Objective: To understand the transition from breast- and bottle-feeding to solid-feeding and factors that might affect the duration of breast- and bottle-feeding.

Design: Cohort followed up from birth with relatively well-educated, middle-class parents.

Setting: Community sample recruited from 3 suburban newborn nurseries (a teaching hospital, community hospital, and large health maintenance organization).

Participants: One hundred ninety-one healthy full-term infants.

Measures: Assessment of feeding practices through the ages of complete weaning from breast- and bottle-feeding.

Results: More than 90% of participants breast-fed for at least 2 weeks. Infants of older mothers were weaned from the breast later than infants of younger mothers. First-born infants were weaned from the breast earlier than later-born infants. Eighty-four percent of infants bottle-fed at some time during the first year of life. More than 40% of the cohort was still receiving bottles at 24 months of age, 16% at 36 months, and 8% at 48 months. The duration of breast- and bottle-feeding was related to maternal work status; mothers who returned to work during the first 3 months postpartum weaned sooner from the breast and later from the bottle than women who returned to work after 3 months postpartum.

Conclusions: The frequency of late bottle-weaning in this well-educated, middle-class cohort was unexpected and was related to the timing of the mother’s return to work. The impact of prolonged bottle-feeding on later growth and adiposity deserves further investigation.
PATIENTS AND METHODS

PATIENTS

Two hundred sixteen newborns and their parents were recruited from the well newborn nurseries at a university hospital, community hospital, and health maintenance organization in the San Francisco, Calif, Bay Area. Infants were eligible for participation if they were born at term (>37 weeks' gestational age) and had Apgar scores of at least 7 at 1 and 5 minutes after birth. Exclusion criteria were any congenital abnormalities or experienced any illness during newborn hospitalization.

Recruitment into the study was performed by trained research assistants who visited the participating newborn nurseries several times each week. Hospital records were used to identify all eligible patients, whose parents were contacted by telephone within 1 week of delivery. Parents who were interested in participating were given an appointment in the Infant Feeding Laboratory of the Department of Psychiatry and Behavioral Sciences at Stanford University, Stanford, Calif. No additional data were collected from eligible parents who declined to participate. No financial or other forms of inducement offered. At the time of their first visit to the laboratory, the study was fully explained, and signed consent was obtained from the parents. This study was approved by the Stanford University Committee for the Protection of Human Subjects. No information or advice on feeding practices was given to parents by the investigators or their staff in the laboratory, and all infants received routine health maintenance care from local physicians or clinics.

MEASURES

Sociodemographic information, including parental birth date, ethnic background, years of education, occupation, and names and birth dates of the infant’s siblings, was collected for the entire cohort. Maternal employment status was assessed every 6 months by self-report. Mothers working 40 or more hours per week were considered full-time, either in or out of the home.

Data on infant feeding practices were collected using the Infant Feeding Report (IFR)—a simple monitoring form completed by mothers for 3 days at the end of each month postnatally and mailed or telephoned to the Infant Feeding Laboratory until the age of complete weaning from the breast and bottle. If the IFR was mailed to the laboratory, a research assistant telephoned the parent to confirm the data recorded on the monitoring form. For each child, the IFRs provide a longitudinal record describing the number of BrFs, BtFs, and SFs each day (averaged for the 3 days of reporting). At each point, whether or not solid foods were also fed, infants were categorized as breast-feeding if they received any of their feedings by breast and as bottle-feeding if they received any of their feedings by bottle during the 3 days of reporting.

Weaning ages were calculated for BrFs, BtFs, and nutritive suckling. Age of breast-weaning was defined by the first of 2 successive IFRs in which there was no reported BrF. Age of bottle-weaning was defined by the first of 2 successive IFRs in which no bottles of infant formula, breast milk, juice, or cow's milk were recorded. Age of complete weaning from nutritive suckling was defined as the later of the breast- and bottle-weaning ages. A breast-weaning age was not calculated for infants who breast-fed for less than 2 weeks. Likewise, a bottle-weaning age was not calculated for infants who did not receive a nutritive bottle for at least 2 successive IFRs.

A self-report questionnaire developed for this study was used at 2 years of age, and annually thereafter, to supplement observations reported by parents in their monthly monitoring of feeding practices.

Each infant's weight and height, recorded on the first day of life, were used to calculate the infant’s birth body mass index (BMI) using the following formula: BMI = weight (in kilograms)/height (in meters)$^2$.

