An Infant and Child Feeding Index Is Associated with the Nutritional Status of 6- to 23-Month-Old Children in Rural Burkina Faso[1]

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ABSTRACT The measurement of child feeding practices is complex and the relation between the quality of feeding and children's nutritional status is difficult to establish. We examined this relation in rural Burkina Faso, West Africa, using an adapted version of the Infant and Child Feeding Index (ICFI). A cross-sectional study was conducted on a random sample of children ($n = 2466$) aged 6–35 mo in 2002. Feeding practices were assessed through a qualitative 24-h recall. ICFIs were made age specific for children aged 6–11 mo ($n = 614$), 12–23 mo ($n = 987$), 24–35 mo ($n = 865$), and were divided into terciles. The association between height-for-age Z-scores (HAZ), weight-for-height Z-scores (WHZ), and ICFIs were examined separately in each age group. Multivariate analyses were performed to control for sociodemographic and economic factors. Adjusted mean HAZ in low, medium, and high categories of ICFI were, respectively, −1.67, −1.53, and −1.21 ($P = 0.003$) among children aged 6–11 mo; −2.54, −2.24, and −2.11 ($P = 0.0002$) among children aged 12–23 mo; and −2.18, −2.20, and −2.45 ($P = 0.05$) among children aged 24–35 mo. There was also a positive association between ICFI and WHZ in children aged 12–23 mo ($P = 0.05$) but a negative association in children aged 6–11 mo ($P = 0.02$). Among the components of ICFI, dietary diversity or variety scores and frequency of meals or snacks supported the positive associations with anthropometric indices, except for WHZ in children aged 6–11 mo, whereas breast-feeding exhibited a reverse association among older children. A suitable ICFI and/or some of its components could be used to identify vulnerable age groups and to monitor interventions in similar rural areas of Africa. J. Nutr. 136: 656–663, 2006.

KEY WORDS: • *child feeding practices* • *dietary diversity* • *breast-feeding* • *Burkina Faso, West Africa*

Breast-feeding and complementary feeding practices are fundamental to children's survival and development (1). In many developing countries, nutritional problems in infants and young children are closely linked to these practices. Among other things, feeding practices have an impact on physical growth, which is regarded as one of the best indicators of children's well-being (2). However, the relation between the quality of feeding practices during early age and nutritional status are difficult to establish, and, depending on the context and overall living conditions, the influence of feeding factors on children's nutritional status can vary considerably (3). In addition, feeding practices are often complex, change with a child's age, and are seldom all positive or all negative. It is therefore not easy to assess the global quality of feeding practices at the scale of the individual child. In 2002, Ruel and Menon (4) proposed an Infant and Child Feeding Index (ICFI)[3] based on an age-specific scoring system that gives points for positive practices in terms of breast-feeding, bottle-feeding, meal frequency, and food diversification. This method takes into account the young child's main feeding practices and expresses them comprehensively through a single summary index. Such an approach has many potential advantages: it summarizes information, facilitates an exploratory diagnosis in a particular situation, and helps target and monitor specific interventions. It may also enable comparisons at an international scale. Using the Demographic and Health Surveys data of 7 Latin American countries, the authors showed that the ICFI was closely related to the mean height-for-age Z-score (HAZ) among children aged 12–36 mo (5). In a later study, the same authors showed that a dietary diversity index calculated over 1 wk, which was one of the components of ICFI, was also related to HAZ (6). This study again used the Demographic and Health Surveys data, but this time in 11 developing

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[3] Abbreviations used: DDS, dietary diversity score; FVS, food variety score; HAZ, height-for-age Z-scores; ICFI, infant and child feeding index; WHZ, weight-for-height Z-scores.

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countries, including some African countries, and it examined a narrower age range of children, 6–23 mo. To our knowledge, only one published study has considered this kind of relation between ICFI or its components and the nutritional status of young children at a smaller-than-national scale, i.e., in a more homogenous sample (7). Conducted in an African rural area of Senegal, the study found that ICFI was not associated with either height-for-age or the linear growth of children aged 12–42 mo.

We examined the relation between feeding practices and nutritional status of infants and young children living in rural Burkina Faso, West Africa. The data are from a cross-sectional study conducted in 2002 and are based on a representative sample of over 2400 children aged 6–35 mo. We followed the principles of the method proposed by Ruel and Menon (5) to build a composite index of ICFI, which, in our study, was adapted to the characteristics of the context and to available data. The relation between this index and its different components with the children's nutritional status were explored separately in 3 age groups (6–11, 12–23, and 24–35 mo). The consistency between the index and its different components was also studied.

SUBJECTS AND METHODS

Setting. Gnagna province is located in northeast Burkina Faso and ranks among the poorest areas of the country owing to climate aridity, low quality of soils, and a landlocked position. The population consists of ~350,000 inhabitants unequally distributed in 278 villages. The *Gourmantche* is the main ethnic group. The mean population density is 41 inhabitants/km^2. The main livelihood of the population is farming and stock breeding.

