Food variety, socioeconomic status and nutritional status in urban and rural areas in Koutiala (Mali)

Anne Hatløy[1,*,†], Jesper Hallund[2], Modibo M Diarra[3] and Arne Oshaug[4]
[1]Fafo Institute for Applied Social Science, Box 2947 Tøyen, N-0608 Oslo, Norway: [2]Research Department of Human Nutrition, The Royal Veterinary and Agricultural University, 1958 Fredriksberg C, Denmark: [3]Institut National de Recherche en Santé Publique, Bamako Box 1046, Mali: [4]Institute for Nutrition Research, University of Oslo 0316, Oslo, Norway

Submitted 27 January 1999, Accepted 4 August 1999

Abstract
Objective: The purpose of this study was to analyse the associations between the food variety score (FVS), dietary diversity score (DDS) and nutritional status of children, and to assess the associations between FVS, DDS and socioeconomic status (SES) on a household level. The study also assessed urban and rural differences in FVS and DDS.
Design: Cross-sectional studies in 1994/95, including a simplified food frequency questionnaire on food items used in the household the previous day. A socio-economic score was generated, based on possessions in the households. Weight and height were measured for all children aged 6–59 months in the households, and anthropometric indices were generated.
Subjects and setting: Three hundred and twenty-nine urban and 488 rural households with 526 urban and 1789 rural children aged 6–59 months in Koutiala County, Sikasso Region, Mali.
Results: Children from urban households with a low FVS or DDS had a doubled risk (OR>2) for being stunted and underweight. Those relations were not found in the rural area. There was an association between SES and both FVS and DDS on the household level in both areas. The FVS and DDS in urban households with the lowest SES were higher than the FVS and DDS among the rural households with the highest SES.
Conclusions: Food variety and dietary diversity seem to be associated with nutritional status (weight/age and height/age) of children in heterogeneous communities, as our data from urban areas showed. In rural areas, however, this association could not be shown. Socioeconomic factors seem to be important determinants for FVS and DDS both in urban and rural areas. FVS and DDS are useful variables in assessing the nutritional situation of households, particular in urban areas.

Keywords
Food variety
Dietary diversity
Socioeconomic factors
Nutritional status
Anthropometry
Mali
Africa

The causes of malnutrition are many and complex, and they are determined by different factors at various levels of the society. To improve and facilitate development programmes that include aspects of nutrition and health, ongoing efforts are underway to elaborate new tools for measuring nutritional conditions. There is a need both for good outcome variables on nutritional status, as well as tools for assessing factors related to the nutritional status such as food intake and SES.

The work in Koutiala was developed in a close research collaboration between the National Research Institute on Public Health in Bamako, Mali (INRSP) and the Institute for Nutrition Research, University of Oslo. INRSP expressed their concerns about an apparently high level of malnutrition in Koutiala, an area considered to be one of the richest agricultural areas of the country. They wanted reliable data on both the level and the causes of malnutrition in the area. In Koutiala, as well recognized in most developing countries[1], the children in rural areas had a poorer nutritional status than the children in urban areas had.

We have earlier shown that the nutritional quality of the diet improves with an increasing number of food items in the diet, measured as the FVS, and number of food groups, measured as the DDS[2]. The FVS and DDS can serve as simple food scoring indices. Also, other studies have shown that these variables can be used to assess the nutritional adequacy of the diet[3–6] both in developed and developing countries. The value of increased food variety in either ensuring essential nutrient adequacy or decreasing the risk of food toxicity has been understood for some time[7]. The use of food variety and dietary diversity as predictors of health outcome is relatively recent[8–12].

In this study, we focused on food variety and dietary diversity in Mali in West Africa. The purpose of this study was to analyse the associations between the FVS, DDS and

†Conducted the survey when employed at the Institute for Nutrition Research, University of Oslo.

*Corresponding author: Email anne.hatloy@fafo.no

https://doi.org/10.1017/S1368980000000628 Published online by Cambridge University Press

nutritional status of children, and to assess the associations between FVS, DDS and SES on a household level. The study also assessed the urban and rural differences in FVS and DDS and discussed some of the mechanisms leading to the differences in the nutritional status in the two areas.

Sampling

The surveys this study is based on were carried out in one agricultural and one urban area in Koutiala County in the southern part of Mali. According to census data from 1987, the population in the county was 247 000, including an urban population of 49 000 in Koutiala town[13]. In the urban area, a cotton factory dominates the economy. The rural population is predominantly subsistence farmers mainly producing cotton and grain, largely millet, sorghum and maize.

The data collection was carried out in two seasons. The first in September 1994, the rainy season, and the second in the post-harvest season in March 1995. A modified 30-cluster sampling scheme, as recommended by UNICEF[14], was used as the sampling method. Initially, a list of all villages in the county was drawn up and their population size estimated based on an updated version of the census of 1987[13]. Secondly, 66 clusters were randomly selected from the list. A cluster was defined to include all households required to obtain a minimum sample of 17 children in the age group 6–59 months. A household was here defined as a group of people that consumed food from the same pot. In each cluster, the first household to be surveyed was randomly selected from a list of heads of households. The next household surveyed was the next one to the left of the first. This was repeated until the sample size required for each cluster was reached. Households were included in the sample independent of having children or not. In the households with children, all children in the age group were included, even in the households where the 17th child was found. The mean number of children in the 132 clusters was 17.8, with a maximum of 24. The same procedure was followed in the two surveys. The sample consisted of 329 urban and 488 rural households, and 11 970 persons of whom 27% were in the urban and 73% in the rural areas.

