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Original Article

Is overweight at 12 months associated with differences in eating behaviour or dietary intake among children selected for inappropriate bottle use?

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Abstract

Bottle feeding beyond the recommended weaning age of 12 months is a risk factor for childhood obesity. This paper describes a sample of toddlers at high risk for obesity: prolonged bottle users from a low-income multi-ethnic community. We report here baseline mealtime and feeding behaviour, 24 h dietary recall and bottle intake data for Feeding Young Children Study (FYCS) participants, by overweight (≥85% weight-for-length) status. FYCS enrolled 12–13-month-olds from urban nutrition programmes for low-income families in the United States who were consuming ≥2 bottles per day. Our sample was predominately Hispanic (62%), 44% of mothers were born outside of the United States and 48% were male. Overall, 35% were overweight. Overweight status was not associated with mealtime/feeding behaviours, bottle use or dietary intake. Most (90%) children ate enough, were easily satisfied and did not exhibit negative (e.g. crying, screaming) mealtime behaviours, per parent report. The sample's median consumption of 4 bottles per day accounted for 50% of their total calories; each bottle averaged 7 ounces and contained 120 calories. Mean daily energy intake, 1098.3 kcal day^{-1} (standard deviation = 346.1), did not differ by weight status, nor did intake of fat, saturated fat, protein or carbohydrates. Whole milk intake, primarily consumed via bottles, did not differ by weight status. Thus, overweight 12–13-month-olds in FYCS were remarkably similar to their non-overweight peers in terms of several obesity risk factors. Findings lend support to the set-point theory and prior work finding that weight and intake patterns in the first year of life alter subsequent obesity risk.

Keywords: prolonged bottle use, dietary assessment, weight, mealtime behaviours, low income, multi-ethnic.

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Introduction

Obesity rates in young children are alarmingly high. For example, by 2010, 10% of birth to 2-year-olds in the United States were ≥95% weight-for-length, while 27% of 2–5-year-olds were ≥85% body mass index (BMI) (Ogden *et al*. 2012). Rates were highest in that nation's low-income children. At 1 year of age, 34% of children in the US Women, Infant, and Children's (WIC) Supplemental Feeding programme were ≥85% weight-for-length; similarly, 31% of low-income 2–4-year-olds had a BMI ≥ 85% (Connor *et al*. 2012). In a sample of urban children, the per cent of overweight and obese children rose dramatically from 11% at 1 year to 46% at 3 years of age (Irigoyen *et al*. 2008). Rapid infant weight gain sets the stage for subsequent obesity. A recent meta-analysis reported that each +1 standard deviation (SD) unit increase in weight between birth and 1 year of age doubled the risk of childhood obesity (Druet *et al*. 2012). An earlier systematic review linked weight gain in the first 2 years of life to subsequent obesity (Ong & Loos 2006). Potentially modifiable risk factors in the first year or two of life involve feeding patterns, dietary habits and parental feeding practices, such as bottle use (Dattilo *et al*. 2012).

Bottle use beyond the recommended weaning age of 12–15 months may be a risk factor for obesity (Bonuck *et al*. 2010; Ciampa *et al*. 2010; Gooze *et al*. 2011). Each additional month is associated with increased odds of moving to a higher weight category (i.e. <85% ≥ 85% ≥ 95% BMI) (Bonuck *et al*. 2004), while bedtime bottle use was associated with a near twofold increased risk of obesity among 3-year-olds in a US sample of nearly 2000 predominately black and Hispanic families (Kimbro *et al*. 2007). This association tracks over time. Twenty-four-month-old bottle users have a 33% risk of obesity at 5.5 years, in a study of nearly 7000 US children (Gooze *et al*. 2011). Potential mechanisms involve excess protein intake (Koletzko *et al*. 2010) from milk (Sutcliffe *et al*. 2006) and formula (Koletzko *et al*. 2009a). Infants randomised to lower protein formula had lower body weight and BMI at 2 years of age (Koletzko *et al*. 2009b). Conversely, high protein intake in 1–2-years-olds is associated with overweight at 7 years (Günther 2007).