Sampling. Eighty villages were randomly selected with a probability proportional to their population, based on data from the 1998 administrative census. Within each village, 12 collective housing units (or "compounds") were randomly selected from an updated list of all the heads of households currently living in the village. All children aged 6–35 mo and their mothers, living in the same compound as the selected heads of households, were included in the study.

Infant and child feeding index. Infant and child feeding practices were assessed through a qualitative 24-h recall of all foods consumed the previous day: breast-feeding, bottle-feeding, number of meals and snacks, and exact composition of the meals ingested. Based on this initial information the ICFI was constructed using the method proposed by Ruel and Menon, which was adapted to the context and to available information. To take into account the age limits of feeding recommendations, the ICFI was compiled separately for the 3 age groups: 6–11, 12–23, and 24–35 mo, respectively.

Breast-feeding. Whatever the age, a score of +1 was attributed to the child who was breast-fed on the day preceding the survey.

Bottle-feeding. Whatever the age, a score of +1 was attributed to the child who was never bottle-fed.

Number of meals and snacks. The number of "true" meals (i.e., porridges, special meals, or family meals) consumed by the child was computed first and then compared with the current age-specific recommendations (8): a score of +2 was given if the recommended level was reached and a score of +1 was given if the number of meals was below the recommendation but different from zero. In addition, a score of +1 was given when the child had consumed additional snacks or leftovers at least twice on the day preceding the survey.

Food diversity. The method proposed by Ruel and Menon takes into account food diversity indices calculated both over the last 24 h and over the last 7 d. Unfortunately, the latter information was not available in our survey. However, we deemed it important to retain the original idea of putting some emphasis on the quality of complementary foods. Consequently, we decided to take into account food diversity in terms of both a food variety score (FVS) and a dietary diversity score (DDS) (9). The FVS corresponds to the number of different food items consumed over the recall period and the DDS refers to the number of different food groups. We took 8 food groups into account: cereals, roots and tubers, nuts and pulses, fruits and vegetables, meat and fish, eggs, milk and dairy products, and fats. For both the FVS and the DDS, the score was divided into terciles separately in each age group. In calculating the ICFI, scores of +2, +1, and 0 points were attributed to the high, medium, and low terciles, respectively.

Together, the ICFI theoretically ranged from 0 to 9 points. In the analyses the index was used after recoding in terciles (poor, average, and good levels of feeding practices) separately for each age-group. The low range and the shape of the population distribution sometimes led to a division into categories whose percentages differ from 33%, especially among the youngest children.

ICFI internal validity was evaluated in several ways: *1*) by testing the associations between ICFI and each of its components through chi-square tests, and *2*) by assessing the associations between the components themselves through T coefficients of Tschuprow and by calculating the Cronbach α coefficient (10). An α value higher than 0.7 is generally considered to be satisfactory (11).

Anthropometry. The children were weighed naked to the nearest 10 g on mechanical 2–16 kg capacity baby scales (Seca). The mothers were weighed to the nearest 100 g on electronic scales (Seca). The recumbent length (of children up to 2 y) or the standing height (of children 2 y and above and mothers) were measured to the nearest mm with locally made wooden boards equipped with height gauges. The measurements were standardized according to the WHO recommended method (2). Special care was taken to determine the children's age with accuracy from an official document when available, or by using a calendar of local events specifically designed for the province. The height-for-age and weight-for-height indices expressed in Z-scores were computed using the 1978 National Center for Health Statistics/WHO reference using Epinut software (Epi Info Version 6, Centers for Disease Control) (12).

Demographic, socio-economic and health context. *Data for each child.* A "health monitoring" composite score was computed using information on whether the child had a health card, current attendance at health center activities and at growth monitoring sessions, adequacy of the child's immunization status with respect to the regular Epinut schedule, participation in meningitides immunization campaigns, and in vitamin A distribution. Altogether the score ranged from 0 to 8 points, and its distribution enabled clear separation into "low" and "high" values. In addition, morbidity during the fortnight prior to the survey was recorded (sick yes/no, regardless of illness type).

Data for each mother. Age, matrimonial status, level of education, and personal sources of income were collected. In addition, a composite score of "care for women" was built from the following information: knowledge and use of family planning, obstetrical background (history of stillbirth or infant death), level of prenatal care (number of visits, malaria prophylaxis, and iron supplementation), beneficial practices during pregnancy (improved feeding, alleviation of physical burden, and postpartum rest time), declared ill treatment, power of decision, and autonomy. Altogether the score ranged from 0 to 12 points and was subsequently divided into terciles.