Before the work started, there was a meeting with the leader and his council in each of the villages or town neighbourhoods. At that meeting a thorough explanation of the content and objectives of the study were given and a verbal consent to participate in the study was obtained. Afterwards, the study was explained to each of the selected households and an oral consent asked for.

Methods

Questionnaire interviews

The majority of the population was illiterate. A household questionnaire was directed both to the head of the household and to the woman who had prepared the food the previous day. The questionnaire included demographic information and data on socioeconomic conditions such as information on transport assets, animals, agricultural equipment and housing. In addition, it included a simplified food frequency questionnaire; the woman had to answer which of 104 food items had been used in the meal preparation or eaten by any of the household members the previous day. The list of food items was elaborated based on in-depth interviews and local knowledge of the area.

In addition a second questionnaire was used to obtain health and nutritional information about children aged 6–59 months ($n=526$ urban and $n=1789$ rural children). That questionnaire included anthropometric measurements and questions about illnesses during the previous 2 weeks. Weight was measured for all the children using a Salter scale with a precision of 0.1 kg. For children less than 2 years old, recumbent lengths were measured, while for the older children standing heights were taken, both by using specially prepared height boards with a precision of 0.1 cm.

Twelve fieldworkers with at least high-school education carried out the interviews. The fieldworkers worked in pairs of one female and one male. In each pair, at least one was from Koutiala with knowledge of Minyanka, the local language. All of them spoke French and Bambara (the main language in Mali). A training programme, as described in a former study from our group[15], was carried out prior to both the surveys.

Food variety

The FVS is here defined as the number of food items eaten by any member of the household the previous day. The FVS was generated from the list of the 104 food items. All food items were given an equal weight. We previously used a modified version of this method[2] which was developed from methods used by Krebs-Smith *et al.*[16] and Drewnowski *et al.*[17]. The households were divided into tertiles, giving a high, medium and low FVS, where high >18, medium $=14$–18 and low 4–13 food items.

Dietary diversity

The DDS is here defined as the number of food groups in the diet consumed in each household the previous day, which is a modification of a method earlier used in the same area[2]. The DDS was generated from the same list as the FVS. Different definitions of DDS have been suggested in recent years, as well as the number of food groups to include, their composition and the use of different dietary assessment methods[3,4,11,16,18]. The number and composition of food groups are often different since they reflect the aim of a specific study; therefore, there is no consensus with regard to the ideal number of food groups in a DDS. A DDS developed for one culture will not necessarily be the same as one used in another, but the theory and the approach for the development of the score can be used across cultures[12].

In this study, the 10 following food groups were chosen for the DDS: staples, vegetables, oil/sugar, fruit, nuts/pulses, meat, milk, fish, leaves/gathered foods and eggs. Food items that did not belong to one of the mentioned groups were excluded ('Other' in Table 3). No consideration was given to the amounts consumed. The DDS was divided into tertiles, which gave the categories: high = ≥ 8, medium = 6–7 and low = 2–5.

Nutritional status

As indicators of nutritional status, z-scores for weight-for-height (W/H), weight-for-age (W/A) and height-for-age (H/A) were used. Children with a W/H, W/A and H/A of less than −2 were considered malnourished.

To determine the age of the children, three calendars were used: an event calendar developed for the area, an agricultural calendar and the Islamic lunar calendar. These tools, utilized together with birth certificates and knowledge of birthday by family members, could estimate the age within a margin of 2 weeks[15].

Socioeconomic status

To determine the SES of the households, a socioeconomic score was created based on a list of 14 possessions (see list in Table 2). A straightforward count of the possessions was made where one point was given for each of the possessions. Thus the maximum score for SES was 14; none of the households reached a score higher than 10. The households were then divided into tertiles to determine high, medium and low SES. This gave a high SES (SES3) to be 7–10 possessions, medium SES (SES2) was 4–6, and low SES (SES1) 0–3 possessions.

Statistical analyses

Data analyses were performed using the Statistical Package for the Social Sciences (SPSS)[19]. As the nutritional indicators and the food variety indices were approximately normally distributed, parametric analyses were chosen. All analyses were carried out separately for urban and rural areas.

To analyse differences between urban and rural areas in the descriptive analyses (Tables 1–3), Pearson's chi-square test was used for the dichotomous variables and Student's *t*-test was used for the continuous variables. The same were also used to determine differences between the two surveys (Table 1).

To look at the associations between SES and DDS and FVS, two methods were used. First, a chi-square test for trends was used to find associations between use of different food groups and SES[20]. Graphical analyses of the association between SES and both DDS and FVS were carried out, and finally Pearson correlations were used between SES and DDS as well as between SES and FVS.

