Original Article

Contribution of complementary food nutrients to estimated total nutrient intakes for urban Guatemalan infants in the second semester of life

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Complementary foods (CF) are introduced earlier or later than appropriate in developing societies. They often contribute poorly to overall adequate micronutrient intake during the critical period for growth and development, which constitutes the period from 6 to 12 months of life. The objective of this study was to determine the contribution of the CF nutrients to the total estimated nutrient intake in infants in the second semester of life. Three non-consecutive 24-hour recalls interviews were conducted with mothers of 64 infants, aged 6-12 months on enrolment, from a convenience sample in a marginal urban settlement in Guatemala City. Retrospective recording of early introduction of pre- and post-lacteal feeding and introduction of first foods and beverages was included. Human milk intakes were estimated by a model based on assumptions that human milk plus CF exactly satisfied the infant's daily energy needs. The WHO/FAO Recommended Nutrient Intakes (RNI) were the standards for adequate nutrient consumption. Instances of exclusive breast feeding to 6 months were rare, with the introduction of CF earlier than recommended. Baby food in jars was mentioned most frequently as the first food offered. The contribution of CF increased with age through the second semester of life. CF contributed more of a nutrient than human milk in all instances. However,CF nutrient density for Ca, Fe, and Zn fell below international standard. Fortified sugar contributed excessive amounts of Vitamin A to the diets. We conclude that for most nutrients, intakes reached or exceeded recommendation levels, unusual within the CF experience in scientific literature.

Key Words: human milk, complementary foods, infant feeding, micronutrient intake, Guatemala

INTRODUCTION

Adequate nutrition is the most important factor for normal growth and development in the first year of life. The World Health Organization (WHO) has recommended that infants be breast fed exclusively,[1] without even the administration of water, for the first 6 months of life. Thereafter, appropriate complementary feeding (CF) should be begun at that time, with feeding of human milk continuing through the second year of life. Changes in lifestyle and cultural norms involved in urban living create disincentives for breast feeding. A baseline survey by Dearden e*t al* [2] in a peri-urban community in Guatemala City found a spontaneous rate of exclusive breast feeding (EBF) of 19%; with an intensive peer-counselling intervention, the EBF rate could only be moved to 21%.[2]

The period of transition to a family diet is fraught with health hazards. Early observations, including some from Guatemala, found an increase in vulnerability to diarrheal episodes after introduction of CF, termed "weanling diarrhea".[3] Victora *et al*. showed that partial breast feeding afforded no protection against food-borne gastroenteritis once the weaning process had begun.[4] The nutrient delivery from CF is the second concern.

Two parallel surveys on infant feeding practices in the 7th through the 12th months of life using the same field team, research protocol and sample size were conducted in a rural Mayan village and a low-income urban neighbourhood in Guatemala in 2007 and 2008, respectively.[5] Enneman *et al* have already presented findings related to estimated total water consumption and dietary diversity, variety and characteristics, respectively.[6,7] In the present study, we address quantitative aspects of macro- and micronutrient intake with respect to a show in appropriate timing of CF and inadequate nutrient intake from CF and beverages in the urban location.

MATERIALS AND METHODS

Study population

The study was conducted in Guatemala City which sits at an altitude of 1500 m above sea-level and is estimated to

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Manuscript received 14 January 2011. Initial review completed 6 April 2011. Revision accepted 12 May 2011.

have 1.2 million inhabitants. The population sample comprised of infants attending a health care centre in the district of "*Centro America*" in Zone 7 in the western sector of the capital. Most households have a per capita earning of less than two US dollars per day, and are thus classified as being poor.

Subjects

The mothers of 97 infants, aged approximately 6 to 12 months, visiting the local public health care centre for various reasons, such as illness, well-baby check-up or vaccinations, were initially recruited for the study. Inclusion criteria were: 1) the infant was at least 6 months old, but had not reached his or her 1st birthday; and 2) the infant had consumed both breast milk and CF the day before the first interview. Exclusion criteria included: 1) exclusive breastfeeding the day before the first interview; 2) no breastfeeding the day before the first interview; 3) congenital anomalies or chronic illness; and 4. failure to sign the study consent form.

The study protocol was approved by the Human Subjects Committee of the Center for Studies of Sensory Impairment, Aging and Metabolism (CeSSIAM) and approved by the local authorities of the Ministry. The purpose and procedures of the study were explained and all enrolled mothers gave written informed consent. Participants received a small compensation in kind after each interview.

Data collection

Each mother was interviewed three times between February and August of 2008. On the day of enrolment, a structured questionnaire was administered which queried sociodemographic characteristics as well as general breastfeeding and CF practices. These including questions on colostrum feeding practices, early introduction of prelacteal feeds such as ¨*aguitas*¨, the use of formulas or whole milk, and early CF items. Mothers were asked what food or beverage items they introduced first, at what age and why they made the choices they made. This tool was administered only once.

A second structured questionnaire was administered on each data collection day. This included questions related to morbidity, exclusivity of breast feeding, timing of breast-feedings, initiation of weaning, the use of formulas (including brands), and dietary supplements. In addition, mothers were asked when they first introduced a predetermined list of 10 commonly consumed food items (ie *Incaparina*®, oatmeal, rice, white rolls, sweet rolls, fruits and vegetables, potatoes, baby food desert, coffee).

Three separate 24-hour dietary recalls were recorded on each data collection day for each infant. Mothers were asked to report all foods and beverages, excluding breast milk, consumed by their infant in the previous 24 hours. Portion sizes were recorded in common household measures and recipes for dishes and household preparations were queried in detail. The interviews were conducted by a pair of trained and standardized nutritionists.

Data were collected on 3 non-consecutive days, always on week days. The first interview took place on the day of enrolment. Most interviews took place within a calendar month. The minimum and maximum time interval between the three interviews was 8 and 91 days, respectively. A total of 8 infants completed a first birthday before the final one or two recall interviews were completed. These children were retained in the analysis, and the reference standards for infants in their 12th month of life were used.

When an interview appointment was missed, efforts were made to contact and reschedule for a future date. If the mother failed to return after multiple contact attempts, the infant was excluded from entering into the final analyses.

Energy and nutrient analysis of complementary feeding (CF)

Each food or beverage item reported was coded and entered into a database. Dishes were disaggregated to the most elemental level possible. Household measures were converted to grams using standard reference tables. A total of 140 items were listed and their nutrient values were derived from USDA FCT obtained on line from the USDA database.[8]

Modelled intakes of breast milk

Although breast milk consumption was a criterion for inclusion, quantitative consumption of breast milk was not evaluated. A simple approach to model the volume of breast milk intake was developed based on the assumption that the energy from breast milk intake is equal to the energy requirement of the infant minus the energy derived from CF.