Data for each household. A composite index of the economic level was constructed through a correspondence analysis performed on the matrix of indicator variables that code the housing quality (walls, roof, and floor), possession of current assets (electric lamp, petrol lamp, radio, bicycle, or moped) and possession of cattle (13,14). For a given household, its value on the first principal component of the correspondence analysis gives a coordinate that is interpreted as a summary indicator of its economic level. This index was then divided into terciles. Other collected variables included the number of people living in the household and in the compound, religion, ethnic group, level of education of the head of household, and whether he had a secondary nonagricultural occupation. The hygiene practices within the household were assessed by a score composed from information on water (type and distance to source), latrines, promiscuity with animals, garbage disposal, and a spot-check of the cleanliness of the compound.

Statistical analysis. All analyses were done separately for each age-group. First, bivariate analyses were used to describe the ICFI distribution as a function of the different socio-economic and demographic characteristics of individuals or households. To study the association between ICFI categories and mean anthropometric indices, potential confounding factors were identified on the basis of the internationally recognized Unicef conceptual model of the causes of malnutrition. Factors that can influence both the ICFI value and the children's nutritional status were considered as potential confounders. They were identified through bivariate analyses carried out separately for HAZ and WHZ, with a significance limit of 0.20. These analyses were adjusted for the child's sex and age and also for the mother's height, which are considered the basic factors that determine the child's nutritional status. Two-way interaction terms between the ICFI and each of the potential confounders were systematically tested. As none was significant, all the potential confounders were introduced in the final multivariate models of regression on the mean nutritional indices, together with the basic factors. Adjustment variables for a given nutritional index remained identical within the different age groups and were similar for HAZ and WHZ.

All statistical analyses were performed taking into account the design effect of the study (cluster effect at the village level) using the SAS (statistical analysis system), version 8.02 (15).The generalized linear model was used to test the association of the ICFI with categorical variables (using the Proc GENMOD procedure, option REPEATED = village) and the linear model was used for the association with the mean anthropometric indices (using the Proc MIXED model, option RANDOM = village). The adjusted means were calculated by considering the observed marginal distribution for the independent variables. Associations were considered significant at $P < 0.05$.

Ethics. The study protocol was approved by the Ministry of Health and by the Ministry of Research of Burkina Faso. Information about the objectives and principles of the study was given to participants in their own language. All individuals surveyed gave oral consent to participate in the study.

RESULTS

Altogether, 933 compounds were visited in the 80 villages resulting in a sample of 1825 households in which 2466 children and 2411 mothers were surveyed. More than half of the children (52%) were stunted (HAZ < -2 Z-scores) 22% with severe forms (HAZ < -3 Z-scores), and 16% were wasted (WHZ < -2 Z-scores) 3% with severe forms (WHZ < -3 Z-scores). About half of the children (47%) had been sick during the 2 wk preceding the survey: 21% had a fever, 20% diarrhea, and 7% a respiratory infection. The mothers were aged 27.6 $\pm$ 6.9 y and had 4.4 $\pm$ 2.8 children ranging from 1 to 15. Their mean height was 161 $\pm$ 5 cm, their BMI was 20.8 $\pm$ 2.0 kg/m^2, and 11% of them had a BMI <18.5 kg/m^2. For analyses that include the mother's BMI, pregnant women were excluded ($n = 303$). The size of households was 10.0 $\pm$ 5.7 persons, and ranged from 3 to 48. The *Gourmantche* were by far the dominant ethnic group, with 85% as heads of households. Values in the text are means $\pm$ SD.

Distribution of the ICFI and its components. The distribution of the ICFI components by children's age groups is presented in **Table 1**. Breast-feeding was almost ubiquitous and was prolonged (36% of children aged 24–35 mo were still breast-fed). Bottle-feeding was almost never resorted to. As expected, the number of meals and snacks increased with age, but among children aged 6–11 mo, 1 out of 2 had no meal on the day preceding the survey. Only 16 different complementary food items were identified for all ages. Animal products (i.e., fish, meat, milk, or eggs), fats, and fruit were rarely consumed by 29%, 15%, and 1.3% of the sample, respectively. On the whole, dietary diversity and variety increased with age. The ICFI distribution per age group and the division into terciles are presented in **Figure 1**.