The association between FVS and DDS and nutritional status were analysed by using logistic regression. In the logistic regression, the nutritional indicators W/H, H/A and W/A were coded 'z-scores < −2' = 1 and 'z-scores ≥ −2' = 0 and were used as dependent variables. FVS and DDS were as described, divided into tertiles, with the upper tertile used as reference. Age was used as a dichotomous variable (6–35 months = 1, 36–59 months = 0). Illness, presence of diarrhoea, malaria/fever or cough, in the children during the previous 2 weeks (as reported by mothers) was also included as a dichotomous variable (yes = 1, no = 0). The socioeconomic

Table 1 Characteristics of the sample in Koutiala from surveys in September 1994 and March 1995, showing means and SD in brackets

	Urban		Rural		Both seasons	
	Sept. 94	March 95	Sept. 94	March 95	Urban	Rural
Households						
Number in survey	181	148	244	244	329	488
Household members	9.8 (7.8)	8.9 (6.1)	18.8 (12.5)	17.6 (12.0)	9.4 (7.1)	18.2 (12.3)[a]
Food variety score	19.3 (6.2)	19.8 (5.9)	14.4 (5.3)	14.2 (5.2)	19.6 (6.1)	14.3 (5.2)[a]
Dietary diversity score	6.7 (1.5)	6.8 (1.3)	6.1 (1.5)	6.1 (1.4)	6.7 (1.4)	6.1 (1.5)[a]
Socioeconomic score	3.9 (2.2)	3.6 (2.1)	5.7 (1.7)	5.6 (1.9)	3.8 (2.1)	5.7 (1.8)[a]
*Children**						
Number in survey	264	262	879	910	526	1789
Age (months)	31 (16)	33 (16)	32 (16)	32 (16)	32 (16)	32 (16)
Weight (kg)	11.4 (3.3)	12.2 (3.4)[b]	11.0 (3.2)	11.1 (3.0)	11.8 (3.3)	11.0 (3.1)[a]
Height (cm)	85 (12)	88 (13)	84 (12)	85 (12)	86 (13)	84 (12)[a]
Height/age (z-score)	−1.2 (1.4)	−1.0 (1.5)	−1.7 (1.4)	−1.5 (1.5)[b]	−1.1 (1.5)	−1.6 (1.4)[a]
Weight/age (z-score)	−1.4 (1.2)	−1.0 (1.2)[b]	−1.7 (1.2)	−1.6 (1.2)	−1.2 (1.2)	−1.7 (1.2)[a]
Weight/height (z-score)	−0.7 (1.2)	−0.5 (1.2)	−0.8 (1.2)	−0.8 (1.1)	−0.6 (1.2)	−0.8 (1.1)[a]
Malnutrition (< −2 z-score)						
Stunting, H/A (%)	25	24	42	36	25	39[c]
Wasting, W/H (%)	13	9	12	13	11	13
Underweight, W/A (%)	29	24	40	36	27	38[c]

[a] Statistically significant, $P < 0.01$ (Student's *t*-test) between urban and rural area, independent of season.
[b] Statistically significant, $P < 0.01$ (Student's *t*-test) between the seasons.
[c] Statistically significant, $P < 0.01$ (Pearson's chi-square) between urban and rural area, independent of season.
* Children aged between 6 and 59 months of age.

https://doi.org/10.1017/S1368980000000628 Published online by Cambridge University Press

score in the urban area was included as a categorical variable in the analyses with food variety (high SES = 3, medium SES = 2, low SES = 1).

The anthropometric scores were calculated by using the software Anthro from WHO[21].

Results

There were significant differences between urban and rural areas both in household characteristics and in nutritional status of children except for the level of wasting (Table 1). The sizes of urban households were smaller; nine members compared with rural households of 18 members. Furthermore, on average, members of the urban households had eaten 20 food items daily, but only 14 in the rural households. The urban households had used seven food groups compared to six in the rural areas. There was no seasonal variation in the FVS or the DDS (Table 1).

The nutritional status of the urban children was significantly better than that of the rural ones for all the indicators. For some of the indicators, there were seasonal variations. These seasonal variations were small and not consistent. The differences between the areas, however, were clear, consistent and not influenced by seasonality. The remaining analyses will therefore only distinguish between urban and rural areas. In the sample, there were 48% girls in the urban area and 49% girls in the rural area. There was no difference in the nutritional status between boys and girls (data not shown). Further analyses were therefore carried out with no gender distinction.

The distribution of possessions in the urban and rural households is shown in Table 2. The rural households showed a much higher homogeneity than the urban ones. In the rural area as many as six of the 14 items were found in less than 3% of the households, while in the urban households the tractor was the only possession found in less than 3% of the households.

The food items and food groups used by the households the previous day of the survey are listed in Table 3. Nearly all households in both urban and rural areas had eaten staples, vegetables and something from the energy-dense group (oil/sugar) but the types of food were quite different. In the urban area, there was a more frequent intake of fruit, meat and milk than in the rural area. In the rural area, on the other hand, more households had used leaves/gathered foods. For most of the food groups (all except nuts/pulses, fish and leaves/gathered foods), there were higher numbers of food items eaten in the urban than in the rural area. Even though nearly all households in both the urban and rural areas had used vegetables the previous day, the urban households had used a mean of 4.7 different vegetables, significantly more than the rural ones which had only used 3.3 different vegetables. The mean number of fruits used the previous day was 0.8 for the rural households, whilst it was 1.8 different fruits – more than double – for the urban ones (Table 3). In the rural area 90% had used the locally produced shea butter, while in the urban area more than 40% had used other oils that were available on the market (mainly cottonseed and peanut oil). Calculated together there was no difference between the areas, 91% in the rural and 90% in the urban area had used at least one fat source the previous day. The rural area had both a higher frequency and more food items eaten from only one food group, namely the leaves/gathered foods.

