3. INFANTS AND TODDLERS

3.1 Infants (0-12 months)

The dynamic growth and development experienced in infancy is the most rapid of any age. The progression in feeding skills (Exhibit 3.1) marks important developmental milestones that support rapid changes in food habits and nutrient intakes. The frequency of dietary assessment during infancy is an important methodological issue in longitudinal studies, as is the selection of a method validated for the developmental stage of the infant and for the specific research questions.

Assessing breastfeeding behaviors, breast milk intake, and milk composition present additional methodologic issues to address, especially because more than two-thirds of mothers currently initiate breastfeeding and about a third of infants are still consuming breast milk at 6 months of age (25;29;70). The benefits of breastfeeding to both the mother and infant are well documented, and it is encouraging that U.S. breastfeeding rates are projected to increase by at least 2 percent per year by 2010 (29). However, the considerable variation in the content of breast milk between women, and within the same woman from day to day, from feed to feed, and during a single lactation (31;32) all make the measurement of breast milk composition and infant intake challenging. Sources of variation include the stage of lactation, parity, maternal body composition, nutritional status, time of day, and within-feed timing of breast milk sample collections (71). Feeding frequency and duration of feeds also differs among women; frequent feedings of up to 10 to 12 feedings a day are not unusual (33), making application of current dietary assessment methods difficult. The lack of consistent definition of breastfeeding behaviors (e.g., exclusive, partial) in the dietary assessment literature (30) also has made comparisons among studies difficult.

Assessing formula intake is not without methodologic challenges. Data on formula preparation methods must be collected. The amount of formula consumed versus the amount offered at a feed must be quantified. In both breast and bottle feeding, the amount of infant regurgitation (spitting up) or drooling during or after feeding may be an important issue in some infants. A further challenge is that many infants receive both breast milk and formula each day. As the infant begins consuming complementary foods, collecting portion size information on the small quantities consumed is difficult. Although not recommended, many infants receive complementary foods such as cereal mixed in a bottle with formula, further complicating accurate assessment of intake.

Another issue is identifying and selecting surrogate reporters of the infant's intake. About one-third of employed mothers with children less than three years of age return to work within 3

months after childbirth, and about two-thirds within 6 months of childbirth (72;73). This requires information from all of the different adults who care for the infant.

Exhibit 3.1 Development of Infant Feeding Skills (25;29;70;74)

Chronological Age	**Feeding Skills**
Birth to 1 month	Suckling and sucking reflexes Frequent feedings of >8 to 12 per 24 hours Only thin liquids tolerated
1-3 months	Volume increases up to 6-8 fl. oz. per feeding Feeding frequency drops to 4-8 per 24 hours Sucking pattern allows thin liquids to be swallowed
4-6 months	Cannot easily swallow lumpy foods, but pureed foods swallowed 6-8 fl. oz. per feeding and 4-5 feedings per day (may be variable in breastfed) Interest in munching, biting, and new tastes Can hold bottle (if bottle fed)
7-9 months	Self-feeding with hands emerges Munching and biting emerges Indicates hunger and fullness clearly Prefers bottle, but can hold open cup with little loss
10-12 months	Likes self-feeding with hands Spoon feeding emerges Drinks from an open cup as well as bottle Enjoys chopped or easily chewed food or foods with lumps Sitting position for eating Enjoys table foods even if some baby foods still used

3.2 Validation of Dietary Assessment Methods in Infant Populations

Collection of a Breast Milk Sample. Human milk samples are used to investigate the nutrient content of the milk and to assess level of exposure of infant populations to certain environmental chemicals. The lack of standardized methods for collecting breast milk samples has hampered evaluation of the literature and made valid comparisons between studies difficult (71). Although the specific protocol for collecting human milk is dependent on the research question, the recommendations in Exhibit 3.2 represent current consensus on guidelines for collecting and storing human milk.

Exhibit 3.2. Guidelines for Collection and Storage of Human Milk: Recommendations from the 2002 Technical Workshop on Human Milk Surveillance and Research on Environmental Chemicals in the United States (71)

- Milk sampling should neither be an undue burden to the mother nor compromise the nutritional status of the infant.
- Standardize study protocols for the time of the day that all subjects will collect milk; the time elapsed since the previous feeding on the breast to be pumped should be at least 2 hr.
- Provide standardized collection and storage containers composed of natural material that does not influence the measurement of the chemical to be analyzed.
- Instruct mothers to use an electric breast pump to express breast milk; a trained individual may need to deliver, demonstrate, and pick up the electric pump.
- For each collection, the mother should:
  1. Wash the breast with a mild contaminant free soap and rinse the breast with distilled water.
  2. Apply the breast pump to the breast and express milk until milk flow declines to a drip; pumping may be done at the same time the infant is nursing from the other breast.
  3. Add collected milk to the storage container kept in the home freezer until the total volume needed for analysis is collected.
- Transport milk to the laboratory in a cooler with dry ice to keep samples frozen; clearly mark the transport cooler with a biohazard label marked "human milk samples."

Test Weighing. The most validation work in this age group has focused on assessing infant milk intake by test weighing. This method involves weighing the infant immediately before and after each feeding without change of clothing or diapers and taking the gain in weight of the infant (in grams) to be the net milk intake (in milliliters). An alternative approach in breastfed infants involves weighing the mother before and after each feeding (75). The introduction of electronic balances, which can integrate moderate movements and record these weights, has improved the accuracy and precision of measuring the weight of the infants (76;77).

Scanlon et al. published a thorough review of test weighing validation studies published through 2000 (78). Additional work in this area was not identified. Test weighing of formula-fed preterm and full-term healthy infants (Table 3.1 at the end of this chapter) in the hospital by nursing staff using an electronic scale showed agreement between test weighing of the infant and the direct measurement of formula within 1 percent (79). In home settings including five to 10 mother-infant pairs, infant test weighing and formula measurements by the mother underestimated intake by 7 to 10 percent using a mechanical scale (80) and overestimated intake by 7 to 11 percent using an electronic scale (75).

Test weighing validation studies in breastfed infants have focused on modifications of procedures to reduce the maternal burden and disruptions of feeding. Results of three studies (31;81;82) examining whether breast milk intake could be estimated from the product of test

weights for one or two feeds in a 24-hour period found the highest correlations between intakes estimated with 24-hour test weighing and estimates calculated from two consecutive test weights in the mid 24-hour period. Differences in mean intake estimates ranged from a 0.6% overestimation among infants 4 weeks of age to an 6% underestimation among infants 12 weeks of age (31). Meier validated the accuracy of home test weighing by mothers using the Baby Weigh electronic scale in a population of pre-term breastfeeding infants (76).

The test weighing method has several obvious limitations for a large-scale longitudinal study. Test weighing is tedious and requires careful training and supervision of mothers with some degree of technical sophistication who can operate an expensive electronic balance in the home (82). Test weighing also interrupts usual feeding routines. When milk intakes of breastfed infants are compared to those of formula-fed infants, both groups of infants should be test weighed (80). No studies have validated test weighing with combined feeding regimens (formula and breastfeeding).

DLW Method. Infant milk intake indirectly estimated from measurements of infant total energy expenditure (TEE) with the DLW method has been validated in small groups of formula-fed (83-86) and breastfed infants (83;87;88) in hospital and home settings (Table 3.1 at the end of this chapter). The method involves carefully (avoiding loss from spitting up) administering a DLW dose to the infant and collecting samples of urine or saliva at baseline and over the subsequent 5 to 15 days. To increase accuracy of energy expenditure measurements, water from supplemental foods or fluids other than milk must be measured and adjusted for, as well as environmental water influx, insensible water losses, change in energy stores during the study period (change in weight), and the macronutrient content of the diet. The method has been refined over time and later studies, correcting for environmental water influx and insensible water loss, found close agreement (1 to 2 % in formula studies and 2 to 5% in lactation studies) between energy intake estimated by the DLW method and direct measurement of formula or test weighing of breastfed infants.

The DLW Method has a number of advantages because it is non-invasive and requires no special equipment. The method does not interrupt infant feeding patterns, it allows for greater mobility of the mother-infant pair, it is unaffected by daily variations in intake or frequent feedings, and is practical under field conditions (87). However, the availability and cost of the isotopes, the need for sophisticated laboratory analysis, and the care required to administer the DLW dose, limit its use in large samples of infants.

Direct Observation. Direct observation involves estimating the volume of breast or formula milk consumed by visually assessing the infant during feeding. Studies by Meier on preterm infants and/or high-risk infants found low correlations (0.48 to 0.79) and large and random errors between direct observation and test weighing when observations were performed

by either mothers, nurses, or lactation consultants (89). Mothers and investigators gave comparable, yet inaccurate, estimates of infant milk intake over a single feed ($r = 0.91$) demonstrating that direct observation cannot be substituted for test weighing if an accurate measure of infant intake is necessary.

Other Methods. Only six studies examining the validity of other dietary assessment methods in older infant populations were identified (Table 3.1 at the end of this chapter). A 2001 study compared energy intake measured by a 5-day estimated Food Record with a 5-day weighed Food Record and the DLW method in a cross-over study design in 6- to 12-month old infants (90). Both weighed and estimated food records overestimated DLW measurement of energy expenditure by 7%. A diet history method was compared with a weighed food record in two studies (91-93); although the diet history methods were not comparable, both overestimated intake measured with a 3- or 4-day weighed food record. The use of the Portable Electronic Tape Recording Automated (PETRA) scale in the home was found to be difficult in a British study of children from low-literacy s immigrant household because the equipment malfunctioned or was damaged in the home and it required intensive participant instruction and monitoring (92).

Though not validation studies, Stuff et al. (94) and Black et al. (95) each studied the day-to-day variation in energy intake of breastfed infants through rigorous tests weighing (Table 3.4 at the end of this chapter). In both studies, the range of pooled within-subject coefficient of variation was wide and increased as the infant aged and more complementary foods were introduced. Black's study includes measurements through 18 months and concluded the number of days of food records needed for breastfed infants is 4 days and for toddlers is 7 days (95).

Two studies examined the validity of the 24HR method. In one study a 24HR collected 24 hours after collection of a duplicate diet by the parent resulted in a significant overestimation of energy and other nutrients (96). A study validating telephone 24HR interviews with face-to-face 24HR in telephone and non-telephone households in the lower Mississippi Delta Region found no significant differences in mean energy intakes, but the results for the 32 infants included in the study of 409 participants were not analyzed separately (97).