Evaluation of the ICFI internal validity. As assessed by chi-square tests, in all age groups the ICFI was strongly associated with the number of meals, the FVS, and the DDS ($P < 0.0001$ in all cases), but not with breast-feeding or bottle-feeding. Similarly, the Tschuprow coefficients showed that these 2 components were not significantly correlated to the other components of the index. In turn, the number of meals, the FVS, and the DDS were strongly correlated among

TABLE 1

ICFI component distribution by age group

Component	6–11mo (*n* = 614)	12–23 mo (*n* = 987)	24–35 mo (*n* = 865)
Breast-feeding, %	99.8	94.8	35.8
Bottle-feeding, %	0.2	0.4	0.5
Meal frequency, %			
Low	0 meal: 60.6	0–1 meal: 16.4	0–1 meal: 12.4
Medium	1 meal: 12.7	2 meals: 31.4	2 meals: 49.1
High	≥2 meals: 26.7	≥3 meals: 52.2	≥3 meals: 38.5
Snack, %			
Low	0–1 snack: 88.9	0–1 snack: 56.0	0–1 snack: 34.3
High	≥2 snacks: 11.1	≥2 snacks: 44.0	≥2 snacks: 65.7
FVS, %			
Low	0 food: 51.5	0–5 foods: 21.1	0–6 foods: 25.1
Medium	1–6 foods: 27.2	6–8 foods: 43.4	7–9 foods: 45.1
High	≥7 foods: 21.3	≥9 foods: 35.5	≥10 foods: 29.8
DDS, %			
Low	0–2 groups: 71.9	0–2 groups: 23.0	0–2 groups: 12.9
Medium	3 groups: 16.7	3 groups: 41.7	3 groups: 41.1
High	≥4 groups: 11.4	≥4 groups: 35.3	≥4 groups: 46.0
ICFI			
Minimum	1	2	1
Maximum	9	8	8
Median	2	6	5
Mean ± SD	3.9 ± 2.3	6.0 ± 2.0	5.7 ± 1.7

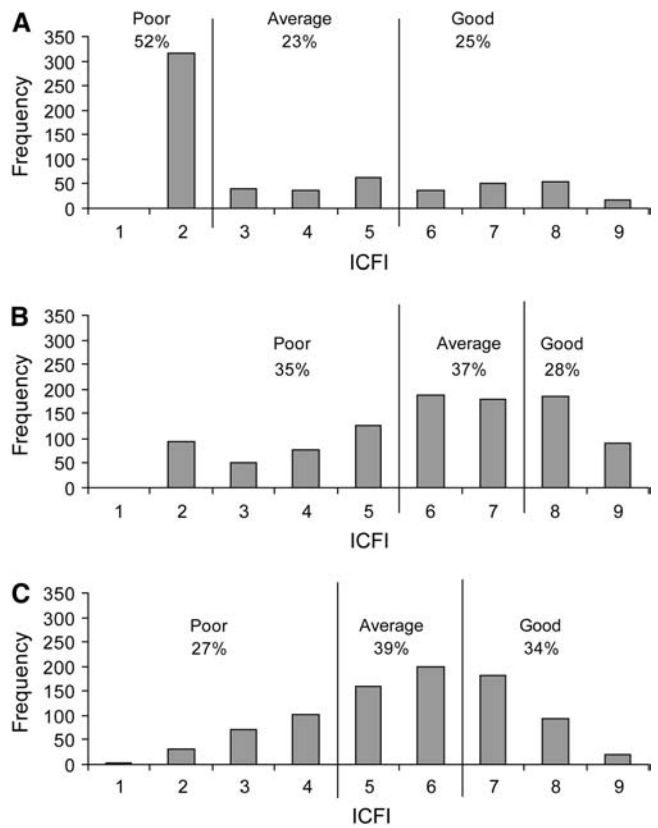

FIGURE 1 ICFI distribution by age group: (*A*) 6–11 mo, $n = 614$; (*B*) 12–23 mo, $n = 987$; (*C*) 24–35 mo, $n = 865$.

themselves, as expected. However, these correlations clearly decreased with the child's age (detailed results not shown). The ICFI internal consistency estimated by the Cronbach α coefficient (**Table 2**) proved to be good among children aged 6–11 mo ($\alpha = 0.79$) but it was lower among children aged 12–23 mo ($\alpha = 0.63$), and rather weak among children aged 24–35 mo ($\alpha = 0.38$). In all age groups, removing breast-feeding and bottle-feeding from the index improved the value of the Cronbach α coefficient.

ICFI distribution according to the socio-economic and demographic characteristics of the sample. At the level of the individual child, adequate health monitoring was closely related to a better ICFI within the 6–11 and 12–23 mo age groups (see **Table 3**). In addition, Fulani children presented a lower ICFI than the Gourmantche or Mossi children. Among the mothers, the level of "care for women" having a minimum level of education or practicing a petty trade was positively related to the ICFI. At the level of the household, economic and hygiene standards were positively related to the ICFI. The size of the household was also associated with the ICFI, but especially to the detriment of medium-sized households.