Data were analyzed using a software program (SPSS 4.0 for the Macintosh, SPSS Inc, Chicago, Ill). Because data concerning weaning from breast- and bottle-feeding were not normally distributed, data have been reported as medians and their ranges. Nonparametric tests were used, where appropriate, in hypothesis testing (eg, Kruskal-Wallis for group comparisons and Spearman rank correlations). A multivariate model was used to test predictors of breast- and bottle-weaning. Using stepwise regression, with breast- and bottle-weaning as the dependent variables, the following were entered as independent variables: early return to work (during the first 3 months postpartum), part- vs full-time work, maternal age, maternal education level, birth order (presence of older or younger siblings), and the infant's sex and BMI at birth.

are listed in Table 1. Dropouts from the study did not differ significantly from participants with respect to parental age, education level, employment status, ethnicity, infant sex, or birth BMI. Dropouts from the study included 15 infants whose parents were unable to comply with the required visits to the Infant Feeding Laboratory and 10 infants whose parents moved out of the area and chose not to remain in the study.

BREAST- AND BOTTLE-FEEDING

More than 90% of the sample breast-fed during the first month of life. By 6 months of age, 48% were at least partially BrF; at 1 year, 19% were at least partially BrF (Figure 1). The practice of sole BrF declined rapidly, from 31% at 2 months of age to 14% at 6 months and 7% at 1 year. The median age of complete weaning from the breast occurred at 6.0 months of age (range, 0.9-39.1 months) for the 175 infants who were breast-fed.

The prevalence of BrF increased during the first year of life, from 64% at 2 months of age to a peak of 84% at 1 year (Figure 1). Bottle-feeding persisted well beyond the first year of life, with 41% of infants still receiving bottles at 24 months of age, 16% at 36 months, 8% at 48 months, and 3% at 54 months. One child in the cohort was not fully weaned from the bottle until 65 months of age. The median age of bottle-weaning was 23 months (range, 9-65 months). The ages of breast- and bottle-weaning for infants who received both were uncorrelated.

As shown in Figure 2, bottles varied in content. Use of human breast milk in the bottle declined quickly, whereas use of formula remained common until 12 to
15 months of age, after which time use of whole cow’s milk was most common.

Figure 3 shows the number of BrFs and BtFs per day during each reporting period. For infants who were solely breast-fed, the median number of breast-feeds per day declined from 7.0 (range, 3.0-10.0) at 2 months of age to 3.3 (range, 1.0-7.0) at 12 months. Likewise, the median number of BtFs for infants who were solely bottle-fed declined from 6.3 (range, 5.0-8.0) at 2 months of age to 1.0 (range, 1.0-13.0) at 15 months. At 2 years of age, 80 children still bottle-fed 3 times per day (range, 1-8 times per day), and 29 children still bottle-fed 2 times per day (range, 1-4 times per day) at 3 years, with more than 70% of them still using bottles at bedtime and when riding in a vehicle at 2 and 3 years.

Infants fed by a combination of BrFs and BtFs were fed more frequently than those fed solely by breast or bottle. For example, bottle-fed infants received a median of 6.3 feeds per day (range, 5.0-8.0 feeds per day) at 2 months of age, whereas infants receiving formula and breast milk reported a median of 7.3 feeds per day (range, 4.0-13.0 feeds per day). The difference in number of BrFs and BtFs per day varied from 1.0 at 2 months of age to 3.7 at 18 months for infants receiving BrFs and BtFs compared with those receiving BtFs alone.

**TRANSITIONAL FEEDING**

Little solid-feeding was reported until 4 months of age, when 35% of infants received at least 1 SF per day. By 9

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**Table 1. Demographics**

<table>
<thead>
<tr>
<th>Demographic</th>
<th>Participants (n = 191)</th>
<th>Dropouts (n = 25)</th>
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<tr>
<td>Age, y</td>
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<tr>
<td>Father</td>
<td>34.8 ± 4.5</td>
<td>36.1 ± 15.7</td>
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<tr>
<td>Mother</td>
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<td>32.3 ± 4.8</td>
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<tr>
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<td>15.0 ± 1.2</td>
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</tr>
<tr>
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<tr>
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<td>12</td>
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<td>12</td>
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<td>Employed, %</td>
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<tr>
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**Figure 1.** Bottle- and breast-feeding prevalence. The percentage of infants fed by breast or bottle at each point is shown.

**Figure 2.** What’s in the bottle? For infants still bottle-feeding at each point, the percentage of infants receiving human breast milk (HBM), formula, whole cow’s milk (WCM), or juice by bottle is shown.