Yet, little is known about the feeding patterns and dietary intake of children in whom bottle use may be a risk for obesity, i.e. low-income, ≥12 months old, despite its prevalence and potential magnitude. In the United States, up to 40–45% of 13–23-month-olds use bottles (Brotanek *et al*. 2005). The practice occurs across ethnic and economic groups (Hammer *et al*. 1999), but is more prevalent among US Hispanics (Nevling *et al*. 1997; Brotanek *et al*. 2005) and Southeast Asians (Graham *et al*. 1997). Regarding magnitude, bottles represent a vessel through which an infant or toddler can consume a large proportion of calories, with relative ease, e.g. by adding solids to the bottle (Hyden *et al*. 2009). Regardless of milk type – formula or breast – bottle feeding is associated with higher monthly weight gain in the first year of life (Li *et al*. 2012). Among 12-month-olds in the WIC supplemental feeding programme, their consumption of a median of 5 bottles of whole milk per day represents up to 75% of their recommended daily caloric intake (Bonuck *et al*. 2010).

In previous pages of this paper, we reported on the rationale for our Feeding Young Children Study (FYCS), a WIC-based bottle-weaning intervention targeting 12-month-olds who consume ≥2 (non-water) bottles per day (Bonuck *et al*. 2010). This paper explores the FYCS baseline sample's mealtime patterns and dietary intake, by overweight status (≥85% weight-for-length) (Bonuck *et al*. 2010). The research questions we sought to answer were: (1) 'Do the appetite and feeding characteristics of normal weight bottle-users differ from those of their overweight peers?'; (2) 'Do dietary intake patterns differ by overweight status?'; and (3) Does bottle frequency and dietary intake consumed via bottles differ by overweight status?'

Materials and methods

Study population

The FYCS, described elsewhere (Bonuck *et al*. 2010; Hyden *et al*. 2013), is a randomised control trial of a

Key messages

- Bottle use beyond recommended age is common and is a documented risk factor for obesity.
- This is the first detailed study of dietary intake and mealtime behaviours among low-income children with inappropriate bottle use at 1 year of age.
- In this sample, we identified a median intake of four bottles a day which accounted for ≈50% of total energy intake.
- About a third of the sample was overweight (>85% weight-for-length).
- Children who were overweight were indistinguishable from their healthy weight peers in terms of their dietary intake, mealtime behaviours and beverage intake.

bottle-weaning intervention. FYCS aims to decrease bottle use and potential obesity-related sequelae among children enrolled at one of three Bronx New York WIC sites. Trained bilingual English-Spanish research assistants (RAs) screened parent-child dyads in the waiting areas while they awaited their 1 year recertification visit. The primary eligibility criterion was the child's consumption of ≥2 bottles of milk or juice per day. Additional eligibility criteria included: child's presence (so anthropometric measures could be obtained); an accompanying parent/guardian who could reliably report on the child's past 24 h intake that day and availability for upcoming study visits. Exclusion criteria included: child of a non-singleton birth, very low birthweight (less than 3 lb, 4 oz), a condition that interfered with developmentally appropriate feeding or growth, or significant delay in developmental milestones.

Study protocols

Eligible, parent-child dyads were consented and randomised in a private space at the WIC clinics. The study was approved by the Institutional Review Board of Montefiore Medical Center. The study consent, screener and questionnaire were professionally translated into Spanish. After consent and randomisation, parents completed the measurement protocol described below.

Measurement

Dietary intake assessment

Research staff were trained and certified to collect 24 h dietary recall data using the Nutrition Data System-Research (NDSR) by the Nutrition Coordination Center at the University of Minnesota. NDSR is a computer-prompted system for obtaining food/beverage data. NDSR employs a multiple-pass method, that proceeds through four phases of data collection: (1) obtain a brief outline of intake during the 24 h period beginning at midnight the day before (i.e. parents being interviewed on a Thursday would detail what the child ate from midnight Wednesday to midnight Thursday); (2) review to identify gaps in time when no foods or beverages are reported, forgotten eating occasions and missed meals or beverages; (3) review to probe for detailed information such as additions to foods, specific amounts consumed, and what vessel beverages were served in; and (4) final review to confirm what has been entered. (Nutrition Coordinating Center U.o.M. 2007).

The NDSR database contains dietary composition of Hispanic and other ethnic foods; its interviewing script was translated into Spanish. Interviews were conducted with a parent or a close relative familiar with the child's diet present in the WIC site. Dietary recalls were by trained research staff in person at the WIC clinic. Each recall took approximately 20 min per person due to relatively simple diets of the subjects. One dietary recall was collected on the full sample.