Association of mean anthropometric indices with ICFI or its components. After adjusting for the potential confounding factors, the mean HAZ was significantly and positively related to ICFI categories among children aged 6–11 and 12–23 mo ($P = 0.003$ and $P = 0.0002$, respectively) (**Table 4**). Inversely, HAZ was negatively related to ICFI categories among children aged 24–35 mo ($P = 0.05$). There was also a positive association between ICFI and mean WHZ among children aged 12–23 mo ($P = 0.05$) but a negative association among the youngest age group ($P = 0.02$), mainly due to a higher mean WHZ in the poor category of the ICFI. As far as the single breast-feeding component of ICFI is concerned, nonbreast-fed children exhibited a higher mean HAZ in ages 12–23 and 24–35 mo ($P < 0.0001$) and also a higher mean WHZ in ages 24–35 mo but not in ages 12–23 mo. For the other components of the ICFI (namely, number of meals, snacks, FVS, and DDS), a positive and significant association with mean HAZ was found among children less than 2 y. Bottle feeding was encountered in less than 0.5% of the sample and was therefore subsequently not studied. With mean WHZ, only snacks and FVS exhibited an association, which was negative and significant among infants aged 6–11 mo and tended to be positive among children aged 12–23 mo ($P = 0.09$). Scores concerning the consumption of selected food groups of particular interest rather than the global variety and diversity showed no significant relationship between the nutritional status of the children and the consumption of any food group (**Table 5**).

DISCUSSION

Summary of main results. Despite the homogeneous rural context, our results showed that the feeding practices composite index of young children that we constructed on the principle proposed by Ruel and Menon (5) was significantly and positively associated with the mean HAZ of children aged 6–11 and 12–23 mo, and with the mean WHZ among children aged 12–23 mo. The corresponding differences of adjusted mean anthropometric indices between the poor and the good ICFI

TABLE 2

Study of internal consistency of the ICFI by Cronbach α coefficient

α Value for ICFI (all items)	6–11 mo (n = 614)		12–23 mo (n = 987)		24–35 mo (n = 865)	
	0,79		0,63		0,38	
Item	Correlation with ICFI	α Value when item is removed	Correlation with ICFI	α Value when item is removed	Correlation with ICFI	α Value when item is removed
Breast-feeding	[1]	[1]	−0.10	0.68	−0.11	0.49
Bottle-feeding	0.03	0.84	−0.03	0.66	−0.01	0.40
Meal frequency	0.75	0.69	0.42	0.57	0.19	0.34
Snack	0.46	0.79	0.20	0.64	−0.03	0.45
FVS	0.87	0.62	0.76	0.37	0.56	−0.03
DDS	0.76	0.68	0.69	0.41	0.43	0.12

[1] Breast-fed groups.

TABLE 3

Association between ICFI and socio-demographic characteristics in children 6–35 mo

Child characteristics	ICFI classes 6–11 mo					ICFI classes 12–23 mo					ICFI classes 24–35 mo				
	n	% of Poor	% of Average	% of Good	P^1	*n*	% of Poor	% of Average	% of Good	P^1	*n*	% of Poor	% of Average	% of Good	P^1
Health monitoring															
Low	283	61	20	19	0.0002	404	43	34	23		402	31	36	33	
High	331	44	25	31		583	30	39	31	0.0002	463	23	42	35	0.12
Ethnic group															
Gourmantche	523	53	21	26		837	33	38	29		733	26	39	35	
Fulani	45	58	31	11	0.05	78	47	30	23	0.05	66	33	38	29	0.46
Mossi	46	37	28	35		72	40	40	20		65	26	46	28	
Mother's characteristics															
Mother's age, *y*															
<20	99	61	20	19		109	30	41	29		61	34	43	23	
20–29	323	50	24	26	0.20	587	37	35	28	0.40	484	25	40	35	0.10
≥30y	192	50	21	29		291	34	39	27		320	27	37	36	
Mother's education															
None	480	53	22	25		784	37	38	25		682	27	40	33	
Any	134	45	25	30	0.01	203	29	34	37	0.004	183	24	38	38	0.20
Mother is a small vendor															
No	493	52	23	25		787	36	38	26		681	28	39	33	
Yes	119	50	20	30	0.40	209	31	32	37	0.02	177	21	39	40	0.03
Care for women															
Low	215	54	27	19		291	42	36	22		289	30	40	20	
Medium	192	55	19	26	0.08	351	32	38	30	0.008	287	26	40	34	0.07
High	207	46	22	32		345	32	36	32		289	24	38	38	
Household characteristics															
People in household, *n*															
1–6	140	46	24	30		210	38	36	26		186	23	41	36	
7–10	179	55	22	23	0.55	306	40	39	21	0.003	272	34	38	28	0.01
≥11 persons	295	52	22	26		471	30	37	33		407	24	39	37	
Hygienic level															
Low	173	51	26	23		259	40	39	21		242	33	37	30	
Medium	301	55	20	25	0.41	471	34	35	31	0.02	407	28	40	32	0.0009
High	140	46	24	30		257	32	39	29		216	16	41	43	
Economic level															
Low	165	53	21	26		242	44	37	19		224	31	38	31	
Medium	204	56	24	20	0.06	347	33	36	31	0.007	323	24	40	36	0.21
High	224	46	22	32		366	32	38	30		293	25	40	35	
Head of household has a secondary activity															
No	354	56	23	21		530	36	38	26		494	28	41	31	
Yes	256	46	22	32	0.01	455	33	37	30	0.23	365	26	36	38	0.17
Agricultural production tools															
No	248	53	22	25	0.41	417	37	38	25	0.12	356	30	39	31	0.06
Yes	366	51	23	26		570	33	36	31		509	24	39	37	