Energy requirements for each age group were computed using the formula: –95.4+88.3×body weight (kg) in addition to sex-specific daily energy requirement for growth.[9]

It was not possible to weigh the participants. Reference growth curves for infants in the 7th to the 12th months of life were constructed using archival data for infants who visited the local well-baby clinic for vaccinations, as described previously.[6] A total of 132 body weight measurements were taken (11 per month and gender) and median values were used for analysis. Data was collected over the span of the previous full calendar year (2007). Breast milk was assumed to provide 272 kJ/100 mL (67 kcal/100 mL).[10]

Data analysis

Data were analyzed using SPSS version 16.0 (SPSS Inc., Chicago, IL, USA). Descriptive statistics for estimated daily energy, protein, fat, carbohydrates, vitamins A, B-1, B-2, B-3, and C, folate, calcium, iron and zinc intakes in CF, breast milk and total diet are presented for the pooled sample based on 3 data collection days for each infant (n=192). In addition, nutrient intakes for CF only are presented by age group (ie 7th-9th months and 10th-12th months). Estimated daily energy and nutrient intakes are presented alongside the percentage of infants with estimated intakes meeting the Recommended Nutrient Intakes (RNI)[11] for CF only and for the total diet for each infant (n=64). Descriptive statistics for the nutrient density of selected nutrients in the CF are presented and compared to reference values from Dewey *et al*[12] and human milk.[10] The top 10 sources of energy, macronutrients and selected micronutrients are presented for the total diet including breast milk.

RESULTS

Demographic characteristics

Of the original 97 mother-infant dyads recruited, 64 (66%) were available for analysis. Reasons for exclusion included, failure to complete the series of 3 interviews (n=25), full weaning (*n*=5) and inappropriate age on enrolment (*n*=3).

Table 1 provides demographic statistics on our sample on the 1st day of data collection. There were a total of 64 mother-infant pairs in which the full series of three interviews were completed, 36 boys and 28 girls. The median age of the sample was 8.0 months at entry into the study. Of these, 40 were in the 7th to 9th months range at the time of enrolment and 24 were in the 10th to 12th months range.

Qualitative aspects of feeding infants in the first semester of life

Colostrum had been given at birth by 63 (98%) of the women interviewed. Using the WHO criterion,[1] 2 of the 64 mothers (3%) had provided exclusive breast feeding during the infant's first 6 months of life. Eighty seven percent of mothers had offered "*agüitas*," the constellation of drinks including plain water or water with grains or herbs in very early life. Thirty-four percent of the mothers had given replacement formulas to their infant at some point prior to the infants' enrolment into the study.

Infants had received their first food, anywhere from the 2nd to the 9th month of life, with a median of the distribution at the 5th month. Urban women almost universally named only one food or beverage item in response to the query on the first food offered to the infant. The ten most commonly mentioned "first foods," in descending order, were: 1) commercial baby food; 2) banana; 3) potato; 4) reconstituted packaged dried soup; 5) assorted vegetables; 6) chicken broth; 7) *Incaparina*® gruel; 8) pumpkin; 9) *güicoyito* squash; and 10) *Nestum*® rice cereal. These were derived from among a total of 24 foods listed across the 64 informant mothers' interviews. Finally, when asked who had made the determinant suggestion as to what would be the first food given to the child and when, 45% listed the maternal grandmother, 25% listed the mothers, themselves, 8% listed a sister, 8% the mother-in-law (paternal grandmother), and 5% a neighbour.

Table 1. Characteristics of the population sample on the 1st day of data collection

	n	Age (month)		Number sampled by month of age					
		mean±SD	median	7th	8th	9th	10th	11th	12th
Total	64	8.6±1.9	8.5	21	8	11	5	7	12
Boys	41	8.5±2.0	8.5	15	4	9	1	4	8
Girls	23	8.8±1.9	8.5	6	4	2	4	3	4

Table 2. Estimated 24-hour intakes of selected nutrients from complementary feeding, human milk and both combined and percentage of infants meeting the Recommended Nutrient Intakes (RNI), based on 192 responses in 64 urban infants

Nutrients	RNI†	Complementary feeding§			Human milk¶		Human milk and complementary feeding combined		
		mean±SD	median	Percentage meeting RNI††	mean±SD	median	mean±SD	median	Percentage meeting RNI††
Protein (g)	10/11‡	12.9±9.7	9.8	48	4.5±2.9	4.6	17.1±7.6	14.1	92
Vitamin A (RAE)	400	640±613	437	52	212±140	219	844±572	654	84
Vitamin C (mg)	30	25.1±19.7	21.3	66	17.0±11.2	17.5	41.4±15.3	37.5	83
Thiamine (mg)	0.3	0.6±1.4	0.4	47	0.1±0.1	0.1	0.7±1.4	0.5	70
Riboflavin (mg)	0.4	0.5±0.5	0.3	45	0.1±0.1	0.2	0.6±0.4	0.5	58
Niacin (mg)	4	4.8±3.2	3.7	31	0.6±0.4	0.7	5.5±2.9	4.4	80
Folate (DFE)	80	102±73	86	53	36±24	37	137±57	119	92
Calcium (mg)	400	217±192	163	13	119±79	123	332±150	273	20
Iron (mg)	9.3	4.8±3.5	3.6	13	0.1±0.1	0.1	4.9±3.5	3.7	13
Zinc (mg)	4.1	2.6±2.0	2.1	23	0.5±0.3	0.5	3.1±1.8	2.5	27

RAE, Retinol Activity Equivalents; DFE, Dietary *Folate* Equivalent
† RNI for infants aged 7-12 months old;[11]
‡ RNI for infants aged 7-9/10-12 months old;[11]
§ Based on 3 non-consecutive 24hr recalls;
¶ Breast milk intakes were modelled based on age- and gender-specific energy requirements;[9]
†† Percentage of infants with estimated intakes meeting RNI.

Quantative aspects of estimated nutrient intakes in the second semester of life

Table 2 presents the arithmetic mean, SD and median for the entire 192 24-hour sample for the intake of protein and selected micronutrients in complementary foods (derived from interviews); from human milk (derived from the modelling); and estimated total estimated intake (as the summation of the two components).