The standard NDSR Food Amounts Booklet, food models, measuring cups and serving bowls, and sample cups and bottles were used to help caretakers with portion size. Data on bottle use were collected by interviewers noting in the comments section if the child used a bottle by each food or beverage item. To increase precision of liquid estimates consumed from bottles, the RAs presented parents with a range of bottles with the ounces marked on each. Dietary data were excluded if the parent report of the child's kilocalories per day was less or greater than two times the interquartile range (IQR; $n = 5$), or if baseline dietary recall was incomplete ($n = 3$).

Anthropometrics

Child length (cm) and weight (kg) were measured by trained RAs at the time of the baseline interview in the WIC clinic offices. A digital scale (SR Instruments SR241, SR Instruments, Tonawanda, NY, USA) was used to weigh the child one time while wearing a clean diaper and or underwear by trained research staff. Length was measured using an average of three measurements on a digital infantometer (Stadiometer 447 Infantronic, QuickMedical, Seattle, WA, USA), up to 1/16th of an inch with the error range of ±0.5 cm. For the children, sex and age standardised z-scores were derived from the World Health Organization (WHO) sex and age standardised growth charts (WHO Multicentre Growth Reference Study Group 2006) using the WHO macro for survey data analysis (WHO Anthro, v.3.2.2 2011, SPSS macro). We identified children whose weight-for-length was ≥ 85 as 'overweight'.

Identifying overweight or obesity in children under 2 years of age is challenging; although WHO BMI-for-age standards for this age group are available, there is no consensus regarding its usage, and it is still unclear whether infant BMI appropriately identifies under- or overnutrition (Nash *et al*. 2008; Weng *et al*. 2012; Zemel 2012). One concern is that the use of recumbent length for BMI calculation at young ages is not interchangeable with stature typically used for BMI calculations (McCormick *et al*. 2010; Flegal & Ogden 2011). In one report comparing children by their WHO BMI-for-age vs. their weight-for-length, fewer were identified as > 85% by the BMI-for-age metric, compared with weight-for-length (Nash *et al*. 2008). The use of weight-for-length percentiles is still considered the standard for evaluating weight in children under 2 years of age (Krebs *et al*. 2007), while BMI is the preferred measure in children 2 years and older (Weng *et al*. 2012).

Parent report of feeding and meal time

Child feeding and meal time behaviour data were obtained with items adapted from the Gateshead Millennium Baby Study (Wright & Parkinson 2002; Wright *et al*. 2011), a longitudinal study of child health in North East England. Items included those pertaining to the child's feeding skills (e.g. self-feeding), length and stress of mealtimes, perception of child appetite, frequency of child feeding behaviours (tantrums at mealtimes, holding food in mouth) and preferences (preferring milk or juice to solids). In prior work, these ratings of appetite in early infancy predicted weight gain at 12 months (Wright *et al*. 2006) although somewhat revised items were not predictive of weight gain at 6–8 years (Wright *et al*. 2011). Items were adapted as needed to clarify British idiomatic terms that were not readily understood. The adaptation was conducted using a two-step approach. Terms were first identified and altered based on expert review and then subject to cognitive testing in a US sample from the target population.

Covariate measurement

Demographic characteristics of all children and their parents were collected using an interviewer-administered survey including questions such as the child's age, race, gender, parents' nativity, level of education and perception of their child's weight.

Statistical analyses

The enrolled sample was 300 child/parent dyads. Children excluded from the final analytic sample reported here include: $n = 1$ deemed ineligible after randomisation, $n = 5$ with outlying values for kilocalories, $n = 3$ with incomplete baseline dietary recall and $n = 5$ missing anthropometric data.

Data were exported from NDSR into Excel 2010 (Microsoft, Microsoft Excel, Redmond, WA, USA) and StatTransfer (StataCorp, College Station, TX, USA) was used to import data into SPSS v.20, (IBM SPSS, Chicago, IL, USA). Descriptive statistics were calculated for baseline child and parent sociodemographics, feeding and meal time behaviour and child dietary intake. Linear univariate associations between weight-for-length z-scores (as a continuous variable) and total energy, bottle energy, number of bottles per day, and total ounce consumed via bottles were explored, as well as multivariate linear regression models including weight-for-length z-scores, gender and age.

We conducted sensitivity analysis using cut points of the 85%, 95% and the 98% of weight-for-length. Results of these analyses were similar therefore we decided to present only the 85% cut-off.