Table 2 Percentage of households possessing different items, used as a basis for calculating socioeconomic score (Koutiala 1994/95)

	Urban (n= 327)	Rural (n= 487)
Item available in household		
Latrine	100	60
Radio	77	73
Motor cycle	44	40
Bicycle	33	91
Donkey/cart	32	85
Ox/plough	22	93
Sheep/goats	20	76
Electricity	15	3
Cattle	10	46
Television	8	1
Refrigerator	7	0
Video	5	0
Car	4	1
Tractor	1	1
Socioeconomic score*		
SES1 (0–3 possessions)	57	13
SES2 (4–6 possessions)	30	48
SES3 (7–10 possessions)	14	39

* One point is given for each of the above mentioned possessions to obtain a socioeconomic index. The index is then divided into tertiles, SES1 to SES3.

SES associated with FVS and DDS

In both the urban and the rural areas, there was a clear association between SES and both dietary diversity (Fig. 1) and food variety (Fig. 2). A correlation was found in the urban area of about 0.3 between SES and both FVS and DDS. The correlation was a bit weaker in the rural area (Figs 1 and 2). The levels of both FVS and DDS were found to be higher in urban than in rural areas. The DDS in SES1 in the urban area was equal to the DDS in SES3 in the rural area (Fig. 1). The difference was even more remarkable for FVS, where the mean FVS was about 3 units higher for SES1 in the urban area than for SES3 in the rural area (Fig. 2).

The differences in DDS between high and low SES groups was mainly due to differences in some of the food groups. Use of staples, vegetables, oil/sugar, fish, leaves/gathered foods and eggs was not found to be influenced by SES (Table 4). In both areas, use of milk was significantly related to SES. In the urban area, the food groups meat and fruits were also used more frequently among the higher SES groups. For nuts/pulses, the use in households in the urban area was not influenced by SES,

Table 3 Food groups and food items used in urban and rural households the day before the survey

	Urban ($n=329$)			Rural ($n=488$)				
Food groups	Frequency of use	Mean number of food items	Food items (used in >10% of households)	Frequency of use	Mean number of food items	Food items (used in >10% of households)	P^a	P^b
Staples	99%	2.7	62% Sorghum 45% Millet 43% Rice 39% Wheat bread 27% Maize 20% Sweet potato	100%	2.0	63% Sorghum 52% Millet 38% Maize 15% Rice 12% Wheat bread 10% Macaroni	0.35	<0.01
Vegetables	99%	4.7	93% Onion 90% Pepper 87% Tomato 77% Okra 68% Tomato, conc. 35% Eggplant 22% Cabbage 17% Cucumber 14% Eggplant, native 12% Ginger 12% Lettuce 10% Pumpkin	98%	3.3	71% Onion 63% Okra 57% Tomato 19% Eggplant 12% Ginger	0.73	<0.01
Oil/sugar	97%	2.1	92% Sugar 65% Shea butter 43% Vegetable oil	93%	1.6	90% Shea butter 59% Sugar	<0.01	<0.01
Fruit	81%	1.8	35% Lemon 25% Tamarin 20% Coconut 17% Mango 14% Melon 14% Orange 14% Jujube 13% Banana	55%	0.8	22% Lemon 13% Mango 10% Orange	<0.01	<0.01
Nuts/pulses	73%	1.9	65% Groundnut 20% Beans	72%	1.9	52% Groundnut 20% Hibiscus 16% Shea butter seed 11% Beans	0.65	0.52
Meat	57%	0.6	47% Beef	26%	0.3	13% Beef	<0.01	<0.01
Milk	56%	0.6	44% Cow milk 13% Powder milk	34%	0.3	31% Cow milk	<0.01	<0.01
Fish	52%	0.6	28% Catfish 21% Carpe	56%	0.6	23% Catfish 22% Carpe 13% Carpion	0.28	0.52
Leaves/gathered	50%	0.7	18% Onion leaves 15% Baobab leaves 11% Amaranth leaves	72%	1.1	40% Baobab leaves 23% Onion leaves 22% Cowpea leaves	<0.01	<0.01
Egg	8%	–		7%	–		0.44	–
Other	99%	–	98% Salt 84% Soumbala 83% Beef tea 56% Green tea 19% Coffee 15% Beverage, non-alcoholic 14% Black tea 12% MSG 10% Soda water	100%	–	97% Salt 86% Soumbala 38% Green tea 30% MSG 27% Beef tea 17% Coffee 12% Beer	0.69	–

[a] *P*-value of Pearson's chi-square test for differences in food groups between urban and rural areas.
[b] *P*-value of Student's *t*-test for differences between urban and rural areas in number of food items in each food group.

while in the rural area, their consumption was significantly higher in households with high SES.