The adequacy of nutrient intakes with respect to recommendation standards was next in order of interest. Using the combination of both components of the diet estimated here, we compared the median of intakes with the RNI.[11] The sample's median exceeded the reference value for vitamins A, B-1, B-2, B-3, and C, and folate, whereas for calcium, iron and zinc, gaps were revealed (*data not shown*). Next, we compared the individual adequacy of 3-day average registration of CF, alone, and these nutrients in combination with those estimated from human milk with the recommended intakes. The percentage of subjects in each age-group who achieved the target intake exclusively from CF is reported in Table 2. Also shown is the percentage with adequacy from estimated total intake of each nutrient. A similar pattern among the nutrients was seen from this analysis as well.

Table 3 presents the same descriptive statistics for the nutrients of interest divided into 3-month periods across the second semester of life, to allow for comparison with previous conventions,[10,12] for the estimated CF component. A similar calculation by 3-month bands was made for the modelled human milk calculations (*data not shown*). The pie-graphs in Figure 1 illustrate the respective partitions of the energy from the CF and the human milk component of the total estimated infant diets with respect to protein, carbohydrate and fat.

Finally, we took the approach, pioneered at the University of California at Davis,[10,12] of nutrient density in the CF. Table 4 shows that nutrient density of the CF was lower than the reference value for calcium, iron and zinc.

Table 3. Estimated 24-hour intakes of selected nutrients from complementary feeding (CF) only, based on 192 responses in 64 urban infants, by age group

	Age-groups			
	7th - 9th month		10th - 12th month	
	(n=40)		(n=24)	
Nutrient	mean±SD	median	mean±SD	median
Energy (kcal)	324±198	314	524±255	535
Protein (g)	9.4±7.3	8.5	18.6±10.6	17.2
Fat (g)	7.7±7.9	5.1	13.0±8.3	14.7
Carbohydrates (g)	56.3±29.6	55.3	85.4±38.7	83.8
Vitamin A (RAE)	537±484	348	812±762	624
Vitamin C (mg)	24.7±19.3	20.8	25.6±20.8	22.5
Thiamine (mg)	0.4±0.3	0.4	0.9±2.2	0.4
Riboflavin (mg)	0.4±0.4	0.3	0.6±0.5	0.6
Niacin (mg)	4.3±2.9	3.6	5.8±3.6	5.0
Folate (DFE)	85±67	65	131±74	113
Calcium (mg)	205±208	147	239±166	219
Iron (mg)	4.7±3.7	3.5	4.9±3.4	3.8
Zinc (mg)	2.3±2.1	1.6	3.2±1.9	2.9

RAE, Retinol Activity Equivalents; DFE, Dietary *Folate* Equivalent

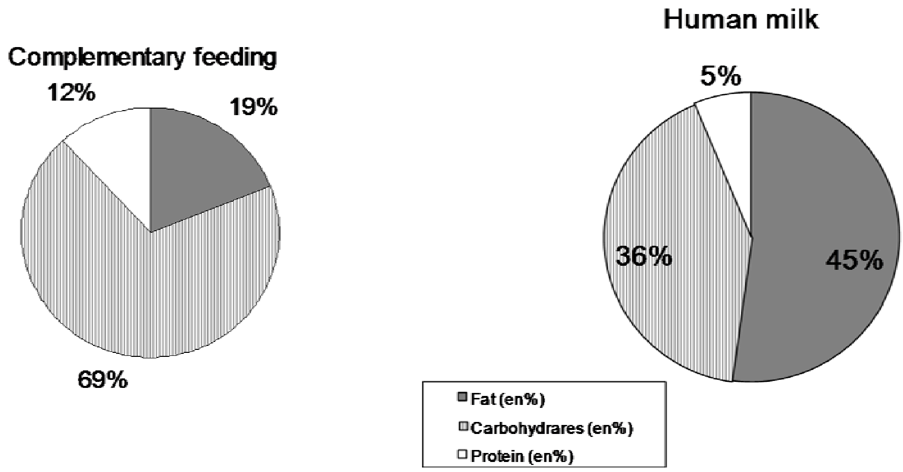

Figure 1. Analysis of the respective energy percent contributions of macronutrient inherent for each component of diet of the infants

Table 4. Nutrient density for estimated complementary foods based on 3-day averages† for 64 urban infants, in relation to reference values from Dewey & Brown (2003) and human milk

Nutrient	Nutrient density as nutrient unit per 100 kcal			
	Infants' complementary foods		Reference value‡	Human milk§
	mean±SD	median		
7th-9th month (n=40)				
Protein (g)	2.8±0.7	2.7	1.0	1.6
Vitamin A (RAE)	177±138	137	31.0	74.5
Vitamin C (mg)	8.0±5.7	6.9	1.5	6.0
Thiamine (mg)	0.12±0.07	0.11	0.08	0.03
Riboflavin (mg)	0.10±0.08	0.09	0.08	0.05
Niacin (mg)	1.3±0.4	1.2	1.5	0.2
Folate (DFE)	25±10	26	11	13
Calcium (mg)	55±26	46	105	42
Iron (mg)	1.4±0.7	1.2	4.5	0.04
Zinc (mg)	0.7±0.3	0.6	1.6	0.2
10th-12th month (n=24)				
Protein (g)	3.5±1.0	3.6	1.0	1.6
Vitamin A (RAE)	164±131	114	30.0	74.5
Vitamin C (mg)	5.0±3.0	3.9	1.7	6.0
Thiamine (mg)	0.19±0.46	0.09	0.06	0.03
Riboflavin (mg)	0.13±0.10	0.09	0.06	0.05
Niacin (mg)	1.1±0.3	1.1	1.0	0.2
Folate (DFE)	27±10	23	9	13
Calcium (mg)	51±34	40	74	42
Iron (mg)	1.0±0.4	0.8	3.0	0.04
Zinc (mg)	0.6±0.3	0.6	1.1	0.2

RAE, Retinol Activity Equivalents; DFE, Dietary *Folate* Equivalent
‡ Based on 3 non-consecutive 24hr recalls;
‡ Recommended density for complementary feeding;[12]
§ Derived from the values for human milk nutrient content.[10]

The principle sources of foods contributing the nutrients of interest were determined in rank-order analyses. As a final perspective on latter infancy feeding, we looked at the foods that made the principle contributions of the nutrients of interest to the intakes of this sample. Table 5 ranks foods and beverages as total energy and the individual macronutrients and Table 6 for the 9 micronutrients.