[1] Comparisons are adjusted for age.

terciles were +0.46 and +0.43 HAZ, and +0.19 WHZ, respectively. In addition, there was a negative difference of −0.25 WHZ between poor and good ICFI terciles among children aged 6–11 mo. However, it appeared that associations relied essentially on some components of the index, such as number of meals, snacks, and dietary diversity or variety for HAZ, and snacks and FVS for the WHZ. Nevertheless, no particular food group was associated with HAZ, nor with WHZ (latter results not shown). Besides, breast-feeding, which is recommended for at least 24 mo, was negatively associated with the mean HAZ of children aged 12–23 and 24–35 mo.

Comparison with other studies. As a whole, our results tend to confirm the HAZ results obtained by other authors based on national or multinational samples, even if there were slight differences in the indices used and in the age ranges. Ruel and Menon (5) showed a relationship between ICFI and HAZ among 6–35 mo-old children, and Arimond and Ruel (6) showed a relationship between food diversity (measured over 7 d) and HAZ among 12–23 mo-old children. On the other hand, we did not reach the same conclusions as Ntab et al. (7), who conducted a study in a comparable area (homogenous sample in a rural African region) but found no relationship between ICFI and HAZ or linear growth. The relatively small size of the sample ($n = 500$) and the wider age group (12–42 mo) could explain this lack of association.

To our knowledge, our study is the first to show that mean WHZ decreased as children aged 12–23 mo moved from the highest to the lowest tercile of ICFI. This is an important finding because this is the age when children display a clear drop in WHZ, which is probably associated with high rates of infection. The result suggests that better feeding practices are particularly important in preventing excessive loss in WHZ at this age. However, we also observed a higher mean WHZ among infants aged 6–11 mo belonging to the lower ICFI

TABLE 4

Adjusted relations of ICFI and its components with anthropometric indices by age group[1]

ICFI/Components	Categories	Height-for-age adjusted Z-scores[2] 6–11 mo (*n* = 574)	12–23 mo (*n* = 883)	24–35 mo (*n* = 792)	Weight-for-height adjusted Z-scores[2] 6–11 mo (*n* = 574)	12–23 mo (*n* = 883)	24–35mo (*n* = 792)
	Poor	−1.67 ± 0.07	−2.54 ± 0.08	−2.18 ± 0.10	−0.90 ± 0.06	−1.39 ± 0.06	−0.83 ± 0.06
ICFI	Average	−1.53 ± 0.11	−2.24 ± 0.08	−2.20 ± 0.08	−1.19 ± 0.09	−1.33 ± 0.06	−0.80 ± 0.05
	Good	−1.21 ± 0.11	−2.11 ± 0.09	−2.45 ± 0.09	−1.15 ± 0.09	−1.20 ± 0.07	−0.85 ± 0.05
	P	0.003	0.0002	0.05	0.02	0.05	0.78
	No	—	−1.21 ± 0.18	−2.03 ± 0.07	—	−1.12 ± 0.14	−0.73 ± 0.04
Breast-feeding	Yes	—	−2.37 ± 0.05	−2.74 ± 0.09	—	−1.32 ± 0.04	−0.99 ± 0.05
	P	—	<0.0001	<0.0001	—	0.17	<0.0001
Bottle-feeding	(Not used)						
	Low	−1.65 ± 0.07	−2.70 ± 0.11	−2.38 ± 0.14	−0.97 ± 0.06	−1.38 ± 0.08	−0.80 ± 0.09
Meal frequency	Medium	−1.16 ± 0.14	−2.25 ± 0.08	−2.10 ± 0.07	−1.17 ± 0.11	−1.29 ± 0.08	−0.80 ± 0.04
	High	−1.39 ± 0.10	−2.22 ± 0.07	−2.48 ± 0.08	−1.10 ± 0.08	−1.31 ± 0.05	−0.86 ± 0.05
	P	0.004	0.0002	0.0009	0.23	0.64	0.65
	Low	−1.57 ± 0.05	−2.48 ± 0.06	−2.35 ± 0.09	−1.00 ± 0.04	−1.37 ± 0.05	−0.83 ± 0.05
Snacks	High	−1.10 ± 0.15	−2.09 ± 0.07	−2.25 ± 0.07	−1.33 ± 0.13	−1.24 ± 0.05	−0.82 ± 0.04
	P	0.004	<0.0001	0.34	0.02	0.06	0.83
	Low	−1.68 ± 0.07	−2.65 ± 0.10	−2.35 ± 0.10	−0.91 ± 0.06	−1.40 ± 0.07	−0.82 ± 0.06
FVS	Medium	−1.56 ± 0.10	−2.26 ± 0.07	−2.18 ± 0.08	−1.22 ± 0.08	−1.34 ± 0.05	−0.83 ± 0.05
	High	−1.08 ± 0.11	−2.11 ± 0.08	−2.37 ± 0.09	−1.10 ± 0.10	−1.22 ± 0.06	−0.82 ± 0.06
	P	0.0001	<0.0001	0.15	0.01	0.09	0.98
	Low	−1.62 ± 0.06	−2.61 ± 0.09	−2.37 ± 0.14	−0.98 ± 0.05	−1.37 ± 0.07	−0.91 ± 0.09
DDS	Medium	−1.36 ± 0.13	−2.27 ± 0.07	−2.29 ± 0.08	−1.17 ± 0.10	−1.32 ± 0.05	−0.88 ± 0.05
	High	−1.07 ± 0.15	−2.15 ± 0.08	−2.25 ± 0.08	−1.15 ± 0.13	−1.27 ± 0.06	−0.75 ± 0.05
	P	0.002	0.0003	0.75	0.22	0.55	0.06