A subjective variable was included in our questionnaire: the fieldworkers' impression of the socioeconomic conditions in the household. They were asked to classify it as good, medium or bad. When comparing the calculated SES in the urban area to that variable, it was found that as many as 94% of the households classified as SES1, were characterized by the fieldworkers as medium (55%) or bad (39%) households. Eighty-seven per cent of

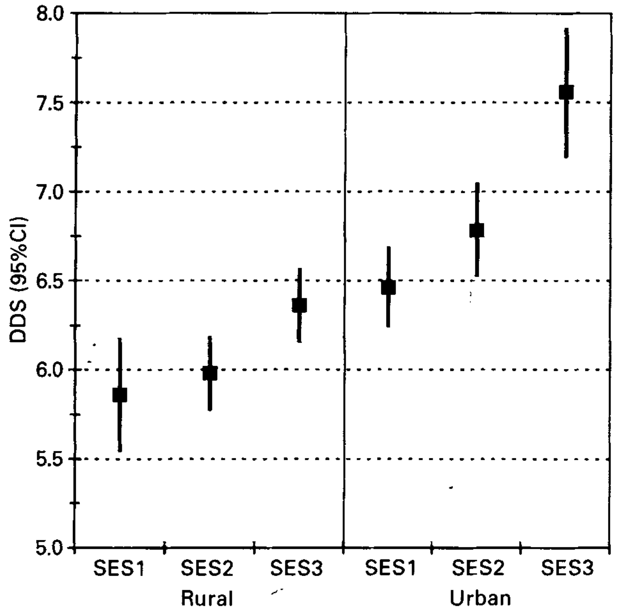

Fig. 1 Associations between DDS and SES in rural and urban households in Koutiala, September 1994 and March 1995. Correlation between DDS and SES (both as continuous variables): rural: Pearson correlation 0.11 ($P=0.02$); urban: Pearson correlation 0.26 ($P<0.01$)

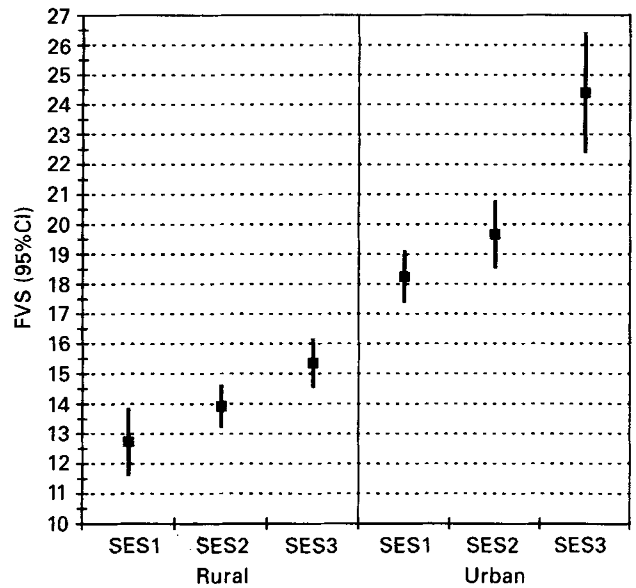

Fig. 2 Associations between FVS and SES in rural and urban households in Koutiala, September 1994 and March 1995. Correlation between FVS and SES (both as continuous variables): rural: Pearson correlation 0.14 ($P<0.01$); urban: Pearson correlation 0.32 ($P<0.01$)

the households identified as SES3 in the urban area were characterized by the fieldworkers as good (49%) or medium (38%) ($\kappa=0.162$, $P<0.01$). For the households in rural area, all the households classified as SES1 were characterized as medium (45%) or bad (55%) by the fieldworkers. For the households classified as SES3 in the rural area, 87% were determined as good (24%) or medium (63%) by the fieldworkers ($\kappa=0.175$, $P<0.01$). This shows a relatively high association in both the urban and the rural areas between the socioeconomic indices used and the assessment through a subjective impression by the fieldworkers.

FVS and DDS associated with nutritional status

The FVS and DDS were indicators based on data collected for all the members of the household. We wanted to see whether these indicators were associated with the nutritional status for the children living there. When calculating odds ratios (ORs) based on logistic regression in the urban area, we found that children from households with the lowest score of FVS had a doubled risk (OR 1.7–2.3) of being malnourished (stunted or underweight), compared with children from households with the highest score (Table 5). Table 6 shows that the same was found for DDS, with a more than doubled risk (OR 2.2–2.4) for being stunted or underweight among those with the lowest variety in food groups compared to those with the highest. In the rural area, this trend was not found. FVS and DDS were not related to the prevalence of wasting either in the urban or in the rural area. The results for SES, illness and age were about the same for FVS and DDS (Tables 5 and 6).

Table 4 Socioeconomic score* and the frequency (%) of food used in the households from different food groups included in the dietary diversity score (Koutiala 1994/95)

	Urban					Rural				
	SES1 (*n*=185)	SES2 (*n*=97)	SES3 (*n*=45)	$X^{2\dagger}$	*P*	SES1 (*n*=64)	SES2 (*n*=232)	SES3 (*n*=191)	$X^{2\dagger}$	*P*
Staple	99	100	100	1.27	0.26	100	100	100	0.15	0.70
Vegetable	97	100	100	3.19	0.07	100	97	99	0.03	0.86
Oil/sugar	96	98	100	2.18	0.14	98	89	96	0.24	0.62
Fruit	77	80	96	6.91	<0.01	44	55	58	3.02	0.08
Nuts/pulses	73	67	84	0.71	0.40	61	71	76	5.14	0.02
Meat	49	60	78	12.40	<0.01	28	23	29	0.35	0.55
Milk	47	63	80	18.44	<0.01	22	32	40	8.26	<0.01
Fish	53	54	48	0.34	0.56	55	55	58	0.27	0.60
Leaves	49	50	56	0.53	0.46	77	70	72	0.09	0.76
Egg	7	7	16	3.02	0.08	2	7	8	2.92	0.09

* Definitions of the different SES groups are given in Table 2.
† Chi-square test for trend as described by Altman[20].