DISCUSSION

The urbanization of developing countries was an important social and cultural theme of the 20th century.[13] Its effects on nutrition have also been an interest of numerous publications.[14-17] Of the developing regions of world, Latin America is the most urbanized, with only three countries of the region, Haiti, Honduras and Guatemala, currently still have a majority rural population. Increased urbanization and characteristics associated with economic and social development, such as female education, prenatal care, skilled attendance at birth, use of contraceptives, have been shown to be negatively associated with breastfeeding duration.[18,19] Nevertheless, a recent study examining breastfeeding trends in seven countries in Latin America showed improvements in breastfeeding duration in all countries except Guatemala.[20] These improvements are mostly explained by changing breastfeeding behaviours, and very little by changing population characteristics. The authors note that socioeconomic and demographic changes associated with less breastfeeding no longer appear to have the negative effects previously observed. Hence, in a Guatemalan setting in which rural-to-urban migration and transition, it has been interesting to examine both qualitative and quantitative questions regarding infant feeding practices, with an emphasis on the quantitative aspects of nutrient intakes.

Limitations

Two previous publications have been derived from this sample.[6,7] We recognize a series of limitations and caveats in the design and conduct of the surveys and the generation of descriptive findings. The sample was a convenience sample of volunteers recruited from a population of mothers visiting a health centre. The motivation for attending on the day of enrolment was both routine well-baby care and illness. This has implications both for how representative the sample is for the community at large

Table 5. The ten leading sources of energy, protein, fat and carbohydrates of the total estimated diet, based on 192 responses in 64 urban infants

Rank	Item: Energy	%†	Cum %‡	Item: Protein	%†	Cum %‡	Item: Carbohydrates	%†	Cum %‡	Item: Fat	%†	Cum %‡
1	Human milk	41.3	41.3	Human milk	25.5	25.5	Human milk	31.0	31.0	Human milk	62.7	62.7
2	Maize tortilla	5.4	46.7	*Incaparina*®	7.0	32.5	Maize tortilla	7.9	38.9	*Nan 1*® infant formula	3.7	66.4
3	Table sugar, fortified	4.2	50.8	Maize tortilla	5.4	37.9	Table sugar, fortified	7.5	46.4	Sweet rolls	3.4	69.8
4	Banana	3.4	54.3	Chicken, drumstick	3.9	41.9	Banana	6.1	52.5	*Nido Crecimiento*®	3.0	72.8
5	Sweet rolls	2.9	57.2	*Nido*® whole milk	3.4	45.3	*Incaparina*®	3.4	55.9	*Nido*® whole milk	2.5	75.2
6	*Incaparina*®	2.8	60.0	*Nido Crecimiento*®	3.3	48.5	Potato	3.4	59.2	Maize and chicken tamale	2.4	77.7
7	*Nan 1*® infant formula	2.6	62.6	Maize and chicken tamale	3.2	51.8	Sweet rolls	2.8	62.0	Maize tortilla	1.6	79.2
8	*Nido Crecimiento*®	2.5	65.1	Chicken meat, breast	2.7	54.5	Pasta	2.5	64.5	Margarine	1.5	80.8
9	Potato	2.1	67.1	Pasta	2.5	56.9	*Nestum*®, rice cereal	2.3	66.8	*Nan 2*® infant formula	1.4	82.2
10	Pasta	2.0	69.1	Mashed Beans	2.3	59.2	*Nan 1*® infant formula	2.1	68.9	Mashed Beans	1.2	83.4
		69.1			59.2			68.9			83.4	

† Percent contribution;

‡ Cumulative percent contribution.

Table 6. The ten leading sources of selected micronutrients of the total estimated diet, based on 192 responses in 64 urban infants

Rank	Item Vitamin A	%†	Cum %‡	Item Vitamin C	%†	Cum %‡	Item Thiamine	%†	Cum %‡
1	Carrots	30.4	30.4	Human milk	40.1	40.1	Artificial drink, orange	25.2	25.2
2	Human milk	24.6	55.0	Banana	5.5	45.6	Human milk	12.9	38.1
3	Table sugar, fortified	10.3	65.4	*Incaparina*®	4.3	49.9	*Incaparina*®	5.7	43.8
4	Beef liver	9.4	74.8	*Nan 1*® infant formula	4.2	54.1	Broth, beans	4.0	47.9
5	*Incaparina*®	3.9	78.7	*Nestum*®, rice cereal	4.1	58.2	Barley	3.8	51.7
6	*Nan 1*® infant formula	2.2	80.9	Potato	4.0	62.2	White rolls	2.9	54.6
7	Pumpkin	2.1	83.1	Orange juice, natural	3.8	66.0	Maize tortilla	2.7	57.3
8	Chicken soup	1.4	84.4	*Nido Crecimiento*®	3.4	69.4	Sweet rolls	2.5	59.9
9	*Nan 2*® infant formula	1.2	85.6	Tomato	2.0	71.4	*Nido Crecimiento*®	2.4	62.3
10	*Nido*® whole milk	1.0	86.6	*Nan 2*® infant formula	2.0	73.4	Pasta	2.3	64.6
	Riboflavin			Niacin			Folate		
1	Human milk	23.6	23.6	Human milk	11.5	11.5	Human milk	25.8	25.8
2	Maize tamale	6.4	30.0	Incaparina®	11.0	22.5	Maize tortilla	13.6	39.4
3	Beef liver	6.0	36.0	Maize tortilla	4.5	27.0	Incaparina®	8.6	48.0
4	Nido Crecimiento®	5.1	41.1	Nido Crecimiento®	4.2	31.3	Mashed Beans	5.7	53.7
5	Nido® whole milk	4.4	45.5	Nan 2® infant formula	4.1	35.4	Nido Crecimiento®	3.9	57.6
6	Nan 1® infant formula	4.4	49.9	Maize and chicken tamale	4.0	39.4	Pasta	3.6	61.2
7	Barley	4.2	54.1	Potato	4.0	43.4	Banana	3.5	64.7
8	Banana	4.1	58.1	Nestum®, rice cereal	3.8	47.2	Oatmeal	2.8	67.5
9	Nan 2® infant formula	3.4	61.5	Pasta	3.5	50.7	White rolls	2.7	70.1
10	Incaparina®	2.9	64.4	Oatmeal	3.5	54.2	Rice	2.1	72.2
	Calcium			Iron			Zinc		
1	Human milk	35.0	35.0	Incaparina®	11.1	11.1	Human milk	16.0	16.0
2	Incaparina®	12.8	47.8	Nestum®, rice cereal	8.0	19.1	Incaparina®	12.1	28.1
3	Maize tortilla	8.6	56.3	Oatmeal	6.2	25.3	Nido Crecimiento®	6.8	34.9
4	Nido Crecimiento®	8.5	64.9	Nido Crecimiento®	5.1	30.4	Maize tortilla	4.9	39.8
5	Nido® whole milk	5.8	70.7	Maize tortilla	4.7	35.1	Nan 1® infant formula	4.3	44.1
6	Nan 1® infant formula	3.3	74.0	Nan 1® infant formula	4.4	39.5	Oatmeal	4.1	48.2
7	Nan 2® infant formula	2.9	76.9	Wheat germ gruel	2.9	42.5	Nido® whole milk	3.3	51.5
8	Water, tap	1.7	78.6	Nan 2® infant formula	2.9	45.4	Nan 2® infant formula	3.2	54.7
9	Sweet rolls	1.2	79.7	Corazon de trigo®, cereal	2.9	48.2	Beef liver	2.6	57.4
10	Cheese	1.0	80.7	Human milk	2.6	50.8	Water, tap	2.6	60.0