For comparisons between the normal and overweight/obese groups, we used chi-square for categorical variables and t-test for continuous variables, for variables not normally distributed we used Mann–Whitney U-test. The significance value was set to $P = 0.05$.

Results

Description of the sample

Just over a third (34.9%) of the sample was ≥85% weight-for-length (hereafter, 'overweight') as shown in Table 1. The mean age was 12.6 months. The majority (62%) was of Hispanic ethnicity and just under half of the mothers were born outside of the United States. It is important to note that 29% were in child care, thus potentially affecting parent recall of dietary intake. Just 14% of the parents of overweight/obese children perceived their child to be overweight.

Mealtime and feeding behaviours

There were no differences by weight status in either 'negative' or 'positive' feeding behaviours (Table 2). Overall, most (≈90%) parents reported that their child eats enough, has a good appetite and few reported mealtime stress. About half reported that their child ate solids slowly. About one in five preferred milk or juice to food. Few (≈5%) reported overt negative behaviours such as crying or screaming at mealtime or holding food in their mouths. However, other negative feeding behaviours are noted only 36% were described as preferring to self-feed. Most parents described their child as 'easy to feed' (≈80%) and as 'easily satisfied' (≈75%).

Dietary intake: macronutrients and beverages

We examined macronutrient intake, overall, and as a proportion of total energy intake, as well as beverage intake (Table 3). Mean daily energy intake, 1098.3 kcal day^{-1} (SD = 346.1) did not differ by weight status, nor did intake of fat, saturated fat, protein or carbo-

Table 1. Baseline demographic and anthropometrics of children and parent enrolled in the Feeding Young Children Study

	Total sample	Normal weight*	Overweight and obese* (>85%)	*P*-value
	n = 286	*n* = 186	*n* = 100	
Weight-for-length, percentiles (IQR)	42.2–92.2	30.7–69.2	91.4–98.7	
Weight-for-length *z*-scores, mean (SD)	0.56 (1.2)	–0.13 (0.82)	1.8 (0.62)	
Child characteristics				
Weight, kg, mean (SD)	10.1 (1.3)	9.4 (0.88)	11.4 (0.98)	<0.001
Weight-for-age *z*-scores, mean (SD)	0.55 (1.1)	–0.03 (0.81)	1.6 (0.72)	<0.001
Length, cm, mean (SD)	76.3 (3.2)	75.9 (3.3)	76.9 (3.1)	0.013
Length-for-age *z*-scores, mean (SD)	0.33 (1.2)	0.21 (1.1)	0.55 (1.3)	0.02
Gender, male, % (*n*)	48 (136/286)	46 (86/186)	50 (50/100)	0.54
Age, months, mean (SD)	12.6 (0.5)	12.6 (0.5)	12.5 (0.4)	0.37
Race/ethnicity, % (*n*)				
Non-Hispanic white/other	7 (19/286)	15 (8/186)	4 (4/100)	0.57
Non-Hispanic black	16 (47/286)	16 (29/186)	18 (18/100)	
Hispanic	62 (178/286)	62 (116/186)	62 (62/100)	
Bi- or multiracial	15 (42/286)	14 (26/186)	16 (16/100)	
Maternal/caregiver characteristics, % (*n*)				
Mother born in the United States	56 (159/286)	54 (100/186)	59 (59/100)	0.39
Education: high school or higher†	73 (204/281)	73 (133/182)	72 (71/99)	0.81
Child weight, respondent's perception‡				
Underweight	6 (16/284)	7.6 (14/185)	2 (2/99)	<0.001
Overweight	6 (16/284)	1 (2/185)	14 (14/99)	
Just the right size	89 (252/284)	91 (168/185)	84 (83/99)	
Child care§	29 (80/280)	29 (53/180)	27 (27/100)	0.60

*Classification of weight category according to the World Health Organization standards defining above 85% of weight-for-length as 'risk for overweight'. †Education: of respondent, *n* = 5 missing data. ‡Weight perception: *n* = 2 missing data. §Child care: based upon past 24 h, *n* = 6 missing data.