1 Values are means ± SD.

2 Comparisons are adjusted for the following factors: age and sex of the child, mother's height, health monitoring, ethnic group, mother's age, care for women, education of mother and of head of household, head of household had a secondary activity, hygiene and economic level of the household, and number of people in household; for HAZ, comparisons are also adjusted for "mother is a small vendor;" for WHZ, comparisons are also adjusted for "household had agricultural production tools."

category, which included >50% of the infants who did not receive complementary food. This could be due to the strong effect of breast milk displacement in this age group.

Dietary diversity. Several studies, some of which were carried out in sub-Saharan Africa, showed that improved dietary diversity or variety was a key point for the improvement of global feeding practices, and that a food diversity index was associated with children's nutritional status (3,6,16,17). We found similar results characterized by three points: *1*) both dietary diversity and variety scores were included in the ICFI; *2*) these scores were measured only over 24 h; *3*) we did not find a relationship between a particular food group and children's nutritional status. This latter point may mean that dietary diversity in itself matters more for the quality of the diet than the consumption of a particular food group. The main justification for including both FVS and DDS in the ICFI, which essentially capture the same construct, was to emphasize the quality of complementary foods in the scoring system. In addition, we assert that this captures slight differences in the quality of the diet, i.e., when several foods of the same group are consumed. We verified this point by examining the results for ICFI calculated with and without FVS. When FVS was removed, the associations between ICFI and mean WHZ were lowered (among both age groups of 6–11 and 12–23 mo), whereas they remained almost identical between ICFI and mean HAZ (results not shown). It has also been pointed out that a 24-h recall cannot appropriately reveal the actual quality of the diet, mainly because of possible variations from one day to another (18). In our context, very few different food items were identified in the overall sample; thus, the chosen indicators may reflect the poverty of the diet, which hardly varies over time. As a matter of fact, we already showed that the nutritional quality of the complementary foods was particularly poor in this area (19). All of these factors lead us to the conclusion that nutritional status is associated with diversification of the daily diet.

Breast-feeding and children >2 y. It could be considered as an anomalous finding in our study that the ICFI was negatively associated with nutritional status in children >24 mo of age. In fact, this is related to our scoring system, which continues to add 1 positive point for breast-feeding in this age group. This association has already been identified as "reverse causality" by other authors (20,21). The hypothesis is that mothers tend to prolong the breast-feeding of malnourished children. It is worthwhile to point out that, beyond the age of 24 mo, there is currently no scientific basis for recommending breast-feeding nor are there recommendations for an optimal number of meals. Nevertheless, in our study the phenomenon was observed among children aged 24–35 mo and also among those aged 12–23 mo, despite the low rate of nonbreast-fed children in the latter age group. In addition, among the 24–35-mo age group, a lower mean HAZ was observed in the class of children consuming a higher number of meals (see Table 4) in which there were also a higher proportion of breast-fed children (data not shown), suggesting that the reverse causality hypothesis may also apply to the number of meals. In any case, taken together, these results stress that the duration of breast-feeding as well as the number of meals can be contextual.