**Figure 3.** Number of sucking feeds per day. At each point, the mean number of feeds per day is given for infants fed by breast alone, by bottle alone, and by breast and bottle.
FAMILY VARIABLES AND FEEDING PRACTICES

Maternal Work Status

Seventy-four percent of mothers returned to work by the time their children were 24 months old. For these mothers, return to work correlated positively with age of breast-weaning \( (r = 0.27; P = .001) \) but negatively with age of bottle-weaning \( (r = -0.18; P = .02) \). The relationship between the mother’s return to work and the subsequent age of bottle-weaning did not relate to the number of hours these children spent in day-care or the type of day-care setting during BrF. We correlated the number of hours per week each child spent in day care, at 2 and 3 years of age, with age of bottle-weaning and found no significant relationship; neither was there a difference between children in family day care, day care at home, or institutional day care.

Table 2 shows the relationships between the ages of breast- and bottle-weaning and maternal employment status. There was a significant difference in age of breast-weaning (Kruskal-Wallis = 14.2; \( P < .001 \)), with mothers who returned to work during the first 3 months postpartum weaning earlier than mothers who returned to work later or not at all in the first 2 years postpartum. Similarly, there was a significant difference in age of bottle-weaning (Kruskal-Wallis = 5.8; \( P = .05 \)) but in the opposite direction—mothers who returned to work during the first 3 months postpartum bottle-fed longer than those who returned to work later or not at all in the first 2 years. There also was a significant difference in age of breast-weaning (Kruskal-Wallis = 15.6; \( P < .001 \)), but not bottle-weaning, between mothers working full-time, part-time, and not at all.

Maternal work status did not correlate with the introduction or use of SF.

Birth Order

Duration of BrF was related to birth order. The median duration of BrF for only-children and first-born children was 5.1 months (range, 1.0-26.0 months) and 5.0 months (range, 1.0-25.0 months), respectively, whereas middle children breast-fed longer (7.4 months; range, 2.0-18.0 months) and youngest children breast-fed the longest (8.8 months; range, 1.0-39.0 months) (Kruskal-Wallis = 12.9; \( P = .03 \)). There was no relationship between birth order and age of bottle-weaning or age of introduction of solid foods.

Maternal Characteristics

Maternal age and educational attainment were significantly associated with feeding practices. Maternal age was positively correlated with age of introduction of solid foods \( (r = 0.36; P < .001) \) and age of breast-weaning \( (r = 0.14; P = .03) \) but not with age of bottle-weaning.
Mother's educational attainment was also positively correlated with age of introduction of solid foods \((r = 0.17, P = .009)\) but not with ages of breast- and bottle-weaning.

**Multivariate Prediction of Breast- and Bottle-Weaning**

Using stepwise regression, with breast- and bottle-weaning as the dependent variables, the presence of an older sibling was the strongest predictor of age of breast-weaning \((F_{1,17} = 11.8; P < .001)\), followed negatively by return to work full time \((F_{2,17} = 9.7; P < .001)\). An early return to work (within the first 3 months postpartum) was the only significant predictor of age of bottle-weaning \((F_{1,167} = 4.6; P = .03)\).

**COMMENT**

In this cohort of healthy infants, we documented considerable variation in the duration of BrF and BtF. The prevalence of BrF declined from almost 100% at birth to 48% at 6 months of age, and to 19% at 1 year. Bottle-feeding was introduced to 64% of infants by 2 months of age and to 85% by 1 year. Infants receiving BrFs and BtFs were fed more frequently throughout the day than infants fed by bottle alone—as much as 3 feedings per day at 18 months of age. The age range of introduction of solid foods was narrow. At 4 months of age, 35% of infants were fed solid foods, whereas at 9 months all infants were fed solid foods an average of 3 times per day. After 9 months of age, infants still receiving BrFs or BtFs were fed 2 or more times each day than those who had been weaned. As in the case of mixed BrF and BtF noted above, the importance of this difference in total feeds per day is unknown.

An unexpected finding in this cohort was the prolonged duration of BtF for many infants. Although the American Academy of Pediatrics acknowledged the risk of nursing bottle caries,\(^23\) it does not explicitly recommend a specific weaning age.\(^1,124\) Pediatricians often recommend that the bottle be given up by 12 to 18 months of age.\(^125\) Historically, texts from early Greek, Roman, and Egyptian times and from the Middle Ages indicate that weaning (from the breast) often occurred in the third year of life or later. More recent feeding practices, in the 19th and early 20th centuries, also included BrF in the second year of life. Since the early 20th century, concomitant with the introduction of artificial milk or formula feeding and the decline in BrF, textbooks\(^26-28\) of pediatrics and nutrition have generally recommended weaning by the first birthday.