† Percent contribution;

‡ Cumulative percent contribution.

and for generalization to the lower urban class of Guatemala City and for the influence of illness on infant's appetite or maternal selection of food offerings. As babies, especially in developing countries pass much of their time suffering from childhood infections, with one estimate suggesting up to one-third of all days,[21] one would not choose only illness-free days to capture the true nature of dietary intake. As the second and third interviews were scheduled, they would have been expected to better to reflect the background prevalence of illness, perhaps, than the first day, when some of the clinic visits corresponded to sickness in the baby.

Limitations of recall, both remote and immediate, would intercede in the collection of these data from rural mothers. The questionnaire about colostrum feeding and early introduction of prelacteal feeds and early complementary items seeks a recall of facts as distant as 11 months in the past. Some loss of fidelity has probably occurred in this line of data collection. Much has been written about the inaccuracies in parental responses for children's diets.[22,23] This is probably least troublesome in infancy, where the caretaker has total control over selection and amounts. Three days of intake recording is known to be insufficient for a stable estimate of usual intake in adults for some nutrients.[24-26] If one assumes, however, that elements of an infants diet are more limited, fewer days would be needed for stable estimates in this age-group. This is undoubtedly true. Nevertheless, we accept that, for some of our nutrients of interest here, the 3-day tally has not provided an accurate reflection of "usual" intakes.

Further limitations, inherent to dietary studies, revolve around the accuracy of the food composition values for the items consumed. Nutrient values from the food composition data-bases used may, in fact, not reflect the items as they exist in Guatemala. At least for commercial items, where package labelling and manufacturer's values were used and human milk, in which a respected international publication (Brown *et al*) was the standard,[10] there should be both internal consistency and relative validity for nutrient composition.

Since the intensity of contact for procedures such as test weighing children through the day was precluded, we used a mathematical model to estimate breast milk consumption on each interview 24-hour period. The caveats have been discussed in detail elsewhere;[6] major consequence of the assumption tree (common body weight by age and gender, uniform exact energy homeostasis for the day; standard energy and micronutrient composition of human milk) is to limit the recognition of true intra-individual and intra-day variation in the contribution of milk nutrients, with its consequences for the apparent variance in the nutrient distribution within our population. We feel, however, that the central tendency expressions (mean, median) would be generally valid. However, we reiterate that we consider the values of and contribution directly assigned to CF the more robust and reliable aspect of the description.

Qualitative

The early, first-semester pattern of infant feeding for the members of this urban community is less than ideal with the ubiquitous violation of the WHO recommendation to exclusively breastfeed during this period.[1]

Offering of colostrum

Almost 100% of the urban mothers reported offering colostrum to their infant in the neonatal period. This is a higher rate than we could find in the comparative literature which ranged from 69% to 92.5% in different urban and rural communities.[27-32] This is a very favourable finding for early immunological protection that such practices support.

Use of prelacteal foods

The criterion for exclusive breast feeding was violated early on given that most of the infants (97%) were reported to have received "*agüitas*," the local term for pre- and post-lacteal water or infusions.[1] In fact, we could only identify two infants who had received EBF to 6 months within the sample. The practice of pre- and post-lacteal feeds varies in the literature from 52% in KwaZulu-Natal, South Africa and 57% in eastern Uganda on the African continent.[33,34] There is a wide variation in this practice across South Asia with a rate of 76% in Gwalior, India,[30] 50% in Nabi Nagar, India,[35] but only 15% in Pokhara, Nepal and 8% in Matlab, Bangladesh.[31,32] This is closely related to overall low rates of "timely first suckling" as recommended by the WHO in,[1] for example, Bangladesh 27.5%,[36] India 23.5%,[37] Nepal 35.4%,[38] and Sri Lanka 56.3%.[39]

Use of infant replacement formula

In our study, infant replacement formula was offered at some time before entry into the study in about one-third of the infants. This is obviously well below the prevalences reported in urban areas of industrialized countries,[40] and is lower than situations in rural Africa in which HIV transmission is an imminent concern.[33] Bottle-feeding rates in infants <12 mo in South Asia ranged from 3.5% in Nepal,[38] 14.8% in India,[37] 22.4% in Bangladesh to 27.2% in Sri Lanka.[36,39]

Age of introduction of CF

Aside from pre- or post-lacteal water and solutions, some urban mothers in our study delayed introduction of a true CF up to the 9th mo of life, but half of the infants had received their first food by 5 mo of age. In Phnom Penh, Cambodia the median age for CF introduction was 6 months.[41] Initiation of CF is reported in other ways throughout the literature, but the consensus is that the majority of children receive CF before 6 months. Examples include infants in rural Malawi and West Bengal, India.[28,42] Only in Nepal, did we find an instance of a minority of infants (40%) receiving CF before 6 months of age.[43] These finding are confirmed in recently published rates of exclusive breastfeeding in infants < 6 months in South Asia ranging from 42.5% in Bangladesh,[36] to 46.4% in India and 53.1% in Nepal.[37,38] Rates of full breastfeeding, which includes exclusive and predominant breastfeeding, were much more encouraging at 79.3% in Nepal,[38] 73.9% in India,[37] 70.2% in Bangladesh and 60.6% in Sri Lanka.[36,39]