https://doi.org/10.1017/S1368980000000628 Published online by Cambridge University Press

Table 5 Odds ratios (and 95%CI) for the food variety score (FVS) as a predictor for different indicators for malnutrition (z-score <−2) for children in Koutiala, Mali in the age group 6–59 months

	Urban			Rural		
Categories	W/H*	H/A*	W/A*	W/H*	H/A*	W/A*
FVS†						
Low 4–13	0.9 (0.4–2.0)	1.7 (1.0–3.1)	2.3 (1.3–4.0)	1.0 (0.7–1.5)	1.2 (0.9–1.5)	1.2 (0.9–1.6)
Mid 14–18	0.7 (0.4–2.0)	1.2 (0.8–2.0)	1.3 (0.8–2.1)	0.9 (0.6–1.3)	1.1 (0.8–1.4)	0.9 (0.7–1.2)
High >18	(ref.)					
SES						
Low 0–3	1.9 (0.8–4.4)	0.9 (0.5–1.6)	0.9 (0.5–1.6)	1.3 (0.7–2.1)	0.9 (0.6–1.3)	0.6 (0.4–0.9)
Mid 4–6	2.1 (0.9–5.3)	1.2 (0.7–2.2)	1.0 (0.6–1.9)	1.1 (0.8–1.5)	1.1 (0.9–1.3)	0.9 (0.8–1.1)
High >6	(ref.)					
Illness‡						
Yes	2.5 (1.4–4.8)	1.2 (0.8–1.9)	2.0 (1.3–3.0)	1.3 (1.0–1.7)	1.1 (0.9–1.4)	1.2 (0.9–1.4)
No	(ref.)					
Age						
<36 months	3.5 (1.7–7.1)	0.9 (0.6–1.3)	2.2 (1.4–3.3)	3.6 (2.5–5.2)	0.9 (0.7–1.1)	1.6 (1.3–2.0)
⩾36 months	(ref.)					
Model information						
Chi-square	26.7	7.1	35.1	69.7	5.0	36.0
Degrees of freedom	6	6	6	6	6	6
Significance, *P*	<0.01	0.31	<0.01	<0.01	0.54	<0.01

*Cut-off −2 z-scores (categories: 1, <−2 z-score; 0, ⩾−2 z-score) for weight/height (W/H), height/age (H/A) and weight/age (W/A).
†Number of children in each FVS category. Urban: low, n=77; mid, n=145; high, n=303. Rural: low, n=747; mid, n=644; high, n=398.
‡Illnesses (fever/malaria, diarrhoea, cough) occurred in the 2 weeks before the survey.

The younger children had a higher risk of being acutely malnourished than the older ones, both in the urban and the rural areas. In the urban area, children who had been ill during the last 2 weeks had an increased risk of being wasted and underweight. In our models, SES did not predict the risk of malnutrition. When SES, illness and age were excluded from the model, the results were about the same, and the conclusions were not influenced.

Discussion

Our data showed that simple food indices such as FVS and DDS collected at household level are associated with the nutritional status of children. The association was only found in the urban area, and was found for being underweight and stunted, but not for wasting. Children living in urban households with a low FVS and DDS had a

Table 6 Odds ratio (and 95%CI) for the dietary diversity score (DDS) as a predictor for different indicators of malnutrition (z-score <−2) for children in Koutiala, Mali in the age group 6–59 months

	Urban			Rural		
Categories	W/H*	H/A*	W/A*	W/H*	H/A*	W/A*
DDS†						
Low 2–5	1.4 (0.5–3.5)	2.2 (1.1–4.2)	2.4 (1.3–4.6)	1.3 (0.8–2.0)	1.0 (0.7–1.3)	1.2 (0.9–1.5)
Mid 6–7	1.3 (0.7–2.6)	1.7 (1.0–2.7)	1.3 (0.8–2.2)	1.1 (0.7–1.6)	0.9 (0.7–1.2)	0.9 (0.7–1.1)
High ⩾8	(ref.)					
SES						
Low 0–3	1.5 (0.6–3.6)	0.9 (0.5–1.5)	0.9 (0.5–1.6)	1.3 (0.7–2.1)	1.0 (0.7–1.4)	0.7 (0.5–1.0)
Mid 4–6	1.8 (0.7–4.5)	1.2 (0.7–2.2)	1.1 (0.6–1.9)	1.1 (0.8–1.5)	1.1 (0.9–1.4)	0.9 (0.8–1.2)
High >6	(ref.)					
Illness‡						
Yes	2.5 (1.4–4.8)	1.3 (0.8–1.9)	2.0 (1.3–3.0)	1.3 (1.0–1.7)	1.1 (0.9–1.4)	1.2 (0.9–1.4)
No	(ref.)					
Age						
<36 months	3.4 (1.6–6.9)	0.8 (0.6–1.3)	2.1 (1.4–3.3)	3.6 (2.5–5.2)	0.9 (0.7–1.1)	1.6 (1.3–2.0)
⩾36 months	(ref.)					
Model information						
Chi-square	29.5	10.0	34.8	70.0	4.2	35.6
Degrees of freedom	6	6	6	6	6	6
Significance	<0.01	0.13	<0.01	<0.01	0.64	<0.01

*Cut-off −2 z-scores (categories: 1, <−2 z-score; 0, ⩾−2 z-score) for weight/height (W/H), height/age (H/A) and weight/age (W/A).
†Number of children in each DDS category. Urban: low, n=78; mid, n=281; high, n=163. Rural: low, n=554; mid, n=878; high, n=351.
‡Illnesses (fever/malaria, diarrhoea, cough) occurred in the 2 weeks before the survey.

more than doubled risk of being underweight and stunted compared with those living in households with the highest scores.

