arsi people. The vegetation is that of a dry savannah. The main rainy season (Keremt) lasts from June to August and the small rains (Belg) occur in February and March. The annual rainfall varies between 600 and 900 mm.[9] Historically, the Arsi in the Rift Valley were nomads who raised cattle.[10] They based their social organization on the 'Gada system'. Today they are mainly Muslims and live in large villages with an economy based on subsistence and cash cropping agriculture. The main cash crops are tef (Eragrostis tef), beans and maize. Most households own some cattle, goats and sheep. Food production on the family plots is done by the men, while women perform domestic functions. However, women also participate in farming activities, especially during the harvest.[7]

Subjects

At the time of the study Elka had 271 households and a population of 1382 with age and sex distribution typical of rural Ethiopia.[11] Of the 1382 people living in the village, we studied 1147. In Elka, compared to census data, we observed a marked difference in the male to female ratio in the 20–39 year age group. The difference was mainly explained by military conscription. Thus, 17% of the population were missing and anthropometric measurements were done for 1147 people.

Methods

Anthropometry. All anthropometric measurements were carried out by field workers whose training included both inter- and intra-observer standardization on a sample of 42 young children from the same village. Checks on the length and height boards and weighing instruments were done throughout the study. The fieldworkers had completed 12 years of formal education and were familiar with the culture and language of the population in the study areas. Each enumerator was trained in preparation for the work, and was regularly supervised including random controls of their recording procedures.

All anthropometric measurements were done at a central location in the village. Instruments were regularly calibrated and the same people did the anthropometric measurements throughout the study. The same length board for infants was used on all length measurements and a height scale attached to a beam balance was used for older children and adults. Length/height measurements were made to the nearest mm. Children under 25 kg were weighed to the nearest 100 g by using 25-kg Salter hanging scales and a standard beam scale was used for heavier children and adults. All weighing scales were centred at zero at the start of each session. Left mid upper arm circumference (MUAC) was measured to the nearest mm with a tape by the standard method.[4]

As birth date registration is uncommon in Ethiopia, age was estimated from the local calendar and events.[4]

Due to the absence of a local standard, international references were used to compare the values of measurements. For children younger than 5 years of age height-for-age (H/A), weight for height (W/H) and weight-for-age (W/A) were compared with standards of the National Centre for Health Statistics (NCHS/WHO).[11] For children who were below two standard deviations of the NCHS median for W/A, W/H, and H/A were considered underweight, wasted or stunted, respectively.[12] For older children and adults the body mass index (BMI), calculated as weight(kg)/height(m)^2, was used to assess nutritional status. BMI values of 18.5, 17 and 16 respectively were used as thresholds below which a person was classified as mildly, moderately or severely malnourished.[13]

The US NHANES standard was used as a reference for the MUAC and TSF values.[4] For MUAC, adults with values $<$80% of the reference median (25.1 cm for men and 22.1 cm for women) were considered malnourished. Similarly, TSF measurements below the 5th percentile of the reference (10 mm for men and 20 mm for women) showed low energy reserve.

Analysis of data. The resulting data were entered into a computer and results checked to reduce data entry errors. Data analysis and statistical evaluation was done by the SPSS/PC+.[14] The weights and lengths/heights of our study were compared with the NCHS reference population and individual H/A, W/A and W/H Z scores calculated using CASP.[15]

There was no significant statistical difference between the state of nutrition for boys and girls (aged $<$18 years), so the data from the two sexes were combined in the analysis presented below.

A correlation analysis was used to investigate possible associations between nutritional indices within the household. As multiple significance testing was done for the correlation analysis, *P* values were corrected according to the Bonferroni method.[16] Probability levels of $<$0.05 were considered significant.