This data compares the introduction of solids to 73% of South African children by 2.5 months,[33] 50% of the infants in Phnom Penh, Cambodia by 6 months, and 65% of Malawi children by 1 months. Three percent of the infants had been given plain water by 1 month, in rural Bangladesh;[31] in the same sample 2% of the infants were given semisolid foods at 1 month, the median age of introducing CF was 4 months of age. By this latter age, 40% of the infants had consumed infant cereal and 17% had consumed fruit or vegetable products , and < 1% had consumed meat in the Infant Feeding Practices Study II.[40] In Pohkara, Nepal 40% of the mothers started CF before the recommended age of 6 months and 22% delayed introduction of CF beyond the recommended age.[43] A subsample of the mothers in the Infant Feeding Practices Study II reported that 21% introduced solid foods before 4 months; 7% introduced solids after 6 months, 20% fed juice before 6 months.[44]

First CF introduced

As to the nature of the first CF, urban mothers generally identified a single food as the very first consumed by their offspring. However, among the respondents, there was a wide variety of different first foods mentioned. This contrasts to other sites; for instance, porridges of corn in rural Malawi or rice in urban Cambodia were identified as the common first foods in these locations.[41,42] Bovine milk and fruit juices were among the typical first foods documented in rural Bangladesh.[31]

Quantitative

The concern that brought us to the current study in Guatemala was related to the eminently quantitative issue of adequacy of nutrient intake in the CF phase. The vast majority of observational literature from developing countries concludes that the contribution of CF is inadequate.[22,31,45,46] Often, however, in the absence of data on human milk contribution, the base of this conclusion seems to be subjective in nature. The difficulty in assessing adequacy is understandable given the recognized difficulties and uncertainties in quantifying the maternal contribution of nutrients in the second semester of life. Brown *et al* pioneered an approach using optimal nutrient densities for the CF contribution of the diet after modelling certain assumptions about human milk intake at different ages across infancy.[10] After revisions in the international recommendations for energy and micronutrients, the density estimates were refined in 2003.[12]

Adequacy issues

As would be expected, the contribution of macro- and micronutrients derived from CF for the urban infants in Guatemala surpassed that from maternal milk, taking an increasing proportion of estimated total energy with increasing age through the second semester of life.

Although the estimated daily intakes of nutrients in the overall diets of the infants examined were above RNI values, more than two-thirds of infants did not meet the RNI for calcium, iron and zinc. The nutrient densities of these '*problem nutrients*' were higher than that commonly reported in developing countries, as they were below the critical densities reported by Dewey *et al.*[12,41,46-57]

With respect to ranking of the leading sources of macro- and micronutrients, the only comparative article found was a publication for the U.S. population of infants and toddlers,[58] which is disaggregated to show the top 5 to 15 sources of foods for 6 to 11 month American infants. With respect to energy and all macronutrients, the leading source in urban Guatemalan infants was human milk; that food ranked second in the US for energy, preceded in order by infant formula. *Incaparina®* gruel was the second provider of protein in Guatemala City; its homologue, infant cereal, ranked only third in the US, following formula and cow milk. For carbohydrates, tortillas and table sugar were second and third among sources in our study, but neither item was not even ranked among the top 15 carbohydrate sources in the US Human milk was second as a source of fat for American infants behind infant formula.

The leading contributor to all of the 9 micronutrients reported in Table 6 in the US survey data compiled by Fox *et al* was universally infant formula.[58] Carrots were the leading source of vitamin A in Guatemala, contributing 30.4%, followed by human milk at 24.6%, the two combining for over half of the vitamin consumed. Fortified table sugar was third at 10.3%. In the Fox *et al* study,[58] infant formula and breast milk combined as the top sources to cover over 50% of all vitamin A consumed. For vitamin C, human milk provided the highest contribution, but this source was only the fourth for American peers. Reconstituted fruit-flavoured drinks were the leading source of thiamine in the urban babies, but that item did not rank among the top 13 sources listed in the US. Human milk topped the list for our urban infants for the remaining three B-complex vitamins of interest. *Incaparina®* gruel was the second leading source for riboflavin and niacin, and third for folate after maize tortilla in second place. The category of infant cereal was in second place as a niacin source and ninth place for folate source in the US survey data. Human milk was the top-ranked source of calcium and zinc in our population, followed by *Incaparina®* in both instances. Infant cereal also ranked second for both essential minerals for 6 to 11 month US infants, behind infant formula. Human milk, by contrast, was 10th, accounting for only 2.6% of iron for our urban infants, with *Incaparina®* ranking first, followed by two additional infant cereal products. Infant formula and infant cereal were the two leading sources in the US survey. It is interesting that iron was the nutrient for which the top 10 sources accounted for the lowest cumulative percentage of the total consumption for any nutrient at just over 50%; by contrast, within this distribution of fat or vitamin A, over 80% of all of the respective nutrients were provided.

Conclusions

In conclusion, early infant feeding of urban Guatemalan children recruited while already consuming CF had been less than ideal, with the offering of pre- and post-lacteal water and solutions and the compromise of exclusivity of breast feeding before 6 months of age. Food selection is diverse, but generally lacking in replacement formula or commercial baby foods, and supports the recommended daily intakes to a greater degree than would have been anticipated from the comparative narrative of the international literature.

ACKNOWLEDGEMENTS

We thank Mirna Tellez, director of the health centre for her enthusiasm and collaboration and the participants for their time and effort.

AUTHOR DISCLOSURES

Financial support was obtained form the Sight & Life, Wyeth Nutrition, and the Hildegard Grunow Foundation. There were no conflicts of interest.