Table 2. Mealtime and feeding behaviours overall and by weight status

	Total sample	Normal weight*	Overweight and obese*(≥85%)	P-value
	$n = 286$†	$n = 186$	$n = 100$	
		% (n)		
Child eats enough‡	88 (252/285)	88 (162/185)	90 (90/100)	0.54
Mealtime stress§	9 (25/285)	9 (16/185)	9 (9/100)	0.21
Appetite¶	87 (249/285)	86 (160/185)	89 (89/100)	0.54
Positive feeding behaviours (usually or always)				
Easy to feed	80 (227/283)	82.5 (151/183)	76 (76/100)	0.19
Easily satisfied when eating	74 (210/283)	78 (142/183)	68 (68/100)	0.08
Prefers feeding self	36 (103/283)	36 (67/184)	36 (36/99)	0.99
Negative feeding behaviours (usually or always)				
Eats solids slowly	50 (143/284)	53 (97/184)	46 (46/100)	0.28
Cries/screams during meals	4 (12/282)	5 (9/184)	3 (3/98)	0.55**
Holds food in mouth	6 (16/283)	5 (9/184)	7 (7/99)	0.45
Drinks milk slowly	15 (43/284)	18 (33/185)	10 (10/99)	0.08
Prefers milk to food	18 (52/284)	17 (32/185)	20 (20/99)	0.55
Prefers juice to food	11 (30/284)	10 (19/185)	11 (11/99)	0.83

*Classification of weight category according to the World Health Organization standards defining above 85% of weight-for-length as 'risk for overweight'. †Some individual variability due to missing data. ‡% Yes, categories were: yes/not always/no. §Stressful or very stressful. ¶Good to excellent. **Fisher's exact test.

hydrates. Likewise, distribution of calories from fat (32.9%), carbohydrates (53.4%) and protein (14.4%) did not differ by weight status. The total sample consumed a mean of 2.0 cups of whole milk per day (SD = 1.8). Whole milk consumption was lower in overweight (mean = 1.7, SD = 1.8) vs. normal weight (mean = 2.1, SD = 1.8) children, but this difference was not statistically significant ($P = 0.12$). The sample consumed an average of one-half cup of non-citrus fruit juice per day and negligible amounts of citrus juice or sugar sweetened beverages.

We studied the univariate linear associations between weight-for-length z-scores, energy intake and bottle use measures and found no statistically significant correlations. In multivariate linear regression model, we found only gender and age (in month) were associated with energy intake [gender: β coefficient = –0.14, 95% confidence interval (CI): –176.4 to –17.5, P-value = 0.017, age: β coefficient = 0.14, 95% CI: 18.4–189.7, P-value = 0.017].

Bottle use frequency and contents

As shown in Table 4, the sample consumed a median of 4 bottles per day (IQR = 3–6), which contained on average 7 ounces/bottle. Children consumed an average of 522 calories via bottles per day, which constituted ≈50% of their daily energy intake. Dietary intake via bottles accounted for 53% of total protein calories, 41% of carbohydrate calories and 61% of fat calories. Dairy intake protein, via bottles, did not differ by overweight status.

Discussion

Prolonged bottle use is a documented risk for obesity. This is the first detailed study of dietary intake and mealtime behaviours among low-income children with this risk factor, at 1 year of age. Overall, ≈ 35% of children were overweight (≥85% weight-for-length), comparable to national WIC data. The sample's median consumption of 4 bottles per day accounted for 50% of their total calories; each bottle averaged 7 ounces and contained 120 calories. Yet, in contrast to what we had anticipated, there were no differences in mealtime/feeding behaviours, dietary intake or bottle use intake by overweight status. Of note, neither total nor dairy protein intake differed by weight status, even though excess protein intake in the first year of life is a risk for later obesity.