Only one FFQ validation study was found. Marshall (98) compared parental reports of beverage intake of infants at 6 and 12 months on a mailed beverage FFQ with a 3-day FR of all foods and beverages consumed. This FR was completed the week after completing the FFQ. Correlations with types of milk consumed ranged from 0.83 to 0.99 while correlations between methods for measurements of water, juice/drinks, or soft drinks were lower.

In the early 1980s, a study comparing an interview that included short questions on breastfeeding practices with the infant's medical record found mothers overestimated reporting of length of previous breastfeeding when questioned at 12 months (99).

3.3 Toddlers (13 to 24 months)

This stage of development is characterized by the slowing of the growth velocity and a rapid increase in fine and gross motor skills supporting increases in independence, exploration of the environment, and language skills (100). The slower rate of growth is reflected in a variable appetite, which is often of undue concern for parents as are the strong food preferences and dislikes many toddlers express. Weaning from the bottle is often complete by 12 to 14 months, but the age may vary. Toddlers gain the ability to handle chopped or soft table food and to use cups and spoons more effectively. Mealtime is messy as toddlers gain and practice self-feeding skills while continuing to eat with their hands. Because toddlers cannot eat a large amount at one time, snacks make a significant contribution to the child's nutrient intake. Recommended average serving sizes are small for toddlers, about one tablespoon of each solid food at 12 months increasing to just 2 tablespoons by age 2 years (100).

Assessing food and beverage intake in toddlers presents unique methodological issues. It is often difficult to quantify the amount a child consumes versus the amount offered. Most portion size estimating aides used with adult populations are not appropriate for toddlers. As in all young children, collecting information on the food and supplement intake of toddlers is complicated because parents often share the responsibility for the child with other adults in the home, at other homes, or at day care centers.

3.4 Validation Studies in Toddler Populations

Of the nine validation studies including children 13 to 24 months (Table 3.2 at the end of this chapter), only four analyzed data separately for this age group. The DLW method for estimating TEE was validated with test weighing on 11 toddlers recovering from malnutrition on a metabolic ward in Lima, Peru (101). A 2001 study validated 5 days of estimated FR with 5 days of weighed FR in a cross-over study design on 34 toddlers (90). No significant differences were found between energy intake by estimated FR and weighed FR. DLW TEE measurements were within 7% of reported intakes of infants in this study but were not measured in the toddlers. A study of 20 toddlers found close agreement between reported energy intake in a diet history interview and a 3-day weighed FR (93).

In 2003, a 111-item HFFQ overestimated energy intake by more than 70 percent in a population of 24 toddlers compared with four quarterly 24HRs (24-Hour Recall) (102). However, correlations between the HFFQ and plasma biological markers of several nutrients were promising: 0.51 for ascorbic acid, 0.48 for alpha-tocopherol, 0.41 for beta cryptoxanthin, and 0.39 for alpha carotene (102). In a WIC population of 233 1- to 5-year olds (55% were aged 1 to 2 years), energy intakes reported on an 84-item HFFQ agreed closely with measurements

from three 24HRs for 20 nutrients were within 10% of the 24HR (103). More than half of the participants in this study were native Americans.

Kuehneman and colleagues (104) examined portion size estimating aides in a small population of children 18 to 36 months. Standard serving sizes for this age group showed the smallest error, compared with graduated food models, National Dairy Council food pictures, and standard Nasco plastic food models.

A recent cross-sectional survey evaluating a short questionnaire to assess risk factors for iron deficiency anemia, which included questions on diet and supplement use in children 9 to 30 months, found the questionnaire was not a valid first-stage screening method for iron deficiency anemia compared with hemoglobin, serum ferritin and MCV biomarkers (Table 3.3) (105).

3.5 Studies of Infant and Toddler Populations

Table 3.3 presents summary data from several epidemiologic surveys collecting food and supplement intake data from infant and/or toddler populations. More information on the specific surveys is included in Table 3.4 at the end of this chapter. The two most recent US nutrition monitoring surveys, the 1999-2000 National Health and Nutrition Examination Survey (NHANES) and the 1994-96 Continuing Survey of Food Intake of Individuals (CSFII), each included 24HR interviews to assess food and beverage intake. Information on the milk intake of breastfed infant was limited to the time each breastfeeding began. Standardized probes solicited detail on type of formula, preparation method, and amount consumed as well as amount and type of complementary food consumed by the infant or toddler. Interviews were conducted with the child's parent or a parent-designated proxy. If intake of food or amount was not known, data retrieval was conducted with the caretaker or day care center. Table 2.5 in Chapter 2, presents the diet-related questions in each of these surveys as well as in the integrated What We Eat in America-NHANES survey, which is currently in the field. The rationale for selecting the instrument for the integrated survey as well as the history of past CSFII and NHANES surveys was recently reviewed (9). The integrated What We Eat in America-NHANES includes two 24HR interviews, one in-person and one by telephone for children under 2 years. Supplement use is queried in a separate questionnaire on frequency, dosage, and duration of use of specific products.

The 1994 (106) and 2003 (107) surveys of US infants sponsored by Gerber Products Company also used a cross-sectional approach, but differed in dietary assessment method. The earlier survey collected 4-day estimated FR from 1,658 mothers of infants and toddlers, while the recent Feeding Infants and Toddler Study collected a telephone-administered, 24HR interview with the mothers of 2,025 children and a second 24HR in a 23 percent sub-sample.

Table 3.3. Summary Table: Studies of infant and/or toddler populations

	Infants (n)	Toddlers (n)	Ethnically Diverse	Longitudinal Study	Cross sectional Study	Assessment Method					Nutrient Biomarkers	Supplement Intake Assessment Method	Outcomes
						Weighed Food Record (no. days)	Estimated Food Record (no. days)	24-Hour Recall (n)	FFQ Type	Other Questionnaire			
National Surveys													
US National Health and Nutrition Examination Survey (NHANES) 1999-2000 (41)	111 BF + 291	14 BF + 441	✓		✓			1; 2 in 10%			✓	Quest.& 24HR	Food, nutrient, physical activity, and chemical exposures
Continuing Survey of Food Intake of Individuals (CSFII) 1994-96 (42)	425 BF + 1,021	68 BF + 2,118	✓		✓			2			✓	24HR	Food and nutrient exposures; diet and health knowledge
Feeding Infants and Toddlers Study, 2002 (US) (107)	2,025	997	✓		✓			1; 2 in 23%				24HR	Food, energy, and 24 nutrients
Gerber Products Company 1994 Survey (106)	1,658				✓		4d					4dFR	Energy and 11 nutrients
Ross Laboratories Mothers Survey, 2001 (29)	>33,000 per mo.		NS*	✓						✓		NS	Mailed quest. on type of milk infant consumed in past 30 d.
The National WIC Evaluation, 1997 (38)	874		✓	✓						✓		Quest.	Monthly infant 15-minute telephone interview; breastfeeding rates, patterns and practices; patterns of introduction of complementary foods and beverages
Russian Longitudinal Monitoring Survey (108)	746		✓	✓				1				NS	Total iron, heme and bioavailable iron in diet
Danish National Birth Cohort (Better Health for Mother and Child) (www.bsmb.dk) (36)	100,000 @ 6 and 18 mo.			✓						✓		Quest.	Telephone interview at 6 mo. (16 min.) and 18 mo. (10 min); food, nutrient, and chemical exposures

***NS = Not specified**

Table 3.3. Summary Table: Studies of infant and/or toddler populations, continued

	Infants (n)	Toddlers (n)	Ethnically Diverse	Longitudinal Study	Cross sectional Study	Assessment Method					Nutrient Biomarkers	Supplement Intake Assessment Method	Outcomes
						Weighed Food Record (no. days)	Estimated Food Record (no. days)	24-Hour Recall (n)	FFQ Type	Other Method			
Population Surveys of Food and Nutrient Exposures													
Avon Longitudinal Study of Pregnancy and Childhood (ALSPAC) Avon, UK (109-113)	1,131@ 8 mo.	1,026 @ 18 mo.	NS	✓			3d					Quest.	Energy and 17 nutrients
Substudy, Avon Longitudinal Study of Pregnancy and Childhood (ALSPAC) Avon, UK (110)	9,640 @ 6 & 15 mo.	9,640 @ 6 & 15 mo.	NS	✓								NS	Mailed questionnaire on age of introduction of foods and reported feeding difficulties
Iowa Fluoride Study, 2003 (98;114)	642		NS	✓			3d		Bev.			Quest.	Energy and 21 nutrients, beverage intake, fluoride supplement use
Norway Infant Feeding Nutrition Survey (115)	2,383@ 6 mo.								FFQ			FFQ	Infant feeding practices (infant feeding practices FFQ) and self reported length and weight
Dortmunc Nutritional and Antrhopometric Longitudinally Designed (DONALD) Study (Germany) (116)	293	354		✓		3d					✓	NS	Infant growth, energy and nutrient intakes, food groups, breastfeeding rates
Adelaide Nutrition Cohort Study, South Australia (117)	140	140		✓		7d						NS	Food, nutrient, energy intake and somatic growth
The Bogalusa Newborn-Infant Cohort Study (118)	440		✓	✓				5 in 4 yrs.		✓	✓	Vit. Incent.	Monthly mailed infant feeding practices quest with food checklist 1-4 mo.; interviewer admin. Quest. at 6 and 12 mo.; 24HR on subset

***NS = Not specified**

Table 3.3. Summary Table: Studies of infant and/or toddler populations, continued

	Infants (n)	Toddlers (n)	Ethnically Diverse	Longitudinal Study	Cross sectional Study	Assessment Method					Nutrient Biomarkers	Supplement Intake Assessment Method	Outcomes
						Weighed Food Record (no. days)	Estimated Food Record (no. days)	24-Hour Recall (n)	FFQ Type	Other Method			
Other Studies													
The DARLING Study, California, 1993 (119)	119	119		✓		4				✓		NS	Test weighing of BM intake, BM samples collected for 24h, sleeping diary for activity assessment, compared growth of FF and BF infants. Milk intake and composition, energy and protein intake.
Carruth et al., 2000 (Tennessee) (120)	94	✓		✓				10		✓			24HR & usual food intake monthly 2-4 months, bi-monthly 6-12 months, every 4 months 16-24 months.
The Leiden Preschool Children Study (121)	124	✓		✓				3				NS	Growth, energy, and 13 nutrients
Habibian et al., 2001 (UK) (122)	163	✓		✓			3					NS	Dental health, number of eating occasions and frequency of eating 19 food/drink categories
Bogen et al., 2000 (105)		282	✓		✓					✓	✓	Quest.	Self-administered 15-item questionnaire on risk factors for iron deficiency anemia compared with hemoglobin, ferritin, and MCV.
Wharf et al., 1997 (UK) (93)	181	✓		✓						✓	✓	NS	Diet history for iron intake, biomarkers of iron status
Sanjur et al., 1990 (123)		90		✓			3					Suppls. provided	Meal patterns, energy and nutrient intakes.