REFERENCES

1. WHO. Global strategy for infant and young child feeding. Geneva: World Health Organization; 2003.
2. Dearden K, Altaye M, De Maza I, De Oliva M, Stone-Jimenez M, Burkhalter BR. The impact of mother-to-mother support on optimal breast-feeding: a controlled community intervention trial in peri-urban Guatemala City, Guatemala. Rev Panam Salud Publica. 2002;12:193-201.
3. Gordon JE, Chitkara ID, Wyon JB. Weanling diarrhea. Am J Med Sci. 1963;245:345-77.
4. Victora CG, Smith PG, Vaughan JP, Nobre LC, Lombardi C, Teixeira AM et al. Evidence for protection by breast-feeding against infant deaths from infectious diseases in Brazil. Lancet. 1987;2:319-22.
5. Campos R, Hernández L, Soto-Mendez MJ, Vossenaar M, Solomons NW. Contribution of complementary food nutrients to estimated total nutrient intakes for rural Guatemalan infants in the second semester of life. Asia Pac J Clin Nutr. 2010;19:481-90.
6. Enneman A, Campos R, Hernandez L, Palma AV, Vossenaar M, Solomons NW. Contribution of complementary foods to the total daily water needs of urban Guatemalan infants. J Hum Nutr Diet. 2010;23:520-8.
7. Enneman A, Hernández L, Campos R, Vossenaar M, Solomons NW. Dietary characteristics of complementary foods offered to Guatemalan infants vary between urban and rural settings. Nutr Res. 2009;29:470-9.
8. USDA. National Nutrient Database for Standard Reference. [cited 2010/10/10]; Available from: http://www.ars.usda.gov/Services/docs.htm?docid=18879.
9. UNU/WHO/FAO. Human energy requirements. Report of a Joint FAO/WHO/UNU Expert Consultation, 17-24 October 2001. Rome; 2004.
10. Brown KH, Dewey KG, Allen LH. Complementary feeding of young children in developing countries: A review of current scientific knowledge. Geneva: World Health Organization; 1998.
11. WHO, FAO. Vitamin and mineral requirements in human nutrition, Second edition. World Health Organization, Food and Agriculture Organization; 2004.
12. Dewey KG, Brown KH. Update on technical issues concerning complementary feeding of young children in developing countries and implications for intervention programs. Food Nutr Bull. 2003;24:5-28.
13. Popkin BM. An overview on the nutrition transition and its health implications: the Bellagio meeting. Public Health Nutr. 2002;5:93-103.
14. Popkin BM. Global changes in diet and activity patterns as drivers of the nutrition transition. Nestle Nutr Workshop Ser Pediatr Program. 2009;63:1-10; discussion -4, 259-68.
15. Popkin BM. What can public health nutritionists do to curb the epidemic of nutrition-related noncommunicable disease? Nutr Rev. 2009;67:S79-82.
16. Doak CM, Adair LS, Bentley M, Monteiro C, Popkin BM. The dual burden household and the nutrition transition paradox. Int J Obes (Lond). 2005;29:129-36.
17. Popkin BM. The nutrition transition: an overview of world patterns of change. Nutr Rev. 2004;62:S140-3.
18. Perez-Escamilla R, Lutter C, Segall AM, Rivera A, Trevino-Siller S, Sanghvi T. Exclusive breast-feeding duration is associated with attitudinal, socioeconomic and biocultural determinants in three Latin American countries. J Nutr. 1995; 125:2972-84.
19. Perez-Escamilla R, Pollitt E, Lonnerdal B, Dewey KG. Infant feeding policies in maternity wards and their effect on breast-feeding success: an analytical overview. Am J Public Health. 1994;84:89-97.
20. Chaparro CM, Lutter CK. Increases in breastfeeding duration observed in Latin America and the Caribbean and the role of maternal demographic and health care characteristics. Food Nutr Bull. 2010;31:S117-27.
21. Brown KH, Solomons NW. Nutritional problems of developing countries. Infect Dis Clin North Am. 1991;5:297-317.
22. Owino VO, Amadi B, Sinkala M, Filteau SM, Tomkins A. Complementary feeding and nutrient intake from habitual complementary foods of infants and children aged 6-18 months in Lusaka, Zambia. AJFAND. 2008;8:28-47.
23. Faber M, Benade AJ. Perceptions of infant cereals and dietary intakes of children aged 4-24 months in a rural South African community. Int J Food Sci Nutr. 2001;52:359-65.
24. Beaton GH, Burema J, Ritenbaugh C. Errors in the interpretation of dietary assessments. Am J Clin Nutr. 1997;65: 1100S-7.
25. Beaton GH. Approaches to analysis of dietary data: relationship between planned analyses and choice of methodology. Am J Clin Nutr. 1994;59:253S-61.
26. Sempos CT, Liu K, Ernst ND. Food and nutrient exposures: what to consider when evaluating epidemiologic evidence. Am J Clin Nutr. 1999;69:1330S-8.
27. Abdul Ameer AJ, Al-Hadi AH, Abdulla MM. Knowledge, attitudes and practices of Iraqi mothers and family child-caring women regarding breastfeeding. East Mediterr Health J. 2008;14:1003-14.
28. Bandyopadhyay M. Impact of ritual pollution on lactation and breastfeeding practices in rural West Bengal, India. Int Breastfeed J. 2009;4:2.
29. Hakim IA, el-Ashmawy IA. Breast-feeding patterns in a rural village in Giza, Egypt. Am J Public Health. 1992;82: 731-2.
30. Tiwari R, Mahajan PC, Lahariya C. The determinants of exclusive breast feeding in urban slums: a community based study. J Trop Pediatr. 2009;55:49-54.
31. Saha KK, Frongillo EA, Alam DS, Arifeen SE, Persson LA, Rasmussen KM. Appropriate infant feeding practices result in better growth of infants and young children in rural Bangladesh. Am J Clin Nutr. 2008;87:1852-9.
32. Sreeramareddy CT, Joshi HS, Sreekumaran BV, Giri S, Chuni N. Home delivery and newborn care practices among urban women in western Nepal: a questionnaire survey. BMC Pregnancy Childbirth. 2006;6:27.
33. Ghuman MR, Saloojee H, Morris G. Infant feeding practices in a high HIV prevalence rural district of KwaZulu-Natal, South Africa. S Afr J Clin Nutr. 2009;22:74-9.
34. Engebretsen IM, Wamani H, Karamagi C, Semiyaga N, Tumwine J, Tylleskär T. Low adherence to exclusive breastfeeding in Eastern Uganda: A community-based cross-sectional study comparing dietary recall since birth with 24-hour recall. BMC Pediatr. 2007;7:10.
35. Khan Z, Mehnaz S, Khalique N, Ansari MA, Siddiqui AR. Poor perinatal care practices in urban slums: possible role of social mobilization networks. Indian J Community Med. 2009;34:102-7.
36. Mihrshahi S, Kabir I, Roy SK, Agho KE. Determinants of infant and young feeding practices in Bangladesh: Secondary data analysis of Demographic and Health Survey 2004. Food Nutr Bull. 2010;31:295-313.
37. Patel A, Badhoniya N, Khadse S, Senarath U, Agho KE, Dibley MJ. Infant and young child feeding indicators and

determinants of poor feeding practices in India: Secondary data analysis of National Family Health Survey 2005-06. Food Nutr Bull. 2010;31:314-33.