Challenges in constructing a composite ICFI. The first consideration in constructing a composite ICFI is the cross-

TABLE 5

Adjusted relations between consumption of selected food groups and height-for-age Z-scores, by age group[1,2]

Food group	Height-for-age adjusted Z-scores[3]		
	6–11 mo (*n* = 574)	12–23 mo (*n* = 883)	24–35 mo (*n* = 792)
Animal source foods[4]			
No	−1.56 ± 0.06	−2.36 ± 0.06	−2.28 ± 0.06
Yes	−1.48 ± 0.13	−2.29 ± 0.08	−2.36 ± 0.10
P	0.21	0.58	0.17
Pulses and nuts			
No	−1.56 ± 0.06	−2.35 ± 0.10	−2.36 ± 0.08
Yes	−1.27 ± 0.17	−2.26 ± 0.06	−2.27 ± 0.13
P	0.12	0.39	0.53
Fats and oils			
No	−1.52 ± 0.05	−2.33 ± 0.06	−2.25 ± 0.11
Yes	−1.46 ± 0.19	−2.22 ± 0.11	−2.44 ± 0.06
P	0.76	0.34	0.13
Fruits and vegetables			
No	−1.56 ± 0.06	−2.37 ± 0.08	−2.40 ± 0.08
Yes	−1.29 ± 0.15	−2.26 ± 0.06	−2.21 ± 0.11
P	0.08	0.28	0.16

1 Values are means ± SD.
2 Cereals were consumed by all infants who received meals. Roots and tubers were not consumed.
3 Comparisons are adjusted for the following factors: age and sex of the child, mother's height, health monitoring, ethnic group, mother's age, care for women, education of mother and of head of household, head of household had a secondary activity, hygiene and economic level of the household, and number of people in household; for HAZ, comparisons are also adjusted for "mother is a small vendor;" for WHZ, comparisons are also adjusted for "household had agricultural production tools."
4 Egg, fish, meat, poultry, milk, and dairy products.

sectional nature of data collection, whereas infant growth results from long-term processes. We therefore have to assume that the feeding practices measured at a given time adequately assess previous practices. We tried to add to the ICFI scoring system some retrospective information about past feeding practices that were available in our study. These were practices whose impact on child nutritional status is well known, such as initiation of breast-feeding (elimination of colostrum, and delaying breast-feeding) (22), or the timing of introducing complementary foods (23,24). Although this led to changes in the distribution of ICFI, it did not modify its association with anthropometric indices.

Furthermore, we faced additional difficulty with respect to the choice of the cutpoints to define the ICFI categories, owing to the low range of the index values (from 1 to 9) and to the shape of its distribution. This was especially true for children aged 6–11 mo, among whom more than half did not consume complementary foods. Yet, similar results were found when only 2 categories for the index in this age group were considered (results not shown). Nevertheless, any difference in the construction of the index can change its characteristics and thus its association with child nutritional status (25).

Among the many difficulties creating a universally applicable ICFI is the lack of consensus in defining positive and negative practices in order to attribute age-specific points in the scoring system. Our results highlight the need for additional research on optimal feeding practices beyond the age of 2 y. We also decided to separate the number of true meals and the consumption of snacks. However, there is no clear definition of what should be considered a real meal or a snack, or how the latter should be accounted for. In the case of food diversity, the option chosen in our study, as in most previous studies (5,6,26), was to divide the variety and diversity scores for each age group into terciles. Yet it is obvious that the limits of the categories cannot be the same in all contexts; this also applies to the food groups and their exact definition (26). In this respect there is no mention of an objective threshold referred to as the necessary diversity level to ensure optimal growth. As far as we know, no such information is available, even if efforts are currently underway to harmonize methods of constructing diversity indices and to validate them with regard to real intakes of micronutrients (27).

Finally, within our sample, almost all the children were breast-fed up to 2 y, whereas bottle-feeding was rare. Consequently, as shown in the index-reliability analysis, these 2 ICFI components lacked internal consistency with the global index because there was almost no variability in these factors for children up to 2 y, and because the association was in the reverse direction beyond 24 mo. Consequently, the only reason to include these variables in an ICFI are: *1*) to retain the conceptual objective of capturing the multidimensional nature of infant feeding, and *2*) to allow for international comparisons, because in other contexts these variables may be more meaningful. Nevertheless, for this purpose our results indicate that it is better to use single variables rather than composite indices that can mask the different practices they include. However, locally developed and adapted indices are relevant for other purposes such as monitoring progress and evaluating the impact of interventions within a specific context.

In conclusion, the contextual characteristics of our study, the differences in the measurement of the feeding practices, and the real meaning of each practice could be sources of difficulty for building and interpreting a composite feeding index, and perhaps this is also a source of confusion for defining its relationship within nutritional indices. Despite the lack of a standard definition, and despite the variations in the methods used to collect data and to construct diversity and variety scores, our results confirm the existing literature and suggest that dietary diversity is positively associated with anthropometric indicators of nutritional status among young children (6,26). Thus, dietary diversity can be considered a good proxy in assessing the global quality of infant and child feeding practices.

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