Table 3. Dietary intake overall and by weight status

	Total sample		Normal weight*		Overweight or Obese* (≥85%)		*P*-value
	n = 286		*n* = 186		*n* = 100		
	Mean	SD	Mean	SD	Mean	SD	
Macronutrients							
Energy (kcal day^{-1})	1098.3	346.1	1105.2	344.6	1085.5	350.2	0.65
Energy (kjoul day^{-1})	4595.4	1448	4624.2	1441.8	4541.9	1465.4	0.65
Fat (g day^{-1})	40.3	15.4	40.1	15.5	40.6	15.2	0.78
Saturated fat (g day^{-1})	17.8	6.9	17.8	7.1	17.8	6.5	0.92
Carbohydrate (g day^{-1})	146.7	52.6	148.1	53.04	144.1	52.1	0.53
Protein (g day^{-1})	39.3	14.8	40	14.8	38.1	14.6	0.29
Dietary fibre (g day^{-1})	7.7	4.8	7.6	4.9	7.9	4.7	0.69
As % of total energy							
Fat (%)	32.9	6.8	32.6	7.1	33.5	6.2	0.28
Saturated fat (%)	14.7	3.9	14.7	4.1	14.9	3.6	0.64
Carbohydrate (%)	53.4	7.9	53.6	8.4	53	7	0.56
Protein (%)	14.4	3.6	14.6	3.5	14.2	3.9	0.48
Other nutrients							
Vitamin C (mg day^{-1})	73	61.2	71.1	62.5	76.4	58.8	0.49
Vitamin D (mcg day^{-1})	10.6	7.1	10.8	8.3	10.2	3.9	0.55
Calcium (mg day^{-1})	1038.6	391.1	1058.6	398.3	1001.5	376.4	0.24
Iron (mg day^{-1})	13	12.2	13.4	13.2	12.2	10	0.41
Beverages†							
All milk (cup‡) (combined types)	2.3	1.7	2.4	1.7	2.1	1.7	0.39
Whole, all types	2	1.8	2.1	1.8	1.7	1.8	0.12
Low fat, all types	0.29	0.94	0.23	0.8	0.4	1.1	0.28
Non-diary, all types	0.025	0.29	0.038	0.36	0	0	0.20
Fruit juice (1/2 cup‡)	1	1.2	1	1.3	1	1.2	0.97
Non-citrus juice	0.97	1.2	0.95	1.3	1	1.2	0.59
Citrus juice	0.04	0.23	0.06	0.27	0.01	0.07	0.09
Sugar sweetened (cup‡)	0.12	0.32	0.10	0.3	0.14	0.3	0.43
Infant formula (5 oz§)	1.7	2.9	1.5	2.9	2	2.9	0.17

*Classification of weight category according to the World Health Organization standards defining above 85% of weight-for-length as 'risk for overweight'. †*P*-values by Mann–Whitney *U*-test. ‡1 cup = 8 fluid ounce ≈ 237 mL. §5 fluid ounce ≈ 148 mL.

The lack of significant difference in dietary intake by weight status aligns with the literature finding inconsistent associations between intake and BMI (Newby 2007). The most recent data, from perhaps the largest study to date – 13 000 US children – suggests that age is an important effect modifier of this association. In that study, beyond 6–10 years of age, children who were >85% BMI actually reported lower daily caloric intake than their healthy weight peers (Skinner *et al*. 2012). All such data are, of course, vulnerable to potential bias. For example, the magnitude of under-reporting has been shown to increase with weight status (Savage *et al*. 2008). Weaker methods of dietary intake assessment introduce additional bias; e.g. 24 h food records maintained by children, yielded a ≈ 50% rate of implausible values (Elliott *et al*. 2011).

Parents of overweight/obese children in our study may have under-reported their caloric intake, as found by others (Carnell *et al*. 2005). This is not likely, as few parents of overweight children perceived their child to be overweight. Thus, motivations of parents of overweight children to under-report intake, is likely reduced. The lack of accurate perception of weight status also mitigates against reverse causality, by which parents of children who are overweight would restrict their intake. Finally, we note that our methodology was designed to mitigate against reporting

Table 4. Bottle use frequency and contents for total sample and by weight status

	Total sample		Normal weight*		Overweight and obese* (≥85%)		*P*-value
	$n = 286$		$n = 186$		$n = 100$		
	Mean	SD	Mean	SD	Mean	SD	
Bottle use							
Bottles per day (IQR)	4.5 (3–6)	1.7	4.5 (3–6)	1.8	4.4 (3–5)	1.5	0.83
Total ounce	30.5	11.8	30.2	12.4	31.2	10.7	0.46
Total gram	865.8	335.1	855	351.4	885.8	303.3	0.46
Energy/bottle (kcal)	120	35	118.4	34.3	122.9	36.2	0.30
Energy/bottle (kjoul)	502	146.5	495.4	143.7	514.3	151.4	0.30
Ounce per bottle	7	1.6	6.8	1.6	7.1	1.5	0.12
Gram per bottle	197.3	45.5	194.2	46	202.9	44.2	0.12
Total energy via bottle (kcal)	522.4	216.1	517.8	222.8	530.9	203.8	0.63
Total energy via bottle (kjoul)	2185.7	904.2	2166.7	932.3	2221.1	852.8	0.63
Bottle contents (Bottle nutrients as % of energy from:)							
Total energy	49.3	17.7	48.6	18.1	50.7	16.8	0.32
Total fat	60.8	21.1	59.7	21.6	62.8	19.9	0.25
Total saturated fat	69.5	20.2	68.3	21.2	71.7	18	0.17
Total protein	52.6	20.1	51.8	20.9	53.9	18.6	0.42
Dairy protein†	92.9	19.3	92	21.2	94.5	15.3	0.92
Vegetable protein†	6.7	18.5	7.4	20	5.5	15.3	0.96
Total carbohydrate	41.1	18.2	40.5	18.8	42.1	17.2	0.47