In the urban area, there were clear associations between both the FVS and DDS and nutritional status measured as weight-for-age and height-for-age. Other studies have reported similar associations between nutritional status and dietary diversity[22–24]. A study conducted in an urban area in Colombia found that height-for-age was positively correlated to FVS[22]. In a study from rural Kenya, height-for-age was significantly higher for the children eating the most varied diets[23]. Those differences were not found for weight-for-height or skinfold thickness. A study from the southern Andes also showed similar results[24].

Associations between food variety scores and SES have been shown in surveys from the southern Andes[24], Malawi and Ghana[25]. Such associations were shown both in the urban and in the rural areas in Koutiala. The lower level of both FVS and DDS in rural compared to urban areas is striking. Table 2 showed a high degree of homogeneity in SES in the rural area, this meant that no matter how the rural households were classified, the items owned by everyone or no-one would not show any important differences between groups. The rural households had a much higher prevalence of agricultural equipment than the urban ones. This explains why a much higher proportion of rural households were defined as being of higher SES than the urban ones (Table 2). This can not, however, be used to explain differences between the areas, only to classify the households within one area. This points to the necessity of creating socioeconomic scores adapted to different contexts even within the same study. In this study, the urban and rural SESs were constructed on the same basis. Both in the urban and rural areas, the SES was associated with dietary diversity and food variety. For further studies, it will be important to identify which items to include in an analysis of the socioeconomic situation, especially in homogenous societies.

We have shown earlier that both FVS and DDS were predictors of the nutrient adequacy of the diet[2]. Thus, members of a household with a low FVS or DDS would have a less nutritionally adequate diet than do members of a household with higher food variety indices. Studies from developed countries have also shown that a high FVS is related to higher energy intake and a higher intake of nutrients[26]. A relationship between energy intake and FVS was also found by Drewnowski *et al.*[18]. DDS has been found to have a significant positive association with nutrient adequacy, measured as the nutrient adequacy ratio (NAR)[9] and as the mean adequacy ratio (MAR)[3,16]. These results support our findings and strongly indicate that the adequacy of the diet is improved with the number of foods eaten and the number of food groups[2]. This may explain why children from households with a high food variety and dietary diversity have a better nutritional status.

Objections could be raised to our results, because the analyses of the nutritional status were carried out on an individual level, with a subsequent danger of a cluster effect. A test showed no differences in the results whether one index child from each household was used in the analyses or using results from the entire sample. Neither did the exclusion of infants that were breast-fed influence the results. Analyses were also performed weighing for the cluster sampling method; this did not influence the results. Thus, to achieve maximal power of the statistical analyses, all children were included in our analyses.

A very simple form of dietary assessment method was used in this study, by only asking which food items had been eaten by any of the household members the previous day. The questions were posed to one woman in each household, the one who had prepared the food. It is obvious that she could not know everything about what all the household members had eaten outside the household. One can assume that some special food items were consumed outside the household by several household members, and were therefore underreported in our study. However, the members eating outside the household would mainly be the men, school children and others with activities outside the house. As the purpose in this study was to analyse the relationship between nutritional status and food variety indices of small children, the food consumption inside the household was therefore probably the most important. It is not likely that there was any systematic misreporting of the foods used inside the household, and thus doubtful that any of the findings are due to biases in the results.

The kind of surveys conducted here require a thorough training and follow-up of the fieldworkers. All the fieldworkers were trained 5 days before the survey, both in the content of the questions and practising the anthropometric measurements. They were thoroughly trained in estimating the age of the child. During the surveys, a supervisor was present in the field and controlled all the questionnaires. Methodology and conduct during interviews were repeatedly discussed with the fieldworkers throughout the study. Bias due to systematically erroneous interview technique is therefore unlikely.

Regarding the external validity of the study, we presume that our sample was representative for both urban and rural areas in Koutiala. It is likely that the same conclusions for the associations between SES and FVS/DDS can be drawn in settings similar to the one in Koutiala. Furthermore, there seems to be a dietary impact on nutritional status in the urban setting. The models were stable and the results consistent. In the rural area, however, we were not able to establish such associations. This does not mean that diet is not important for nutritional status in these areas. The diet was fairly monotonous and differences in FVS and DDS between households were small. In addition, there may be other factors that have a stronger influence on the nutritional status than composition of the diet. Further studies have to be carried out with special attention to an identification of such factors in rural areas.

Measuring DDS could seem to be an easier index to use than the FVS. One should, however, be aware of the danger of asking about food groups directly – there is no guarantee that the respondent will define the food groups to contain the same items that the interviewer does. We therefore propose that a list of food items should be used to obtain information both for the FVS and the DDS. These data can be used to calculate both of the two indices. In this study the two indices seemed to give similar and complementary results. A former study showed that using both of them together did improve the possibility of identifying vulnerable groups[2].

Conclusions

Food variety and dietary diversity seem to be positively related to nutritional status (weight-for-age and height-for-age) of children in heterogeneous communities, as our data from the urban area showed. In rural areas, however, differences between households in FVS and DDS is less pronounced and it seems that other factors have stronger influences on the nutritional status than the food variety and dietary diversity.