***NS = Not specified**

Most of the other large studies used a longitudinal approach to dietary assessment during the first 12 months of life, with many continuing data collection through 2 years or longer. Three large European studies collected weighed or estimated food records at various time intervals (109;112;113;116;117;124). The most rigorous are the German DONALD study which collected 3-day weighed FRs at 3, 6, 9, and 12 months and then annually (124;125), and the Adelaide Nutrition Study (117) in South Australia, in which parents completed 7-day weighed FRs four times between 3 and 24 months. A number of studies paired other assessment measures with infant feeding practices questionnaires that parents completed periodically and returned by mail. For example, the Bogalusa Newborn-Infant Cohort Study (118) mailed monthly infant feeding practices questionnaires with food checklists to parents for the first four months and then had interviewers administer a questionnaire at 6 and 12 months. This was paired with a 24HR recall interview in a subset of participants at 6 and 12 months and then annually.

Maternal test weighing of breastfed infants and 24-hour breast milk sample collection was successful in a longitudinal study of 73 breastfed and 43 formula-fed infants from middle- and upper-income households participating in The DARLING Study (119), conducted by the University of California at Davis. This cohort was followed longitudinally 18 months. Carruth and colleagues (120) have been successful in following a cohort of infants from middle and upper socioeconomic status households for the completion of ten 4HR and usual intake interviews in the home over a 22 month period.

As is evident from the Table 3.3 and Table 3.4, most literature reviewed did not discuss supplement intake assessment methods.

3.6 Research Needs in Infant and Toddler Populations.

This review confirms the scant available information on the validity and measurement error for the FFQ, DH, and FRs in infant and toddler populations. Validation studies on the 24HR and on methods to assess supplement intake are lacking. Validation studies using larger and more representative populations, similar methodologies, and that examine the impact of gender, ethnicity or infant age on the validity of infant and toddler feeding measures are needed. Scanlon et al. identified the need for a comprehensive study that evaluates multiple measures of infant feeding simultaneously (78). The reliability of test weighing and the DLW method in representative population samples also should be evaluated. As in all age groups, the further use of biomarkers to evaluate accuracy of subjective self-report methods is needed. The impact of social desirability on reporting on infant intake should be examined, especially with regard to reporting important parenting behaviors, such as infant feeding. In addition, research is needed on the impact of parental BMI, education, and ethnicity on reporting validity. Finally more work

is needed to validate portion size estimating aides (126). In a longitudinal study, the timing and frequency of dietary assessment in infants and toddlers should be examined.

Table 3.1. Validation of dietary assessment methods in infant (0-12 mo.) children

Reference	Study Population	Test Method (TM)	Reference Measurement (RM)	Design Features	Correlation Between TM and RM	Mean Intake Difference Between TM and RM
TEST WEIGHING – FORMULA FEEDING (FF)						
Borschel et al., 1986 (80)	1 mo. = 7M, 4F 2 mo. = 7M, 5F 4 mo. = 7M, 7F 6 mo. = 10M, 8F Purdue University community	Test weighing of infant by mother (mechanical scale)	Direct measurement of formula by mother	Test weighing by mother for a 24h period using a mechanical scale. Direct measurement of formula for same 24h period by mother.	Pearson correlation 1 mo. = 0.66 2 mo. = 0.78 4 mo. = 0.86 6 mo. = 0.85	**Test weighing vs. Direct measure** 1 mo. = -10% (174 vs. 194 ml/kg/d) 2 mo. = -14% (136 vs. 159 ml/kg/d) 4 mo. = -9% (120 vs. 132 ml/kg/d) 6 mo. = -7% (103 vs. 111 ml/kg/d)
Hendrickson et al., 1985 (79)	Newborns = 188 Billings, MT.	Test weighing of infant by nurse (scale not specified)	Direct measurement of formula by a second nurse	Single feed test weighing and formula measurement by nurse.	Linear correlation 0.82	**Test weighing vs. Direct measure** - 1% (41.7 vs. 42.3 ml/feeding)
Montandon et al., 1986 (75)	1 mo. = 5 4 mo. = 4 USA	Test weighing of infant by mother (electronic scale)	Direct measurement of formula by the laboratory. Direct measurement of formula by mother.	Test weighing by mother for 5 consecutive 24h periods. Formula intake measured pre- and post-feed by laboratory and by mother for 5 consecutive 24h periods.	Not specified	**Test weighing vs. Direct measure** <u>Laboratory FF measurement</u> 1 mo. = 7% (908 vs. 850g/d) 4 mo. = 13% (1014 vs. 1168g/d) <u>Mother FF measurement</u> 1 mo. = 7% (908 vs. 852g/d) 4 mo. = 11% (1014 vs. 1135g/d)
TEST WEIGHING – BREASTFEEDING (BF)						
Arthur et al., 1987 (127)	1-7 d = 21 2-18 mo. = 20 Australia	Test weighing of infant by investigator	Test weighing of mother (seated on electronic scale) by investigator	Single breastfeeding measured by both the maternal and infant test weighing methods. In newborns, the evaporated water loss measured by weighing the mother at three consecutive 10 min intervals immediately after feeding.	1-7 d = 0.94 $p < 0.001$ 2-18 mo. = 0.99 $p < 0.001$	**Test weighing infant vs. mother** 1-7 days = -1.0g $\pm$ 8.7g after correction for evaporated water loss (EWL) 2-18 mo. = 0.7g $\pm$ 3.1 g after correction for EWL

Table 3.1. Validation of dietary assessment methods in infant (0-12 mo.) children, continued

Reference	Study Population	Test Method (TM)	Reference Measurement (RM)	Design Features	Correlation Between TM and RM	Mean Intake Difference Between TM and RM
TEST WEIGHING – BREAST FEEDING, CONTINUED						
Matheny and Picciano, 1985 (31)	4 wks. = 11 8 wks. = 11 12 wks. = 20 Illinois (Champaign/ Urbana area)	Abbreviated methods to estimate 24h BM intake: a) doubling test weights for 12h periods-- 6am to 6pm, 7am to 7pm, 2pm to 2pm; b) 1-feed method (1st feed); and c) 2-feed method (mid 24hr feeds).	Test weighing by mother for 24h period	Test weighing by mother for 3 consecutive 24h periods at 4, 8, and 12wks were completed. Three abbreviated methods to estimate 24h breast milk (BM) intake were compared with 24h measurements.	Selected Results 4 weeks 7am to 7pm = 0.87 (d2) to 0.78 (d3) 2pm to 2am = 0.82 (d1) to 0.89 (d2) 1st nursing x no./24h = 0.61 (d1) to 0.84 (d3) 12 weeks 7am to 7pm = 0.80 (d2) to 0.86 (d1) 2am to 2pm = 0.61(d2) to 0.81 (d1) 1st nursing x no./24h = 0.63 (d2) to 0.80 (d1) 2-mid 24h feeds x no/24h 4wks = 0.75 (d1) to 0.92 (d2) 8wks = 0.83 (d2) to 0.97 (d3) 12wks =0.70 (d2) to 0.86 (d1)	**Abbreviated methods vs. Test weighing** 4 weeks 7am to 7pm = 20% to 40% overestimation 2am to 2pm = 0.4% underestimation to 3% overestimation 1st nursing x no./24h= 14% to 26% overestimation 12 weeks 7am to 7pm = 25% to 52% overestimation 2am to 2pm = 5% underestimation on all days 1st nursing x no./24h = 27% to 54% overestimation 2-mid 24h feeds x no./24h 4wks = 6% underestimation to 0.6% overestimation. 8wks = 0.7% to 3.7% underestimation 12wks = 3% to 6% underestimation

Table 3.1. Validation of dietary assessment methods in infant (0-12 mo.) children, continued

Reference	Study Population	Test Method (TM)	Reference Measurement (RM)	Design Features	Correlation Between TM and RM	Mean Intake Difference Between TM and RM
TEST WEIGHING – BREAST FEEDING, CONTINUED						
Houston et al., 1983 (81)	1-9 days = 18 (10M, 8F) Scotland	1-feed method (1st feed after 9am) 2-feed method (2 feeds after 9am) 1-feed method (mid 24h feed) 2-feed method (mid 24h feed)	Sum of test weights by mother for all feeds from midnight to midnight	Mothers weighed infants pre- and post-feeds for 24h periods for up to 9d (63 completed 24h periods). <u>Post 9am 1 or 2-feed methods</u>: Product of test weights of infant for the first 1 or 2 consecutive feeds after 9am and the number of feeds during the 24h period. <u>Mid-24h 1 or 2 feed method</u>: Product of test weights of infant for one or two feeds in the middle of the 24h period.	1 feed after 9am = 0.90 2 feeds after 9am = 0.97 1 feed mid 24h = 0.89 2 feeds mid 24h = 0.94	Not reported
Neville and Kellar, 1984 (82)	3-9 days and 21-56 days = 6 Colorado	1-feed method (mid 24h feed) 2-feed method (mid 24h feed)	Test weighing by mother for 24h period	Test weighing for consecutive 24h periods 3-9d (representing 275 feedings) and 24h periods at weekly intervals from 21d to 56d (representing 29d and 234 feedings). Product of 1 or 2 consecutive mid-24h feeds and the total number of feeds in the 24h period compared with test weighing for 24h.	<u>Days 3-9</u> 1-feed method =0.63 2-feed method =0.74 <u>Days 21 to 56</u> 1-feed method = 0.13 2-feed method = 0.09	**1 or 2 Feed Method vs. Test weighing** <u>Days 3-9</u> 1-feed method = 0.2% overestimation (515 vs. 514 ml/d) 2 feed method = 3 % underestimation (498 vs. 514 ml/d) <u>Days 21 to 56</u> 1-feed method = 0.4% overestimation (672 vs. 699 ml/d) 2-feed method = 0.7% underestimation (664 vs. 669 ml/d)

Table 3.1. Validation of dietary assessment methods in infant (0-12 mo.) children, continued