The sensitivity, specificity and predictive values of each of the nutritional indices of within household nutritional risk of young children were calculated.[17] We

TABLE 1 *State of nutrition among children and adult men and women*

Children 0–5 years old (No. = 268)			
H/A	<–3 (severe)(%)	(No. = 62)	23.5
	–3 to <–2 (moderate)(%)	(No. = 49)	18.6
	–2 to <–1 (mild)(%)	(No. = 51)	19.3
	⩾–1 (normal)(%)	(No. = 102)	38.6
W/A	<–3 (severe)(%)	(No. = 35)	13.3
	–3 to <–2 (moderate)(%)	(No. = 60)	22.7
	–2 to <–1 (mild)(%)	(No. = 66)	25.0
	⩾–1 (normal)(%)	(No. = 103)	39.0
W/H	<–3 (severe)(%)	(No. = 0)	0
	–3 to <–2 (moderate)(%)	(No. = 23)	8.7
	–2 to <–1 (mild)(%)	(No. = 65)	24.3
	⩾–1 (normal)(%)	(No. = 172)	65.2
Children 6–17 years (No. = 417)			
Mean BMI (SD)		15.8	(2.5)
BMI <16 (severely malnourished)(%)		66.4	
Mean MUAC in cm (SD)		16.7	(1.7)
Mean skinfold in mm (SD)		6.9	(2.2)
Adult women (No. = 265)			
Mean BMI (SD)		21.0	(2.6)
Mean MUAC in cm (SD)		24.4	(2.6)
Mean skinfold in mm (SD)		10.1	(4.3)
Skinfold <20 mm (%)		97.4	
Adult men (No. = 197)			
Mean BMI (SD)		19.8	(1.9)
Mean MUAC in cm (SD)		24.0	(1.9)
Mean skinfold in mm (SD)		5.5	(2.1)
Skinfold <10 mm (%)		95.5	

used the nutritional status among young children, older children and adult men to predict nutritional status among adult females.

RESULTS

Nutritional Status

Table 1 describes different anthropometric indices of the Elka community. The mean H/A, W/A and W/H Z-scores (SD) were –1.43 (1.84), –1.15 (2.00) and –0.50 (1.15), respectively. Stunting was common among young children (41.2% stunted) while wasting was found among 8.7% of the children. A low BMI was common among children aged 6–17 years: 65% of boys and 69.1% of girls had a BMI <16 and were thus classified as severely malnourished.

The mean height (SD) for women was 155 cm (6.3) and 167 cm (7.6) for men. The mean weight (SD) for women was 50.5 kg (7.2) and 55.4 kg (6.6) for men. Of women 17.4% were malnourised and of men 18.8% based on a BMI <18.5.

Intra-Household Correlations

Table 2 shows that some of the anthropometric measures for the different age-groups among children were significantly correlated with both maternal and paternal nutritional indices. The nutritional indices among children aged 0–2 years did not show any significant correlation with children aged 2–5 years.

Screening for Maternal Malnutrition Based on Anthropometric Indices of Other Household Members

Table 3 shows the efficacy of using anthropometric indices to screen for maternal malnutrition. The results show that screening for maternal malnutrition based on other household anthropometric indices is inefficient. All indices showed low sensitivity and higher specificity. The positive predictive values were low for all anthropometric indices considered. However, the negative predictive values were high for all indicators.

DISCUSSION

Although some correlations between anthropometric indices among household individuals are significant, they are weak. Thus, anthropometric measurements of young children, older children and adult men are inefficient to screen for maternal malnutrition. Epidemiological significant associations are not always clinically important. A useful screening tool aims to identify people who merit fuller examination of the illness or severity of malnutrition. A high discriminatory capacity of a test is found when both the sensitivity and specificity are high. In our study, the low sensitivity and high specificity suggest that intra-household members may not fully share risk factors for malnutrition.

Based on the customary opinion of shared socio-economic, genetic and environmental features within households[1,2] our findings were unexpected. However, earlier studies have shown that social factors only account for a small percentage of the variance in nutritional indices in local communities.[7,18,19]

Some factors may explain the lack of intra-household correlations among household members. Although we studied only one area with a limited population and may have missed statistically significant epidemiological associations, the sample size is believed to be large enough to evaluate anthropometric indices as screening tools. The study was only done in a rural community typical of the drought-prone areas in southern Ethiopia. Our study sample may have thus been too homogenous economically, environmentally and behaviourally to detect intra-household correlations. The results may have differed if we had studied urban centres known to

TABLE 2 *Within household correlations between child, and maternal and paternal nutritional indices*