38. Pandey S, Tiwari R, Senarath U, Agho KE, Dibley MJ. Determinants of infant and young feeding practices in Nepal: Secondary data analysis of Demographic and Health Survey 2006. Food Nutr Bull. 2010;31:334-51.
39. Senarath U, Dibley MJ, Godakandage SSP, Jayawickrama H, Wickramasinghe A, Agho KE. Determinants of infant and young feeding practices in Sri Lanka: Secondary data analysis of Demographic and Health Survey 2000. Food Nutr Bull. 2010;31:352-65.
40. Grummer-Strawn LM, Scanlon KS, Fein SB. Infant feeding and feeding transitions during the first year of life. Pediatrics. 2008;122(S2):S36-42.
41. Anderson VP, Cornwall J, Jack S, Gibson RS. Intakes from non-breastmilk foods for stunted toddlers living in poor urban villages of Phnom Penh, Cambodia, are inadequate. Matern Child Nutr. 2008;4:146-59.
42. Bezner Kerr R, Berti PR, Chirwa M. Breastfeeding and mixed feeding practices in Malawi: Timing, reasons, decision makers, and child health consequences. Food Nutr Bull. 2007;28:90-9.
43. Subba SH, Chandrashekhar TS, Binu VS, Joshi HS, Rana MS, Dixit SB. Infant feeding practices of mothers in an urban area in Nepal. Kathmandu Univ Med J (KUMJ). 2007; 5:42-7.
44. Fein SB, Labiner-Wolfe J, Scanlon KS, Grummer-Strawn LM. Selected complementary feeding practices and their association with maternal education. Pediatrics. 2008;122(S2): S91-7.
45. Islam MM, Khatun M, Peerson JM, Ahmed T, Mollah MA, Dewey KG, Brown KH. Effects of energy density and feeding frequency of complementary foods on total daily energy intakes and consumption of breast milk by healthy breastfed Bangladeshi children. Am J Clin Nutr. 2008;88:84-94.
46. Kimmons JE, Dewey KG, Haque E, Chakraborty J, Osendarp SJ, Brown KH. Low nutrient intakes among infants in rural Bangladesh are attributable to low intake and micronutrient density of complementary foods. J Nutr. 2005;135: 444-51.
47. Allen LH, Backstrand JR, Stanek EJ, 3rd, Pelto GH, Chavez A, Molina E, Castillo JB, Mata A. The interactive effects of dietary quality on the growth and attained size of young Mexican children. Am J Clin Nutr. 1992;56:353-64.
48. Brown KH, Black RE, Becker S, Nahar S, Sawyer J. Consumption of foods and nutrients by weanlings in rural Bangladesh. Am J Clin Nutr. 1982;36:878-89.
49. de Kanashiro HC, Brown KH, López de Romaña G, Lopez T, Black RE. Consumption of food and nutrients by infants in Huascar (Lima), Peru. Am J Clin Nutr. 1990;52:995-1004.
50. Faber M. Complementary foods consumed by 6-12-month-old rural infants in South Africa are inadequate in micronutrients. Public Health Nutr. 2005;8:373-81.
51. Hautvast JL, van der Heijden LJ, Luneta AK, van Staveren WA, Tolboom JJ, van Gastel SM. Food consumption of young stunted and non-stunted children in rural Zambia. Eur J Clin Nutr. 1999;53:50-9.
52. Heinig MJ, Nommsen LA, Peerson JM, Lonnerdal B, Dewey KG. Energy and protein intakes of breast-fed and formula-fed infants during the first year of life and their association with growth velocity: the DARLING Study. Am J Clin Nutr. 1993;58:152-61.
53. Hotz C, Gibson RS. Complementary feeding practices and dietary intakes from complementary foods amongst weanlings in rural Malawi. Eur J Clin Nutr. 2001;55:841-9.
54. Lander R, Enkhjargal T, Batjargal J, Bolormaa N, Enkhmyagmar D, Tserendolgor U, Tungalag S, Bailey K, Gibson R. Poor dietary quality of complementary foods is associated with multiple micronutrient deficiencies during early childhood in Mongolia. Public Health Nutr. 2010;13:1304-13.
55. Lartey A, Manu A, Brown KH, Peerson JM, Dewey KG. A randomized, community-based trial of the effects of improved, centrally processed complementary foods on growth and micronutrient status of Ghanaian infants from 6 to 12 mo of age. Am J Clin Nutr. 1999;70:391-404.
56. Lopez de Romana G, Brown KH, Black RE, Kanashiro HC. Longitudinal studies of infectious diseases and physical growth of infants in Huascar, an underprivileged peri-urban community in Lima, Peru. Am J Epidemiol. 1989;129:769-84.
57. Perlas LA, Gibson RS, Adair LS. Macronutrient and selected vitamin intakes from complementary foods of infants and toddlers from Cebu, Philippines. Int J Food Sci Nutr. 2004;55:1-15.
58. Fox MK, Reidy K, Novak T, Ziegler P. Sources of energy and nutrients in the diets of infants and toddlers. J Am Diet Assoc. 2006;106:S28-42.

Original Article

Contribution of complementary food nutrients to estimated total nutrient intakes for urban Guatemalan infants in the second semester of life

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嬰兒副食品對於瓜地馬拉城市 6-12 月嬰兒的總營養素攝取的貢獻

與已開發國家比較，開發中國家嬰兒副食品的使用時機往往過早或過晚。這些副食品對於嬰兒成長和發育的關鍵期，也就是第 6 到第 12 個月時，所需的微量營養素量並無多大貢獻。本研究主要目的在探討副食品對於嬰兒第二期的營養素攝取量的貢獻。利用便利取樣抽取 64 名居住在瓜地馬拉城市邊緣的 6-12 個月大的嬰兒，請母親填寫三次非連續的 24 小時回憶問卷。問卷包含哺乳前後第一次給予的食物和飲料。母乳的攝取量的評估，是假設母乳加上副食品剛好滿足嬰兒一天的所需熱量。以 WHO/FAO 的建議營養素攝取量(RNI)為足夠的營養素攝取量的標準。這六個月只有哺餵母乳的例子相當罕見，而副食品的使用往往早於建議時機；第一次食用的副食品以罐裝最常見。隨著年紀增長，副食品使用也隨之增加。在所有訪視者中，副食品所貢獻的營養素量比母乳多。但是副食品的鈣、鐵和鋅的營養密度低於國際標準。強化糖所給予的維生素 A 過量。我們結論如下，副食品所提供的多數營養素量都滿足或超過建議量，此與過去關於副食品的文獻結果並不相同。

關鍵字：母乳、副食品、嬰兒餵養、微量營養素攝取量、瓜地馬拉