Reference	Study Population	Test Method (TM)	Reference Measurement (RM)	Design Features	Correlation Between TM and RM	Mean Intake Difference Between TM and RM
DOUBLY LABELED WATER (DLW) METHOD – FORMULA FEEDING						
Butte et al., 1991 (83)	1 mo. = 9 4 mo. = 9 Houston, Texas	DLW method	5d of test weighing of formula and complementary food intake	Mother-infant pair in CRC unit for 24h for dosing. Spot urine collected for 14d. Weight measured d1 and d14. Test weighing of ready-to-feed formula intake for 5d by mother in home. Pre-weighed jars of complementary food and pre-weighed towels for formula loss (spit up, spills) provided.	Not specified	**DLW vs. Test weighing** 70g/d (SD 155) or 8% overestimation of intake. When corrected for environmental water influx and insensible water loss, 14g/d (SD 154) or 2 % overestimation of intake.
Lucas et al., 1987 (84)	5-11 wks. = 8 UK	DLW method (14 studies on 8 infants)	7d of test weighing	Dosing d1. Spot urine collected for 7d. Formula intake measured by test weighing for 7d.	0.93	**DLW vs. Test weighing** -8g/d (827 vs. 837g/d) or 1% (SD 5%) underestimation of intake. Corrected for environmental water influx and insensible water loss
Vio et al., 1986 (85)	Mean age 147.3 d = 10 Recovering from protein-energy malnutrition Chile	DLW method	15d of test weighing	Dosing d1. Spot urine collected for 15d. Direct measurement of formula intake and complementary food intake for 15d in hospital	0.97	**DLW vs. Test weighing** -14ml/d (519-963 vs. 519-1002ml/d) or 2% underestimation of intake.

Table 3.1. Validation of dietary assessment methods in infant (0-12 mo.) children, continued

Reference	Study Population	Test Method (TM)	Reference Measurement (RM)	Design Features	Correlation Between TM and RM	Mean Intake Difference Between TM and RM
DOUBLY LABELED WATER (DLW) METHOD – FORMULA FEEDING, CONTINUED						
Wong et al., 1990 (86)	1 mo. = 10 4 mo. = 10 (14 M, 6 F) Houston, Texas	DLW method	5d of test weighing	Mother-infant pair in CRC unit for 24h for dosing. Spot urine collected for 14d. Weight measured d1 and d14. Test weighing of ready-to-feed formula intake for 5d by mother in home. Pre-weighed jars of complementary food and pre-weighed towels for formula loss (spit up, spills) provided.	Not specified	**DLW vs. Test weighing** -1.2± 15.5kcal/kg/d to – 0.3 ± 16.0kcal/kg/d, or 1-2 % underestimation of intake. Used Roberts or modified Jones mode of calculation and estimated or measured values for insensible water loss.

Table 3.1. Validation of dietary assessment methods in infant (0-12 mo.) children, continued

Reference	Study Population	Test Method (TM)	Reference Measurement (RM)	Design Features	Correlation Between TM and RM	Mean Intake Difference Between TM and RM
DOUBLY LABELED WATER (DLW) METHOD – BREASTFEEDING						
Butte et al., 1991 (83)	1 mo. = 10 4 mo. = 10 (12M, 8F) Houston, Texas	DLW method	5 consecutive days of infant test weighing before and after each feed	Mother-infant pair in CRC unit for 24h for dosing. Spot urine collected for 14d. Weight measured d1 and d14. Test weighing of BM intake for 5d. by mother in home. Pre-weighed jars of complementary food and pre-weighed towels for BM loss (spit up) provided.	Not specified	**DLW vs. Test weighing** 55g/d (SD 50) or 5 % overestimation of intake. ($P < 0.001$) Corrected for environmental water influx and insensible water loss.
Butte et al., 1988 (88)	Mean age 101 days $\pm$ 42 days = 9 Houston, Texas	DLW method	5 consecutive days of infant test weighing before and after each feed	Mother-infant pair in CRC unit for 24h for dosing. Spot urine collected for 14d. Weight measured d1 and d14. Test weighing of BM intake for 5d by mother in home. Pre-weighed jars of complementary food and pre-weighed towels for BM loss (spit up) provided.	Not specified	**DLW vs. Test weighing** 12g/d (648 $\pm$ 6 g/d vs. 636 $\pm$ 84g/d) or 2% overestimation of intake. Corrected for environmental water influx and insensible water loss
Butte et al., 1983 (87)	Experiment 1: Mean age 3.2 mo. $\pm$ 0.4 mo. = 14 (5 M, 9 F) Experiment 2: Mean age 2.5 mo. $\pm$ 1 mo .= 8 (4M; 4F) Houston, Texas	DLW method	48h of infant test weighing before and after each feed. 24h infant test weighing before and after each feed by mother in home	Experiment 1: Spot urine samples collected at 48h after dosing. Test weighing before and after each feed for 48 h. Experiment 2: Spot urine collected over 5d at 48, 72, and 120h. Test weighing of infant before and after each feed for 24h.	<u>Experiment 1:</u> Interclass correlation of 0.60. <u>Experiment 2:</u> Interclass correlation of 0.28.	**DLW vs. Test weighing** <u>Experiment 1:</u> 167ml/d (1616 $\pm$ 353 vs. 1449 $\pm$ 234ml/d) or 12% overestimation of intake. ($P < 0.001$). <u>Experiment 2:</u> 187ml/d (878 $\pm$ 188 vs. 691 $\pm$ 141ml/d) or 27% overestimation of intake. ($P < 0.001$).

Table 3.1. Validation of dietary assessment methods in infant (0-12 mo.) children, continued

Reference	Study Population	Test Method (TM)	Reference Measurement (RM)	Design Features	Correlation Between TM and RM	Mean Intake Difference Between TM and RM
FOOD RECORDS (FR) or DIET HISTORY (DH)						
Lanigan, et al., 2001 (90)	6-12 mo. = 38 (45% M) 12-24 mo. = 34 (53% M) UK	5d Estimated FR	5d Weighed FR DLW method (subset of 21 infants 6-12 mo.)	Cross-over design of 5d weighed FR and 5-d estimated FR; collection periods separated by approximately 2wks. DLW spot urine collected for 7d. Random assignment to one method in week 1 crossing over to alternative method in week 2. Parents attended 3 training sessions. BM intake: BM intake (6% of total group energy intake) estimated from recording of duration of each feed. Milk consumption based on Medical Research Council data of 135g for infants 6-7mo. and 100g for 8-12mo., where a feed of 10 or more minutes was equivalent to a full feed; consumption adjusted proportionally to feedings of less time. Child Care Input: Not specified	Not specified	**Estimated vs. Weighed FR** 3.6% mean difference (937 ± 2 vs. 904 ± 206kcal/d) [non-significant] **Estimated/Weighed FR vs. DLW** Both overestimated DLW measurement of energy expenditure by 7%: **Estimated intake vs. DLW** = 238 ± 1623kJ/d. **Weighed intake vs. DLW** = 243 ± 1690kJ/d.
Harbottle et al., 1994 and 1992 (91;92)	4-40 mo. = 117 Indo-Asian children from low literacy HHs. Sheffield, UK	4d Weighed FR (infants) or 5-d weighed FR (children) with a Portable Electronic Tape Recording Automated (PETRA) scale	Diet History (DH) and collection of food samples	The weighed FR completed by mother in home or occasionally by older female sibling or other relative. Field worker provided participant training in home and did monitoring visit after first 24h of weighed FR. DH collected in home to validate FR. BM Intake: Not Specified Child Care Input: Not Specified	Not specified	**DH vs. Weighed FR** DH higher than weighed FR for mean intakes as follows: 7% energy, 9% protein, 3%, fat; 9% iron and 6% vitamin C. Analyzed by age group, differences were significant for energy at 12 to < 18mo.; for iron at 6 to < 12mo. and 12 to < 18mo.; and for vitamin C at < 6mo.

Table 3.1. Validation of dietary assessment methods in infant (0-12 mo.) children, continued

Reference	Study Population	Test Method (TM)	Reference Measurement (RM)	Design Features	Correlation Between TM and RM	Mean Intake Difference Between TM and RM
FOOD RECORDS (FR) or DIET HISTORY (DH), CONTINUED						
Wharf et al., 1997 (93)	8 mo. = 20 18 mo. = 20 From healthy full-term pregnancies Norwich, UK.	DH (Standardized question sheet reprinted in article)	3d weighed FR (at least one weekend day and 2 weekdays)	DH obtained by interview using a standardized question sheet. One week later mothers kept a 3-d weighed FR. BM Intake: Not Specified Child Care Input: Not Specified	8 mo. Iron intake = 0.93 18 mo. Iron intake = 0.66	**DH vs. FR** 8 mo. overestimated kcal by 5% and iron intake by 8%. 18 mo. overestimated kcal by 5% and iron intake by 2%. Differences not significant at 8 or 18 mo.
24-HOUR RECALL (24HR)						
Horst, et al., 1988 (96)	6 mo. = 41 Non-breastfed Netherlands	24HR	Duplicate diet (collected by parent day before 24HR)	In 1984, parents were instructed in the home to collect a duplicate portion of all foods the infant consumed in 24h. The morning after the duplicate portion was collected, the 24HR interview was conducted in the home and the duplicate portions were collected. BM Intake: Not Applicable Child Care Input: Not Specified	Spearmen rank correlation coefficients = 0.77 to 0.90 for energy and micro nutrients and 0.69 to 0.96 for minerals (all highly significant).	**24HR vs. Duplicate plate** 24HR 9% higher in energy and macronutrients; 10% and 13% higher in calcium and phosphorus; and 2% higher in iron than duplicate diet. All differences significant except iron.
Bogle et al., 2001 (97)	0-2 yrs. = 32 3-5 yrs. = 28 Lower Mississippi Delta Region: 17 from telephone HHs and 43 from non-telephone HHs.	Telephone 24HR	In-person 24HR Multiple pass methodology from 1994-96 CSFII	Dual sampling frame from telephone and non-telephone HHs. In telephone HHs caretaker completed 24HR either in-person or by telephone. In non-telephone HHs 24HR completed in-person or by cell phone provided by the interviewer. BM Intake: Time of feeds collected. Low BF rates; BF infants excluded from analysis. Child Care Input: Caretaker provided information or interviewer contacted child care center.	Not specified	**Telephone 24HR vs. In-person 24HR** Results reported for total sample and not by age group. Mean non significant difference between telephone and in-person interviews for telephone HHs was –171kcal, and for non-telephone HHs –143kcal (P=0.1).