References

1 Ruel MT, Garrett JL, Maxwell D, *et al. Urban Challenges to Nutrition Security: A Review of Food Security, Health and Care in the Cities.* FNCD Discussion Paper No. 51. Washington: International Food Policy Research Institute, 1998.

2 Hatløy A, Torheim LE, Oshaug A. Food variety – a good indicator of nutritional adequacy? *Eur. J. Clin. Nutr.* 1998; **52**(12): 891–8.

3 Guthrie HA, Scheer JC. Validity of a dietary score for assessing nutrient adequacy. *J. Am. Diet. Assoc.* 1981; **78**: 240–5.

4 Schuette LK, Song WO, Hoerr SL. Quantitative use of the food guide pyramid to evaluate dietary intake of college students. *J. Am. Diet. Assoc.* 1996; **96**(5): 453–7.

5 Strohmeyer SL, Massey LK, Davison MA. A rapid dietary screening device for clinics. *J. Am. Diet. Assoc.* 1984; **84**(4): 428–32.

6 Ries CP, Daehler JL. Evaluation of the nutrient guide as a dietary assessment tool. *J. Am. Diet. Assoc.* 1986; **86**(2): 228–33.

7 FAO/WHO. *Preparation and Use of Food-based Dietary Guidelines.* WHO Technical Report Series. Geneva: World Health Organization, 1998.

8 Kant AK, Schatzkin A, Harris TB, Ziegler RG, Block G. Dietary diversity and subsequent mortality in the First National Health and Nutrition Examination Survey Epidemiologic Follow-up Study [see comments]. *Am. J. Clin. Nutr.* 1993; **57**(3): 434–40.

9 Kant AK, Schatzkin A, Ziegler RG. Dietary diversity and subsequent cause-specific mortality in the NHANES I epidemiologic follow-up study. *J. Am. Coll. Nutr.* 1995; **14**(3): 233–8.

10 Vecchia CL, Munoz SE, Braga C, Fernandez E, Decarli A. Diet diversity and gastric cancer. *Int. J. Cancer* 1997; **72**: 255–7.

11 Franceschi S, Favero A, La Vecchia C, *et al.* Influence of food groups and food diversity on breast cancer risk in Italy. *Int. J. Cancer* 1995; **63**(6): 785–9.

12 Hodgson JM, Hsu-Hage B, Wahlqvist ML. Food variety as a quantitative descriptor of food intake. *Ecol. Food Nutr.* 1994; **32**: 137–48.

13 Bureau Central de Recensement/Direction National de la Statistique et de l'Informatique, eds. *Recensement General de la Population et de l'Habitat. Vol. 3: Region de Sikasso.* Bamako, Mali: Ministere du Plan/DNSI, 1990.

14 Henderson RH, Sundaresan T. Cluster sampling to assess immunization coverage: a review of experiences with a simplified sampling method. *Bull. World Health Organ.* 1982; **60**: 253–60.

15 Oshaug A, Pedersen J, Diarra M, Ag Bendech M, Hatløy A. Problems and pitfalls in the use of estimated age in anthropometric measurements of children from 6 to 60 months of age: a case from Mali. *J. Nutr.* 1994; **124**(5): 636–44.

16 Krebs-Smith SM, Smiciklas-Wright H, Guthrie HA, Krebs-Smith J. The effects of variety in food choices on dietary quality. *J. Am. Diet. Assoc.* 1987; **87**(7): 897–902.

17 Drewnowski A, Ahlstrom Henderson S, Driscoll A, Rolls BJ. The dietary variety score: assessing diet quality in healthy young and older adults. *J. Am. Diet. Assoc.* 1997; **97**: 266–71.

18 Drewnowski A, Henderson SA, Shore AB, Fischler C, Preziosi P, Hercberg S. Diet quality and dietary diversity in France: implications for the French paradox. *J. Am. Diet. Assoc.* 1996; **96**(7): 663–9.

19 SPSS 8.0 for Windows [computer program]. Chicago: SPSS Inc, 1997.

20 Altman DG. *Practical Statistics for Medical Research*, 1st edn. London: Chapman and Hall, 1997.

21 Anthro [computer program]. Division of Nutrition, Center for Disease Control in collaboration with Nutrition Unit, World Health Organization, 1989.

22 Gwynn ER, Sanjur D. Nutritional anthropometry: diet and health-related correlates among preschool children in Bogota, Colombia. *Ecol. Food Nutr.* 1974; **3**: 273–282.

23 Corbett EL, Butterworth AE, Fulford AJC, Ouma JH, Sturrock RF. Nutritional status of children with schistosomiasis mansoni in two different areas of Machakos District, Kenya. *Trans. R. Soc. Trop. Med. Hyg.* 1992; **86**: 266–73.

24 Leatherman TL. Health implications of changing agrarian economies in the southern Andes. *Hum. Org.* 1994; **53**(4): 371–80.

25 Ferguson EL, Gibson RS, Opare-Obisaw C, Osei-Opare F, Lamba C, Ounpuu S. Seasonal food consumption patterns and dietary diversity of rural preschool Ghanian and Malawian children. *Ecol. Food Nutr.* 1993; **29**: 219–34.

26 Randall E, Nichaman MZ, Contant CF. Diet diversity and nutrient intake. *J. Am. Diet. Assoc.* 1985; **85**(7): 830–6.