	Maternal				
	BMI	Height	Weight	TSF	MUAC
Child 0–2 years (No. = 122)					
H/A	0.20	0.22*	0.28*	0.25*	0.01
W/H	0.16	0.01	0.13	0.16	0.11
W/A	0.25*	0.17	0.30*	0.28*	0.06
Child 2–5 years (No. = 139)					
H/A	0.08	0.06	0.09	–0.13	–0.06
W/H	0.20	0.21	0.27*	0.03	0.11
W/A	0.17	0.16	0.21	–0.06	0.09
Children 6–18 years (No. = 148)					
BMI	0.12	–0.02	0.09	0.12	0.03
MUAC	0.09	0.16*	0.15	0.01	0.11
	Paternal				
Child 0–2 years (No. = 122)					
H/A	–0.08	0.182	0.08	0.01	0.01
W/H	–0.17	0.17	–0.01	–0.32*	0.02
W/A	–0.15	0.22	0.04	–0.20	0.01
Child 2–5 years (No. = 79)					
H/A	0.10	–0.09	–0.16	0.07	0.24*
W/H	0.39*	0.06	0.37*	0.16	–0.09
W/A	0.14	–0.05	0.08	0.13	0.16
Children 6–18 years (No. = 124)					
BMI	0.05	–0.05	0.01	0.29*	0.03
MUAC	0.14	0.08	0.16	0.01	0.18*

* $P < 0.05$ (after Bonferroni correction).

have greater social stratification. The prevalence of different forms of malnutrition varied in our study population. Of children <5 years of age 43% were stunted. As the W/A represents a composite measure of both wasting and stunting,[4] the high prevalence of stunting is also reflected in a high prevalence of children having a low weight for age (less than –2 Z scores W/A). This probably reflects the influence of chronic food shortage and of repeated infections on the growth of children.[8,20] About 8% of the children were wasted, suggesting that acute food shortage may have occurred at the time of the study.[21] The association between different anthropometric indices is complex[22,23] and few have studied the validity of cutoff points to compare childhood and adult measures of malnutrition. Although we made great efforts to reduce measurement errors, such bias may also weaken the intra-household correlations. It is also possible that the weak intra-household correlations found may change during periods of famine. However, both acute and chronic malnutrition occurred frequently and the Elka society was at the time of the study recovering from the major famine that had occurred in the mid 1980s.[7]

It has been shown in Ethiopia that famine vulnerability and survival strategies vary considerably at the community and household levels.[3] The question of targeting development activities and food aid to vulnerable populations at times of crisis is controversial.[6] Often, because of limited resources some selection mechanisms are used. However, targeting strategies may vary for different communities. Recently, more emphasis has been on the use of social indicators to target such interventions, but evaluations of such programmes are limited.

Even if the explanation of our findings varies, we question some assumptions underlying commonly held views on the use of anthropometry in developing countries. In particular we doubt the commonly held view on the use of childhood nutritional indicators as proxies of

TABLE 3 *Results of screening for maternal malnutrition (BMI <18.5) based on different anthropometric indices and age-groups of other household members*

	Sensitivity	Specificity	PPV	NPV
0–2 years old				
H/A <–2	22.2	67.9	13.3	79.9
W/H <–2	5.6	91.4	14.3	79.0
W/A <–2	27.8	74.1	19.2	82.2
MUAC <12 cm	29.9	80.0	23.8	84.2
MUAC <13.5 cm	76.5	47.5	23.6	90.5
2–5 years old				
H/A <–2	55.6	52.3	10.9	91.8
W/H <–2	11.1	86.6	9.1	90.7
W/A <–2	36.4	61.8	10.5	88.7
MUAC <12 cm	18.2	85.2	13.3	89.3
MUAC <13.5 cm	27.3	65.9	9.1	87.9
6–18 years old				
BMI <17.5	86.2	25.8	20.8	89.2
MUAC <16 cm	29.6	72.3	19.5	81.9
Adult male				
BMI <18.5	19.2	77.7	16.7	80.6
MUAC <25.1	76.9	21.4	18.5	80.0
Skinfold <10 mm	96.2	2.7	18.7	75.0

PPV: Positive predictive value; NPV: negative predictive value.

household or community nutritional risks. The nutritional status of an individual may not accurately reflect food availability in the family. Our study shows that there are few alternatives to separate screening of population subgroups. The results may have practical consequences for the way development and food relief programmes are handled in rural areas in countries like Ethiopia. However, more research is needed to evaluate the practical usefulness of alternative socioeconomic and anthropometric indicators.

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