Table 3.1. Validation of dietary assessment methods in infant (0-12 mo.) children, continued

Reference	Study Population	Test Method (TM)	Reference Measurement (RM)	Design Features	Correlation Between TM and RM	Mean Intake Difference Between TM and RM
FOOD FREQUENCY QUESTIONNAIRE (FFQ)						
Marshall, et al 2003 (98)	6 wks. = 240 (50% M) Followed longitudinally through 5 yrs. From well educated, economically secure HHs in longitudinal Iowa Fluoride Study (IFS) USA	Beverage FFQ	3d Estimated FR (2 weekdays and 1 weekend)	From 1992-2000, instruments mailed to parents when children were 6wks, 3, 6, 9, and 12 mo. and every 4 mo. through 3 yrs of age and then every 6 mo. until 5 yrs. Parents completed FFQ for the week preceding the 3-d FR and returned by mail. Analysis reported at 6 and 1 mo. and 3 and 5 yrs. BM Intake: estimated at 6 mo. by calculating total energy requirements based on mean intake for body weight minus energy from other beverages divided by the energy concentration of human milk. At 12 mo. infants were assigned an intake of 2 oz. of human milk. Child Care Input: Parent obtained information from childcare provider or provider completed FR.	Spearman correlations 6 mo. BM = 0.95 IFS = 0.84 cow's milk = 0.86 juice/drinks = 0.66 water = 0.54-0.66 12 mo. BM = 0.95 IFS = 0.84 cow's milk = 0.86 juice/drinks = 0.69 water = 0.60 soft drinks = 0.26-0.35 (liquid or powdered)	**Beverage FFQ vs. FR** 6 mo. BM FFQ estimate = 0.1 feedings higher than FR IFS FFQ estimate = 0.2oz higher than FR 12 mo. BM FFQ estimate = 1.6 feedings lower than FR IFS FFQ = 1.4oz higher than FR cow's milk FFQ intake = 0.7oz higher than FR
OTHER QUESTIONNAIRES						
Persson and Carlgren, 1984 (128)	6 mo. and 12 mo. = 93 Child Health Center, Sweden	Interview with short questions on prevalence, and duration of breastfeeding, and timing of introduction of solid foods	Notes in medical record on breastfeeding prevalence	Mothers of infants were interviewed at 6 and 12 mo. after birth. Infant's medical record was reviewed for reporting of breastfeeding practices at well baby visits.	Not specified.	**Medical record vs. Interview** 6 mo: 94% of the mother's reporting of breastfeeding prevalence agreed with the notes in the medical record. 12 mo: about 25% of the mothers who stopped breastfeeding before 6mo. added one or two months to their answer.

Table 3.2. Validation of dietary assessment methods in toddler (13 to 24 months) populations

Reference	Study Population	Test Method (TM)	Reference Measurement (RM)	Design Features	Correlation Between TM and RM	Mean Intake Difference Between TM and RM
DOUBLY LABELED WATER (DLW) METHOD FOR TOTAL ENERGY EXPENDITURE (TEE) – FORMULA FEEDING						
Fjeld et al., 1988 (101)	Mean age 16.4 mo. = 11 Recovering from protein energy malnutrition; free of infection, fever or diarrhea. Lima, Peru	DLW method (16 studies on 11 infants)	10d test weighing of formula by investigators	Children were hospitalized in a metabolic ward. Dose 1 administered d1 and Dose 2 administered d5-10. Urine collected pre and 6h and 24h after dose 1 and 5-10 days post. Milk intake measured days 1 through 10.	0.98	**DLW vs. Test Weighing** 76 g/d or 6% overestimation of intake With corrections for environmental water influx and insensible water loss, -29 g/d or underestimation of 2% $\pm$ 3%
FOOD RECORDS (FR) or DIET HISTORY (DH)						
Lanigan, et al., 2001 (90)	6-12 mo. = 38 (45% M) 12-24 mo. = 34 (53% M) UK	5d Estimated FR	5d Weighed FR DLW method (subset of 21 infants 6-12 mo.)	Crossover design of 5d weighed FR and 5d estimated FR; collection periods separated by approximately 2wks. DLW spot urine collected for 7d. Random assignment to one method in week 1 crossing over to alternative method in week 2. Parents attended 3 training sessions. Child Care Input: Not specified	Not specified	**Estimated vs. Weighed FR** 3.6% mean difference (937 $\pm$ 205 vs. 904 $\pm$ 206kcal/d) [non-significant] **Estimated/Weighed FR vs. DLW (Infants only)** Both overestimated DLW measurement of energy expenditure by 7%. **Estimated intake vs. DLW** = 238 $\pm$ 1623kJ/d. **Weighed intake vs. DLW** = 243 $\pm$ 1690kJ/d.

Table 3.2. Validation of dietary assessment methods in toddler (13 to 24 months) populations, continued

Reference	Study Population	Test Method (TM)	Reference Measurement (RM)	Design Features	Correlation Between TM and RM	Mean Intake Difference Between TM and RM
FOOD RECORDS (FR) or DIET HISTORY (DH), CONTINUED						
Davies et al., 1994 (129) National Diet and Nutrition Survey	1.5-4.5 yrs. = 81 52%M; 29% 1.5-2.49 yrs.; 38% 2.5-3.49 yrs.; 27% 3.5-4.49 yrs. UK	4d Weighed FR	DLW method to estimated TEE	In fall of 1989, DLW dose followed by 10 daily spot urine collections. During 10d period, mothers kept 4d Weighed FR including 1 weekend day. 64% response rate for all parts of study.	**4d Weighed FR vs. DLW** 0.41 kJ/d $P < 0.01$ 0.36 kJ/kg $P < 0.01$	**4d weighed FR vs. DLW** -7% (778 vs. 838 kcal/d) Mean energy difference was greatest for ages 1.5-2.5 yrs. (6% underestimation), and smallest for ages 3.5-4.5 yrs. (1% overestimation)
Harbottle and Duggan, 1993 and 1994 (91;92)	4-40mo = 117 Indo-Asian children from low literacy HHs. Sheffield, UK	4d Weighed FR (infants) or 5d weighed FR (children) with a Portable Electronic Tape Recording Automated (PETRA) scale	Diet History (DH) and collection of food samples	The weighed FR completed by mother in home or occasionally by older female sibling or other relative. Field worker provided participant training in home and did monitoring visit after first 24h of weighed FR. DH collected in home to validate FR. BM Intake: Not Specified Child Care Input: Not Specified	Not specified	**Weighed FR vs. DH** FR lower than DH for mean intakes as follows: -7% energy, -9% protein, -3%, fat; -9% iron and -6% vitamin C. Analyzed by age group, differences were significant for energy at 12 to < 18 mo.; for iron at 6 to < 12 mo. and 12 to < 18mo.; and for vitamin C at < 6 mo.
Wharf et al., 1997 (93)	8 mo. = 20 18 mo. = 20 From healthy full-term pregnancies Norwich, UK.	DH (Standardized question sheet reprinted in article)	3d Weighed FR (at least one weekend day and 2 weekdays)	DH obtained by interview using a standardized question sheet. One wk. later mothers kept a 3d weighed FR. BM Intake: Not Specified Child Care Input: Not Specified	8 mo. Iron intake = 0.93 18 mo. Iron intake = 0.66	**DH vs. Weighed FR** 8mo overestimated kcal by 5% and iron intake by 8%. 18mo overestimated kcal by 5% and iron intake by 2%. Differences not significant at 8 or 18 mo.

Table 3.2. Validation of dietary assessment methods in toddler (13 to 24 months) populations, continued

Reference	Study Population	Test Method (TM)	Reference Measurement (RM)	Design Features	Correlation Between TM and RM	Mean Intake Difference Between TM and RM
24-HOUR RECALL (24HR)						
Bogle et al., 2001 (97)	0-2yrs. = 32 17 from telephone HHs and 43 from non-telephone HHs. Lower Mississippi Delta Region, US	Telephone 24R	In-person 24HR	Dual sampling frame from telephone and non-telephone HHs. In telephone HHs caretaker completed 24HR either in-person or by telephone. In non-telephone HHs 24HR completed in-person or by cell phone provided by the interviewer. Multiple pass methodology from 1994-96 CSFII used for 24HR. BM Intake: Time of feeds collected. Low BF rates; BF infants excluded from analysis. Child Care Input: Caretaker provided information or interviewer contacted child care center.	Not specified	**Telephone 24HR vs In-person 24HR** Results reported for total sample and not by age group. Mean non significant difference between telephone and in-person interviews for telephone HHs was –171kcal, and for non-telephone HHs –143kcal (P=0.1).
FOOD FREQUENCY QUESTIONNAIRES (FFQ)						
Parrish et al., 2003(102) Diabetes Autoimmunity Study in the Young (DAISY)	1-3 yrs. = 68 49%M; 79% white; 57% of mothers 4 yrs. college; 79% HH income > $30,000; high risk for development of diabetes	111-item Harvard FFQ Self-administered Past year intake	4 24HR NCC method, 3 mo. apart with primary caregiver Blood sample on random sub sample of 38: Plasma lipids; alpha tocopherol; and ascorbic acid	In 1997-98, primary caregiver of participants completed 24HR interview quarterly. At end of year primary caregiver completed self administered Harvard FFQ. Child Care Input. Alternative caregivers (child care, fathers non living in home, grandparents, etc.) contacted for information in 24HR. Responses of parent and alternative caregiver combined into one 24HR.	**Pearson Correlation FFQ vs. 24HR** 0.08 kcal (-0.16 to 0.31) Energy-Adjusted nutrient correlations ranged from 0.33 for protein to 0.41. FFQ and plasma correlations: vitamin C (0.51); alpha tocopherol (0.48), beta cryptoxanthin (0.41) and alpha carotene (0.39)	**FFQ vs. 24HR** All ages: +70% kcal 2070 ± 709 kcal vs. 1220 ± 347 kcal 1 yr. (n=24) +72% kcal 1960 ± 597 kcal vs. 1140 ± 332 kcal 2 yr. (n=20) +77% kcal 2080 ± 787 kcal vs. 1170 ± 327 kcal

Table 3.2. Validation of dietary assessment methods in toddler (13 to 24 months) populations, continued