The frequent continuation of BtF beyond 1 year of age has recently been reported using data from the 1991 National Health Interview Survey Childhood Supplement, citing BtF rates of 19.9% at 2 years and 9.3% at 3 years.\(^22\) However, in our cohort, 42% of infants continued to receive BtFs beyond 2 years of age and 16% of infants continued to receive bottle-feeds beyond 3 years. The prolongation of BtF beyond the second year of life in our cohort did not reflect only occasional bottle use; those still receiving bottles at 2 to 3 years of age were given an average of 2.9 bottles per day, and those still receiving bottles at 3 to 4 years were given an average of 2.1 BtFs per day.

Continuation of bottle-feeding beyond 2 years of age is associated with ethnicity, race, socioeconomic status, and parental education.\(^22\) In our sample, despite relatively high educational attainment in general, and an absence of poverty, the practice of BtF was even more common at 2, 3, and 4 years of age than was reported by Kaste and Gifte\(^22\) in their analyses using the 1991 National Health Interview Survey.

Although the association of maternal work status and breast-weaning has been reported previously,\(^11,14,15\) the unique effect of birth order on age of breast weaning was also significant. Infants with older siblings were breast-fed longer than those without siblings, and those with 2 or more older siblings were breast-fed longer than middle children. These sibling effects were not caused by a later return to work by mothers of infants with older siblings. The relationship between birth order and breast-feeding duration may suggest that previous experience in caring for an infant could be an important factor in the feeding of subsequent children.

Previous studies have not assessed the relationship of maternal work and other maternal factors to duration of BtF. The association between mother’s early return to work and prolonged BtF has not been reported previously. It is possible that mothers returning to work soon after delivery might be more dependent on others, including child care workers, to feed their children and to participate actively in the bottle-weaning process; yet, the number of hours per week in day care and the type of day-care setting were not related to age of bottle-weaning. In their analyses of the National Health Interview Survey data, Kaste and Gifte\(^22\) found a higher prevalence of inappropriate BtF practices among children whose parents were likely to be “working poor” (based on income and educational status), leading these authors to speculate that working parents might be under more stress than nonworking parents. Although we did not collect data concerning the stress experienced by parents in our study, we also wonder whether parents returning to work soon after their child’s birth might find it more difficult to wean their children from BtF because of a combination of factors, including the stress of their jobs, the length of their workday, and other factors that might affect their parenting behavior. It is also unclear as to what extent fathers play a role in the decision to discontinue BtF. Reasons for the prolonged duration of BtF, particularly among mothers who returned to work earlier, and the impact of prolonged BtF on growth and later eating behavior deserve further study.

One potential impact of prolonged BtF is as a risk factor for the development of early dental caries.\(^29\) Because we did not systematically assess dentition in our cohort, we cannot comment on the occurrence of dental caries in relation to prolonged BrF in this sample. On the other hand, the frequent use of bottles at bedtime among 2- and 3-year-old BrF patients in our cohort was similar to that reported by Kaste and Gifte\(^22\) (about 79%), suggesting that this use of the feeding bottle is common, even among well-educated parents.
Another potential impact of variation in BrF or BtF practice may be on growth. Some investigators noted an association between BrF and reduced skinfold thickness and BMI,30-32 weight gain,33 and growth,33,34 whereas others did not.35-38 These differences in growth and weight gain led to the suggestion that new growth charts may be needed for breast-fed infants.39 Under some circumstances, advice to breast-feed “as long as possible” might lead to growth impairment.40 A decreased rate of growth in nursing infants sometimes results from an energy intake after 4 months of age41 that is significantly lower than the intake of bottle-fed infants, even after supplementation with solid foods.42,43 Because adiposity does not accrue in a linear fashion during the first years of life, we elected not to analyze the relationship of feeding practices to cross-sectional assessments of growth obtained in this cohort; instead, the possible relationship between growth and feeding practices will be tested within a multivariate model after all children in the cohort have experienced their adiposity rebound.44

It is important to acknowledge the limitations of this study. Data were gathered from a relatively well-educated sample that is not reflective of the economic and ethnic diversity of the general population. Furthermore, recruitment of the sample favored those parents who might have had a heightened interest in feeding practices, physical activity, and the growth of their infants. Although it may be difficult to generalize our findings to the broader population of infants and their parents, the findings remain important in view of the prevalence of BtF, as reported by Kaste and Gilte,22 and the frequent use of BtF at bedtime.

Our findings may be of particular significance in light of the increasing prevalence of childhood obesity and the possible relationship of BtF to later risk of increased adiposity.30,31 Further studies, including accurate measures of energy intake during the transitional feeding period, would provide additional data concerning the potential relationship of BtF duration to later growth, weight gain, and adiposity.

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