*Classification of weight category according to the World Health Organization standards defining above 85% of weight-for-length as 'risk for overweight'. †Percent of total bottle protein, *P*-value by Mann–Whitney *U*-test.

biases. We employed a gold standard multiple-pass dietary recall method. To increase accuracy, we provided food and serving models.

Our findings that overweight status was not associated with energy or macronutrient intake aligns with the 'settling point' theory. That is, after a period of increasing weight due to a positive energy balance, the overweight children may have reached a 'settling point' or 'steady state' (Moreno & Rodriguez 2007). Alternatively, overweight children in our sample may have been less active. Data from older children finds that healthy weight children are more active than their overweight peers (Chung *et al*. 2012). Our study did not assess the child's energy expenditure, the assessment of which, in young children, is fraught with difficulty. Although validation data for a tool to assess activity in pre-school children aged 2–6 years was recently reported (Bayer *et al*. 2012), we know of no validated measures for younger children.

Of course, it is possible that our study lacked sufficient power to detect a significant difference in dietary intake by overweight status. The true difference between the two groups might be as small as 100 Kcal – which is <1/3 of an SD. To have 80% power to detect that would require 150 in each group, whereas our overweight sample was $n = 100$ and our normal weight sample was $n = 186$.

Comparative data on dietary intake for children at 12–13 months of age, such as those in our sample, are sparse. National Health and Nutrition Examination Survey 1999–2004 data found a higher mean daily intake than our sample – 1400 kcal day^{-1}, but nearly identical proportions of calories from fat, carbohydrates and protein (United States Department of Agriculture F.a.N.S., Special Supplemental Feeding Program for Women, Infants and Children (WIC) 2008). Our samples' total energy intake of 1098 kcal day^{-1} exceeds the American Heart Association's recommended 900 kcal day^{-1} for 1-year-olds (Gidding *et al*. 2005). It also exceeds the Institute of Medicine's recommended kcal day^{-1} of 770 and 844 for girls and boys, respectively, 12 months of age, based upon children with comparable lengths and weights to our sample. Macronutrient intake in our sample exceeds recommendations for 7–12–month-olds for: carbohydrates (147 g vs. 95 g), protein (39 g vs. 11 g) and total fat (40 g vs. 30 g) (United States Department of Agriculture F.a.N.S., Special Supplemental Feeding Program for Women, Infants and Children (WIC) 2009).

There are several limitations to our study. The dietary recalls were conducted in person by trained research staff, which is a strength. However, only one dietary recall was conducted on the whole sample at baseline. Second, as noted above, there are always risks of potential biases in report of intake. Third, while our incorporation of bottle use in an automated multiple-pass system is novel, the methodology has not been validated. To our knowledge, this is the first study of dietary intake in children to incorporate bottle use as part of an automated, multiple-pass assessment of dietary intake.

In summary, we reported on the mealtime/feeding behaviours, dietary intake and bottle-use patterns of 12–13-month-old children at heightened risk of obesity. In contrast to what we had anticipated, children who were overweight did not differ from their normal-weight peers on any observed measures. Thus, feeding and dietary intake patterns prior to a child's first birthday appear to set the stage for being overweight at the 1-year mark in this group. Our results have implications for preventive practices parents can take to reduce their child's risk of overweight in the first year of life including maternal pre-pregnancy overweight and breastfeeding (Weng *et al*. 2012).

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Conflicts of interest

The authors declare that they have no conflicts of interest.

Contributions

KB, RK and CH designed the research; SBA prepared and analysed the data; MH analysed the data and prepared the first draft of the paper. All authors assisted with interpretation of the analysis. All authors read and approved the final manuscript.

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