Reference	Study Population	Test Method (TM)	Reference Measurement (RM)	Design Features	Correlation Between TM and RM	Mean Intake Difference Between TM and RM
FOOD FREQUENCY QUESTIONNAIRES (FFQ)						
Blum et al., 1999 (103)	1-5 yrs. = 233 55% 1-2 yrs. 45% 3-4 yrs. M and F; 56% Native American; 44% white; WIC Program participants North Dakota, US	Modified 84-item Harvard FFQ 2x with 1 mo. interval Modified for 1 mo. period; self-administered	24HR 3x in 1mo. (@ 10d intervals) NDS computer assisted	1st HFFQ administered at routine WIC visit. 3 24HRs administered by telephone or in-person 10 days apart. HFFQ administered again after final 24HR. Mean of 3 24HR and 2 HFFQs compared	Pearson Correlation Protein = 0.43 CHO = 0.52 Fat = 0.59 14 other nutrients ranged from 0.26 – 0.63 Correlations not different for younger vs. older children or for Native Americans vs. Caucasians.	**HFFQ vs. 24HR** 0.2% kcal overestimation 1688 ± 482 kcal vs. 1684 ± 467 kcal HHHQ overestimated 10 of 20 nutrients, HFFQ intakes for each nutrient within 10% of 24HR.
Kuehneman et al., 1994 (104)	18-36mo. =22 Mean age 25.6 mo.; 12 from minority backgrounds; 8 in WIC program; most caretakers had HS education Omaha, Nebraska	64-item FFQ Interviewer administered with different portion size measurement aides: 1) graduated food models; 2) food pictures; 3) plastic food models; 4) standard serving sizes for age group.	24h duplicate diets Monthly for 12 mo.	FFQ administered in 1-hour interview with child caretaker. For each food, all three types of portion size measurement aides shown and caretaker asked to indicate if portion was same, less, or more. For 12 mo. following interview participant collected 24h duplicate diet monthly. The mean difference between actual amount ingested and the estimated amount in FFQ for each of the four comparisons for 38 foods was determined. Child Care Input: Not specified	Not specified	For 31 of the 38 foods, there was no significant difference between the standard serving size and the amount consumed. For the 38 foods studied, the standard serving size showed the smallest error for 17 foods compared with 4 for the graduated models, 6 for food pictures, and 5 for plastic models.

Table 3.4. Nutrient and/or food intake surveys in infant/toddler (0-24 months) populations

Reference/ Survey Name	Study Population	Diet Assessment Method	Objective and Design Overview	Nutrients and Outcomes Assessed
FOOD RECORDS (FR) or DIET HISTORY (DH)				
Marshall, et al., 2003 (114) Iowa Fluoride Study (IFS)	642 infants Followed longitudinally from birth through age 5 49% M; 81% HHs with HS education; 13% income <$19,000. Iowa	3d Estimated FRs 1 weekend and 2 week days Iowa Fluoride Study (IFS) Questionnaire (includes beverage FFQ) with each Food Record	Objective: Longitudinal investigation of the relationship of dietary and non-dietary fluoride exposures and the relationship between fluoride exposures and dental fluorosis and caries. Design: Starting in 1992, parents mailed IFS questionnaire and 3d FR at 6 wks, 3, 6, 9, and 12 mo. every 4 mo. until 3yrs and then every 6mo through 5yrs. IFS questionnaire collected information on child's beverage intake, general health, and oral health behaviors. Dental examinations at 4 and 7yrs. Supplement Intake: Questions on IFS questionnaire. BM Intake: Not specified Child Care Input: Not specified Instrument Selection Rational: Not specified	Energy intake and intake of 21 nutrients, dairy products, sugared beverages, and sugar-free beverages. Dental caries at 1, 2, 3, 4, 5 years. Fluoride supplement use during infancy reported in Levy and Guha-Chowdhury, 1999. (130)
Ryan et al., 2002 (106) Gerber Products Company 1994 Survey	1,658 infants up to 24 mo. 51% M; 94% white, 50% w/ HH incomes $25,000-$59,000; 34% of infants in some day care. US	4d Estimated FR	Objective: Survey to assess how infant-feeding practices have changed during the last 15yr and how they conform to expert recommendations at those times. Design: Cross-sectional mailed survey in fall of 1994. Recruited mothers (38.4% of HHs contacted) completed 4-d FR. Supplement Intake: Recorded in FR BM Intake: Estimated by assuming that published amounts of BM intakes of infants of the same weight applied to the sample and further that totally BF infants nursed for at least 121min. per day. The number of minutes the mother actually BF was divided into the total number of ounces of BM the infant should theoretically consume based on weight. Child Care Input: Foods eaten at day care included; caregivers given detailed written instructions on recording amounts consumed. Instrument Selection Rational: Not specified	Energy intake and 11 nutrients (protein, iron, zinc, calcium, phosphorus, ascorbic acid, thiamin, riboflavin, niacin, and vitamins B6 and A).

Table 3.4. Nutrient and/or food intake surveys in infant/toddler (0-24 months) populations, continued

Reference/ Survey Name	Study Population	Diet Assessment Method	Objective and Design Overview	Nutrients and Outcomes Assessed
FOOD RECORDS (FR) or DIET HISTORY (DH), CONTINUED				
Emmett et al., 2002; Northstone et al., 2002; Rogers and Emmett, 2002 (109;111;112) Avon Longitudinal Study of Pregnancy and Childhood (ALSPAC) Children in Focus (CIF) substudy	18 mo. = 1,026 (77% response rate) 43 mo. = 863 (69.1% response rate) UK	3d Estimated FR 1 weekend and 2 weekdays not necessarily consecutive	Objectives: To investigate food and nutrient intake in toddlers and preschoolers. To examine types of drinks consumed by children at 18 mo., to determine an associations with sociodemographic characteristics, and to investigate the use of the bottle for providing these drinks. Design: Parents sent FR one week before clinic visit. Mothers recorded all drinks consumed in a 3dFR and containers for drinks. Data analyzed for first24h period. Supplement Intake: Not specified BM Intake: Record breastfeeding; 2.4% at least one BF at 18 mo. Child Care Input: Not specified Instrument Selection Rational: Not specified	Kcal; CHO; starch, sugar, non-milk energy sugar; protein; PUFA; MUFA; P:S ratio; cholesterol; 15 vitamins and minerals
Habibian et al., 2001 (122)	163 infants Followed longitudinally at 6, 12, and 18 mo. 51% M; community-based volunteer sample; 84% from middle-high SES HHs, 96% Caucasian UK	3d Estimated FR 1 weekend and 2 week days	Objective: Describe the dental health of infants and toddlers relative to their dietary habits and oral hygiene behavior over the first 18 mo of life. Design: Longitudinal dietary data obtained by mailed 3-d FR at 6, 12, and 18 mo. Parents completed and returned FR by mail. Dental examinations at 12 and 18mo. Demographic and feeding and oral hygiene questionnaire completed at 18 mo. dental exam. Supplement Intake: Not specified BM Intake: Not specified Child Care Input: Not specified Instrument Selection Rational: Not specified	Number of eating occasions, frequency of consumption of 19 food/drink categories, tooth eruption, plaque accumulation, dental caries

Table 3.4. Nutrient and/or food intake surveys in infant/toddler (0-24 months) populations, continued

Reference/ Survey Name	Study Population	Diet Assessment Method	Objective and Design Overview	Nutrients and Outcomes Assessed
FOOD RECORDS (FR) or DIET HISTORY (DH), CONTINUED				
Alexy et al., 1999; Alexy et al., 1998; and Kersting et al., 1998 (124;125;116) DONALD Study (Dortmund Nutritional and Anthropometric Longitudinally Designed Study)	3-36 mo. = 354 Followed longitudinally at @ 3, 6, 9, 12, 18, 24, and 36 mo. 46% M; upper SES volunteer sample Germany	3d Weighed FR @ 3, 6, 9, 12, 18, 24, and 36 mo.	Objective: The DONALD Study is a cohort collecting detailed data on diet, metabolism, growth and development from healthy subjects between infancy and adulthood (once a year for subjects older than 2 yrs). (http://www.fke-do.de/donald.html) Design: Cohorts of 30 to 40 infants recruited each year from 1985-96. Parents kept 3d FR of all food and fluids consumed as well as leftovers using electronic scale. Product wrappers are kept. Dietary records evaluated with dietitian. Infant weighed (BM intake) on infant weighing scales. Semi-quantitative recording was allowed if weighing not possible. More than 90% of the recorded food items were weighed in 87% of records. Supplement Intake: Not specified BM Intake: Test weighing pre and post feeds. Child Care Input: Not specified Instrument Selection Rational: Not discussed	Growth, energy and nutrient intake, food groups, breastfeeding rates, meal patterns
Wharf et al., 1997 (93)	181 healthy full-term infants age 4, 8, 12, or 18 mo. 56% M; 56% non-manual HHs, non-representative sample Norwich, UK	DH (assessment of overall pattern of eating coupled with a 24HR)	Objective: To determine the effects of dietary, physiological or environmental factors on body iron levels in infants aged 4-18 mo. Design: Nutritionist administered (mother or father) DH using a standardized question sheet in the infant's home. Capillary blood sample taken. Supplement Intake: Not specified BM Intake: DH standardized questions. Child Care Input: Not specified Instrument Selection Rational: DH method selected for this study because infants have a limited range of foods and it was a relatively easy and non-invasive procedure for the mothers. DH form printed in Table 1 of article. No discussion of assessment of supplement intake.	Hb, Hct, MCV, zinc protoporphyrin, plasma ferritin, daily iron intakes

Table 3.4. Nutrient and/or food intake surveys in infant/toddler (0-24 months) populations, continued

Reference/ Survey Name	Study Population	Diet Assessment Method	Objective and Design Overview	Nutrients and Outcomes Assessed
FOOD RECORDS (FR) or DIET HISTORY (DH), CONTINUED				
Boulton et al., 1995 (117) Adelaide Nutrition Study Cohort	Birth-2 yrs. = 140 Followed longitudinally at 3, 6, 12, and 24 mo.; and 4, 6, and 8 yrs. South Australia	7d Weighed FR @ 3, 6, 12 and 24 mo.	Objective: This study re-examined data collected in the 1980s on food energy and nutrient intake and somatic growth measured at intervals throughout infancy to 8 years. Design: Children randomly selected by birth order and followed longitudinally from birth to mid-teenage. Up to 2 yrs. 7d Weighed FR kept before each study visit. A 3d Weighed FR kept at 4 yrs., and a 4d Weighed FR at 6 and 8 yrs. Supplement Intake: Not specified Child Care Input: Not specified Instrument Selection Rational: Not specified	Food energy, nutrient intake, and somatic growth.
Heinig et al., 1993 (119) The DARLING Study	Breastfed = 73 Formula fed = 46 Followed longitudinally at 3, 6, 9, 12, 15, and 18 mo. Mean maternal age = 30 yrs., 87% Caucasian, 48% BF and 70% FF >$30,000/yr. University of California, Davis, US	4d weighed FR at 3, 6, 12, 15, and 18 mo. Test weighing of BM intake. BM samples collected over 24h on the day after 4d FR. Duplicate samples collected for food mixtures or family recipes.	Objective: To compare intake and growth between matched cohorts of infants either BF or FF until > 12 mo. of age. Design: BR infants recruited 1986-87; FF recruited 1987-89. Stratified matching ensured that FF infants were comparable by SES, ethnic group, maternal anthropometrics, and infant sex and birth weight. Mothers kept 4d weighed FR of infant intake at 3, 6, 9, 12, 15, and 18 mo. BM intake determined by test weighing. Supplement Intake: Not specified. BM Intake: Test weighing. Because feeding times were often irregular, milk intake per 24h was calculated by summing volumes during the interval from the beginning of the first feed of the first day to the beginning of the first feed occurring after that time on the last day, dividing by the interval (in hours), and multiplying by 24. Child Care Input: Not specified. Instrument Selection Rational: Not specified	Infant weight and length monthly 1-18 mo.; infant morbidity collected weekly; infant activity level assessed at 9 and 18 mo. (by sleeping diary for 7d and by 30min observation daily for 3d). Milk intake and composition; energy and protein intake.

Table 3.4. Nutrient and/or food intake surveys in infant/toddler (0-24 months) populations, continued

Reference/ Survey Name	Study Population	Diet Assessment Method	Objective and Design Overview	Nutrients and Outcomes Assessed
FOOD RECORDS (FR) or DIET HISTORY (DH), CONTINUED				
Noble and Emmett, 2001 (113) ALSAP	8 mo. = 1,131 55% M Avon, UK	3d Estimated FR (2 weekday and 1 weekend day, not necessarily consecutive)	Objective: To characterize the diets of 8mo. old infants born in 1992 and compare their nutrient and food intakes with those from the 6 to 9mo. old groups of the National Diet and Nutrition Survey. Design: A week before the clinic appointment three 1-d dietary diaries and an instruction leaflet were sent to the caregiver. At the clinic a trained assistant went through the completed FR with the caregiver to clarify any anomalies. Supplement Intake: Vitamin/mineral supplement questionnaire. BM Intake: Duration of each feed documented in FR; duration was used to estimate volume of milk (10ml per minute). Child Care Input: Not specified Instrument Selection Rational: Not specified	Energy intake and 17 nutrients. Length and weight. Under and over-reporting estimated by comparing predicted energy expenditure (PEE) with observed energy intake (OEI).
Sanjur et al., 1990(123)	12- 24 mo. = 90 49% M, mean age 21 mo.; 66% Mexican American; low SES Denver, Colorado, US	3d Estimated FR three times 3-6 mo. apart.	Objective: To examine the diet and nutrient intake of children 1 to 2 years old. Design: Toddlers were part of double blind randomized trial of supplement intake. 3d FR collected at 3 study periods over 6 mo. Records reviewed by nutritionist. Supplement Intake: Participants part of randomized trial with 5 supplement treatment groups. BM Intake: Not specified Child Care Input: Not specified.	Meal patterns, energy, protein, fat, CHO, calcium, iron, vitamins A and C, thiamin, riboflavin, niacin, sodium, phosphorous, potassium, and magnesium

Table 3.4. Nutrient and/or food intake surveys in infant/toddler (0-24 months) populations, continued

Reference/ Survey Name	Study Population	Diet Assessment Method	Objective and Design Overview	Nutrients and Outcomes Assessed
FOOD RECORDS (FR) or DIET HISTORY (DH), CONTINUED				
Stuff et al., 1986 (94)	5 and 6 mo. = 9 6 and 7 mo. = 8 All exclusively BF for 5 mo.	5d Infant Test weighing (pre and post BF) and weighed FR for complementary foods	Objective; To examine between-individual variation (BIV) and day-to-day variation (DDV) of total caloric intakes and milk intake during the transition from exclusive BF to BF with complementary foods. Design: Test weighing for 5 consecutive 24h periods. Complementary food weights measured by mother and weighed again in laboratory, Supplement Intake: Not assessed BM Intake: Test weighing Child Care Input: Not applicable Instrument Selection Rational: Not specified	BM Intake BIV at 5, 6, and 7 mo. = 8.8, 14.7, 37.0. DDV at 5, 6, and 7 mo. = 16.6, 18.3, and 20.0. Total Caloric Intake BIV at 5, 6, and 7 mo. = 8.8, 14.7, and 37.0 DDV at 5, 6, and 7 mo. = 16.6, 18.3, 20.0
Black et al., 1983 (95)	Breastfed = 48 Followed longitudinally from 6 wks-7.5mo Fully weaned = 37 Followed from 10-18mo. UK	BF infants: 4d test weighing infant before and after each feed and weighed record of all other food and drink kept monthly FF infants 4d weighed FR	Objective; To examine the day-to-day variation in energy intake of BF and fully weaned infants. Design: During 1978-1981 mothers of 48 BF infants kept 4-day FRs each month from 6wks to 7.5mo. Mothers of 37 fully weaned infants kept 4-day FRs at 10, 12, 15, and 18mo. Supplement Intake: Not specified. BM Intake: Test weighing before and after each feed. Child Care Input: Not specified. Instrument Selection Rational: Not specified	Pooled within-subject coefficient of variation (CVw) at 1-3, 3-5, 5-7, 10 + 12, and 15 + 18 mo. was 10.6, 10.6, 12.0, 13.6, 18.1%. Between-subject coefficient of variation (CVb) was 20.1, 19.3, 16.9, 19.4 and 23.3% at these ages. Some individuals were more variable than others; the range of CVw at each age was wide; at 2-4 and 15-18 mo. it was 1-21 and 6-30% respectively. The number of days of food records needed for BF infants is 4d and for toddlers is 7d.

Table 3.4. Nutrient and/or food intake surveys in infant/toddler (0-24 months) populations, continued

Reference/ Survey Name	Study Population	Diet Assessment Method	Objective and Design Overview	Nutrients and Outcomes Assessed
24-HOUR RECALL (24HR)				
Devaney et al., 2004 (107) Feeding Infants and Toddler Study	3,022 infants and toddlers: 4-6 mo. – 29% 7-11 mo. – 38% 12-24 mo. - 33% (50% M) 12% Hispanic; 20% nonwhite; 27% on WIC; higher distribution of middle income than a national distribution National random sample US	Telephone 24HR with 2 dimensional food measurement booklet. 2nd 24HR on a sub-sample of 703	Objective: To assess the nutrient adequacy of US infants and toddlers 4 to 24 mo. of age. Design: In March through July 2002, three telephone interviews: 1. Recruitment and HH interview; 2. 24HR with supplementary questions on growth, development and feeding patterns; 3. 2nd 24HR on random subset. Supplement Intake: 24HR BM Intake: Duration of each feed in minutes. For exclusively BF infants under 7 mo., assumed intake of 780ml breast milk per day, and for infant receiving both breast and formula, subtracted amount of formula from 780 ml. For infants over 7 mo., assumed intake of 600 ml breast milk per day. Child Care Input: Parent or interviewer called childcare provider for out-of-home intake information. Instrument Selection Rational: Nutrition Data System for Research (NDS-R) from the University of Minnesota Nutrition Coordinating Center for the 24HR because includes "a well-tested, computerized, 24-hour dietary recall collection linked to a comprehensive food and nutrient database."	Energy (kcal), protein, carbohydrate, fat, saturated fat, cholesterol; vitamins A, C, D, and K, B-6, B-12; beta carotene, thiamin, riboflavin, niacin, folate, calcium, phosphorus, magnesium, iron, zinc, sodium; dietary fiber; and caffeine

Table 3.4. Nutrient and/or food intake surveys in infant/toddler (0-24 months) population, continued

Reference/ Survey Name	Study Population	Diet Assessment Method	Objective and Design Overview	Nutrients and Outcomes Assessed
24-HOUR RECALL (24HR), CONTINUED				
Carruth et al 2000; and Skinner et al., 1999. (120;157)	94 healthy, full-term white infants Followed longitudinally until 24 mo. 52%M; recruited with mothers; mothers >18 yrs; 50% college degrees; middle or upper SES families. Tennessee, US	24HR and usual food intake interviews at 2, 3, 4, 6, 8, 10, 12, 16, 20, and 24mo.	Objective: To determine the nutrient and food intakes of healthy, white infants from middle and upper SES families and to compare intakes to current recommendations. Design: In 1992-94, using incomplete random block design, 98 mother-infant pairs were interviewed longitudinally in mother's home, collecting 24HR, usual food intake, and food likes and dislikes. Supplement Intake: 24HR BM Intake: a value of 750ml breast milk/day was used to compute energy and nutrient intakes/day for totally BF infants. No changes in the estimated amount of BM were made as the infant aged or as foods were added to the diet. For infants who had both formula and BM reported on 24HR, the volume of formula consumed was subtracted from 750ml to obtain BM estimate. Child Care Input: Not specified. Instrument Selection Rational: Not available	Intakes of energy, carbohydrate, protein, fat, calcium, iron, magnesium, phosphorus, potassium, sodium, zinc; vitamins A, D, E, K, C, B6, B12; thiamin, riboflavin, niacin, folate, and pantothenic acid. Introduction of complementary foods. Weight, length, and head circumference.
Kohlmeier et al., 1998 (108) Russian Longitudinal Monitoring Survey	0-6 yrs. = 746 48% M; recruited from a probability sample of 7,200 HHs.	24HR	Objective: Russian Longitudinal Monitoring Survey is designed to monitor social, economic, and health conditions in Russia using interview-administered questionnaires, 24HR, and anthropometric measurements. This study evaluated iron sufficiency in the Russian diet. Design: In 1992 through 1994, four rounds of interviewer-administered 24HR of a nationally representative longitudinal survey of 10,548 women and children. Supplement Intake: Not specified BM Intake: Not specified Child Care Input: Not specified Instrument Selection Rational: Not specified	Total iron, heme, and bioavailable iron in diet.

Table 3.4. Nutrient and/or food intake surveys in infant/toddler (0-24 months) populations, continued

Reference/ Survey Name	Study Population	Diet Assessment Method	Objective and Design Overview	Nutrients and Outcomes Assessed
24-HOUR RECALL (24HR), CONTINUED				
Webber et al 1987 (118) The Bogalusa Newborn-Infant Cohort Study	440 infants born 1/1/1974 through 6/30/1975 48%M; 50% Black Bogalusa, LA	Mailed Infant Feeding Practices Questionnaire with food checklist at 1, 2, 3, and 4mo. Interviewer-administered Infant Feeding Practices Questionnaire at 6 mo. and 1 mo. 24HR on subsample of infants at 6 (n=125), 12 (n=99), and 24 mo. (n=135); and at 3 (n=106) and 4yr (n=219).	Objective: To describe distributions, interrelationships, and trends throughout time for selected anthropometric measurements, BP levels, serum lipid and lipoprotein concentrations, and dietary intake patterns in longitudinal cohort from birth through 7 yrs. Design: Infants recruited at birth in 1974 and 1975. When children were 1, 2, 3, 4, and 6 mo. of age, Infant Feeding Practices questionnaires mailed to parents. When the children were 6mo. and 1, 2, 3, and 4 yrs. of age, replicate cardiovascular disease examinations were performed. Supplement Intake: Multivitamin (Vi-Daylin F) provided as incentive. BM Intake: Infant Feeding Practices Questionnaire Child Care Input: Not specified. Instrument Selection Rational: Not specified	Birthweight, any complications, Apgar scores, morbidity, serum lipid levels, length, weight, blood pressure, energy, and 11 nutrients.

Table 3.4. Nutrient and/or food intake surveys in infant/toddler (0-24 months) populations, continued

Reference/ Survey Name	Study Population	Diet Assessment Method	Objective and Design Overview	Nutrients and Outcomes Assessed
24-HOUR RECALL (24HR), CONTINUED				
Hoffmans et al., 1986 (121) The Leiden Preschool Children Study	124 infants Followed longitudinally at 4, 16, and 28 mo. 50%M; community based population sample Netherlands	24HR	Objective: To characterize the food and nutrient intake of a community-based population of children from 4 to 28 mo. Design: Infants born in 1979 and 1980 were followed longitudinally. Body weight and length and 24HR were obtained at 4, 16, and 28 mo. of age in the spring of each year. Supplement Intake: Not specified BM Intake: Infants weighed by mother before and after each feed to estimate intake to nearest 0.1kg. Child Care Input: Not specified Instrument Selection Rational: 24HR is considered to be fairly accurate if the day-to-day variation is limited. Dietary habits of infants are characterized by regularity and limited variation in the kind and amount of food. When complementary foods are introduced and the pattern of family eating is emerging, the within-subject coefficient of variation increases(95). For groups of children however, it has been demonstrated that the 24HR and a 7-d record method gave comparable results (128).	Energy intake and 13 nutrients. Length and weight.

Table 3.4. Nutrient and/or food intake surveys in infant/toddler (0-24 months) populations, continued

Reference/ Survey Name	Study Population	Diet Assessment Method	Objective and Design Overview	Nutrients and Outcomes Assessed
FOOD FREQUENCY QUESTIONNAIRE				
Lande et al., 2003 (115)	6 mo. = 2,383 53% M Norway	Mailed semi-quantitative 40 item FFQ	Objective: To describe and evaluate infant feeding practices during the first 6 mo. of life in relation to recommendations and maternal and infant characteristics. Design: In October through December 1998, mailed FFQ 2wks before infants turned 6 mo. of age. Parents completed FFQ and took questionnaire to 6 mo. check up for measurement of length and weight. Parents returned questionnaire by mail. Supplement Intake: FFQ included categories and amounts for vit./min. supplements. BM Intake: Question on if infant ever BF and frequency in six categories from one to 10 times or more in 24h period. Question on when BF stopped. Child Care Input: Not specified Instrument Selection Rational: Not specified	Categories of complementary foods. Self-reported length and weight as measured at 6-mo. examination.
OTHER QUESTIONNAIRES				
Thom et al., 2003 (131)	8-13 mo. = 81 Low birthweight infants; 56% preterm average for gestational age Dunedin Hospital, Dunedin, New Zealand	Questionnaire on infant feeding practices	Objective: To determine the iron status of a selected group of low birth weight infants at approximately 9 mo., and examine feasibility of predicting iron status by examining history of supplementary iron intake. Design: Between November 1995 and September 1996 questionnaire (not specified if mailed or interviewer administered) to caregiver on infant feeding practices; collection of 1ml blood sample. Supplement Intake: Questions on study questionnaire BM Intake: Questions on BF frequency and duration on study questionnaire. Child Care Input: Not specified Instrument Selection Rational: Instrument provides a easy method to screen for iron deficiency anemia.	Hb, Hct, serum ferritin, transferrin saturation.

Table 3.4. Nutrient and/or food intake surveys in infant/toddler (0-24 months) populations, continued

Reference/ Survey Name	Study Population	Diet Assessment Method	Objective and Design Overview	Nutrients and Outcomes Assessed
OTHER QUESTIONNAIRES, CONTINUED				
Ryan et al., 2002 (29) Ross Laboratories Mothers Survey (RLMS)	Probability sample from commercial list 1.7 million questionnaires mailed; >33,000 completed each mo. (28% response rate).	Questionnaire (Type of milk in hospital, at 1 week of age, in the last 30 days, and most often in last week; employment; and WIC program participation.)	Objective: To update reported rates of breastfeeding and exclusive breastfeeding through 2001 and to compare rates in 2001 to those from 1996. Design: 117,000 questionnaires mailed each month to mothers until infant was 12 mo. of age. 1.7 million questionnaires mailed in 2001. Sample was a probability sample of new mothers selected from a database of names supplied by Experian. Questionnaire asks mothers to recall type of milk fed to their infant in the hospital, and during each month of age. Supplement Intake: Not collected. BM Intake: Two categories of BF were considered: BM or a combination of human milk and formula or cow's milk and exclusive BF (only human milk). Child Care Input: Whether mother's employed collected. Instrument Selection Rational: Maintained consistency with previous questionnaires since 1954)	US BF initiation rates and rates at 6 mo.
Northstone et al., 2001(110) Substudy of Avon Longitudinal Pregnancy and Childhood study (ALSPAC)	9,694 infants Followed at 6 mo. and 15 mo. Avon, UK	Mailed questionnaire completed by mother (Questionnaire on food and drinks consumed by the infant and any feeding difficulties)	Objective: To determine the variety of foods given to infants at both 6 and 15 mo. of age according to the age at which lumpy solids were introduced and to determine the mother's perception of difficulty in feeding her child at 15mo. Design: In 1991 infant's mother completed mailed questionnaire at 6 and 15mo. Supplement Intake: Not specified BM Intake: Questions on consumption of listed beverages (including BM), age introduced, and current frequency of consumption. Child Care Input: Not specified. Instrument Selection Rational: Not specified.	Age of introduction of specific foods and beverages and reported feeding difficulties.

Table 3.4. Nutrient and/or food intake surveys in infant/toddler (0-24 months) populations, continued

Reference/ Survey Name	Study Population	Diet Assessment Method	Objective and Design Overview	Nutrients and Outcomes Assessed
OTHER QUESTIONNAIRES, CONTINUED				
Bogen et al., 2000 (105)	9-30 mo. = 282 53% F; 91% black, 62% on Medical Assistance; attending inner city well child clinics Baltimore, MD.	15-item self-administered questionnaire of risk factors for iron deficiency anemia (IDA) (Infant diet, beverage intake, solid food intake, vitamin/mineral supplementation, and WIC program participation)	Objective: To evaluate a parent-completed diet and health history as the first stage of 2-stage screening for iron deficiency anemia. Design: Cross-sectional survey conducted in inner-city clinics in children 9-30 mo. old having routine anemia screening as part of regularly scheduled visit. Parents completed self-administered questionnaire and children had venous blood sampling. Supplement Intake: Question on questionnaire BM Intake: Question on questionnaire Child Care Input: Not applicable Instrument Selection Rational: Questionnaire was developed from review of literature concerning risk factors for IDA and expert opinion	Hemoglobin, ferritin < 10 ug/L, and MCV >14.5%
Baydar et al., 1997 (25a) WIC Infant Feeding Practices Study	874 maternal-infant pair WIC program participants 51%M; 20% black; 20% Hispanic; nationally representative WIC Program sample US	15-minute computer assisted telephone interview (or in-person interview in non-telephone HHs) monthly 1 through 7mo and at 9 and 12mo.	Objective: To provide a nationally representative description of infant feeding practices among WIC program participants and to identify attitudes and practices of WIC program participants associated with the initiation and continuation of breastfeeding. Design: Between August 1994 and December 1995, a nationally representative WIC Program sample mother-infant pairs participated in 15min computer-assisted telephone interview in telephone HHs and in-person computer assisted interview in non-telephone HHs monthly through 7mo of age and then again at 9 and 12mo. Supplement Intake: Not specified BM Intake: Interview questions on initiation, duration, and factors affecting BF. Child Care Input: Mother or caretaker interviewed; information on child care collected. Instrument Selection Rational: Questionnaire based on FDA survey of infant feeding practices questionnaire.	Breast feeding initiation rates, patterns, and practices; patterns of introduction of complementary foods and beverages.

Table 3.4. Nutrient and/or food intake surveys in infant/toddler (0-24 months) populations, continued

Reference/ Survey Name	Study Population	Diet Assessment Method	Objective and Design Overview	Nutrients and Outcomes Assessed
OTHER QUESTIONNAIRES, CONTINUED				
O'Malley et al., 1991 (132)	6-23 mo. = 49 Migrant Head Start families in northern Colorado.	Interview with questionnaire on infant feeding practices.	Objective: To provide descriptive information on migrant farm laborers' infant feeding practices in northern Colorado. Design: Non-randomized convenience sample of 49 families with infants 6 to 23mo. Location of interview not specified. Supplement Intake: Not specified BM Intake: Questions on questionnaire. Child Care Input: Not specified Instrument Selection Rational: Questionnaire developed from NHANES, CSFII, and migrant farm worker survey questionnaires.	Breastfeeding practices, introduction of complementary foods and liquids, participation in food programs, and treatment practices for constipation and diarrhea.