Breast Milk Composition, Milk Intake, and Their Relationship to Infant Weight Gain

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Introduction

- Rapid weight gain in infancy is associated with a higher risk of obesity later in childhood (1,2).
- Protein content in human milk is positively related to 12 month BMI in infants (3).
- Fat content in human milk is inversely related to weight, BMI and adiposity gains in infants (3).
- Less is known about the influence of carbohydrate content on infant weight gain. However, one study found a positive relationship between carbohydrate content and weight, BMI and adiposity gains in infants (3).
- There are mixed findings on the impact of maternal factors on breast milk composition. Pre-pregnancy BMI has been shown to influence composition (4).
- Few studies have analyzed both human milk macronutrient composition and infant milk intake.

Objective

To investigate how the total intake of breast milk and its macronutrients influences weight gain over the first year of life. Additionally, we sought to examine whether any maternal factors impacted breast milk macronutrient composition.

Methods

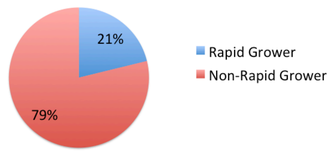
- Data from healthy mother-infant pairs (n = 118) enrolled in the STRONG Kids 2 cohort at the University of Illinois at Urbana-Champaign
- At 6 weeks postpartum, mothers collected 30 ml of breast milk using an electric breast pump. Mothers recorded the date, time, and infant's weight before and after each feeding for a period of 24 hours.
- Maternal breast milk was analyzed for protein, carbohydrate, and fat content. Analysis was performed using a Bradford Assay, an Orcinol Assay, and a total lipid extraction, respectively.
- Infant length and weight and maternal height and weight were collected by the STRONG Kids 2 research team at 6 week, 3 month, and 12 month in-home visits.
- Other height, weight, and length measurements and demographic data of mothers and infants were drawn from the STRONG Kids 2 questionnaires completed by mothers.
- Weight-for-Length Z-score (WFLZ) was calculated using the 2006 WHO growth charts and weight categories were applied (5).
- Data were analyzed using SAS Software. Associations were examined using Pearson Correlation and Linear Regression.

Results

Table 1. Infant Characteristics (n = 118)

Variables		
Gender		
Male	53	44.92%
Female	65	55.08%
Weight-for-Length Z-Score		
Birth	−0.55 ± 1.41	
6 weeks	−0.42 ± 1.16	
12 months	0.68 ± 0.97	
Feeding Method at 6 weeks		
Breastfeeding	93	78.81%
Formula-feeding	8	6.78%
Both	16	13.56%
Ethnicity		
Hispanic/Latino	5	4.24%
Non-Hispanic/Latino White	87	73.73%
Non-Hispanic/Latino Non-White	11	9.32%

Figure 1. Growth Pattern From Birth to 12 months



Infants were classified into 2 groups according to change in weight-for-age Z-score from birth to month 12. Rapid growth was defined as a change > 0.67 Z-scores

Table 2. Mother Characteristics (n = 118)

Variables		
Age (years)	30.45 ± 4.87	
Pre-pregnancy BMI (kg/m^2)	27.47 ± 7.17	
BMI category		
Pre-pregnancy		
Underweight/Normal	45	38.14%
Overweight	31	26.27%
Obese	35	29.66%
6 weeks		
Underweight/Normal	36	30.51%
Overweight	40	33.90%
Obese	42	35.59%
12 months		
Underweight/Normal	41	34.75%
Overweight	28	23.73%
Obese	38	32.20%

Figure 2. Cohort Weight-for-Length Z-Score Categories by Age

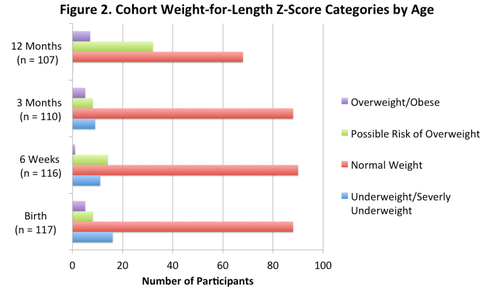


Table 3. Infant Milk Intake

Total Milk Intake (ml)	754.4 ± 205.0
Total Milk Intake (ml/kg)	151.1 ± 39.1
Average Intake per Feeding (ml)	86.7 ± 27.1

Table 4. Breast Milk Macronutrient Composition (mg/ml)

Protein	10.3 ± 2.6
Carbohydrate (lactose)	78.5 ± 7.2
Fat	41.2 ± 14.1

Table 5. Correlation Between Macronutrient Intake and Infant Weight-for-Length Z-score at Various Time Points (*p-value*)

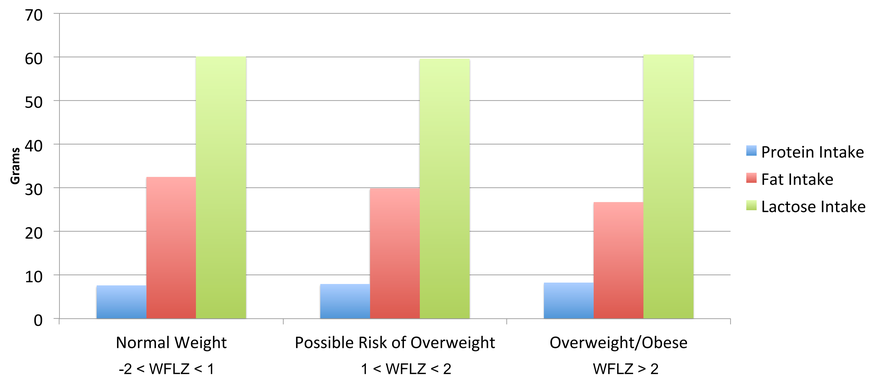
Intake (mg/day)	6 Weeks	3 Months	12 Months
Protein	0.23	0.51	0.14
Fat	0.86	0.25	0.30
Lactose	0.27	0.43	0.18

Table 6. Mother's BMI at Months 3 and 12 Was Positively Associated With Lactose Concentration (mg/ml)

Time Postpartum	p-value
3 month	0.04
12 month	0.02

* Outcomes were confirmed using linear regression after controlling for maternal income, employment, WIC, and education.

Figure 3. Mean Macronutrient Intake Did Not Differ Across Weight-for-Length Z-scores category at 12 Months



Additional Results

- Breast milk macronutrient composition fell within normal ranges.
- No significant differences were noted in the mean milk intake values based on growth patterns from birth to 12 months.

Conclusions

- No significant differences were noted between mean macronutrient intake or macronutrient concentration values across weight-for-length z-score categories or individual weight-for-length z-scores at 6 weeks, 3 months, or 12 months.
- Findings may be due, in part, to the low number of infants in our sample who experienced rapid weight gain during infancy.
- Additionally, results may indicate that factors other than breast milk composition play a role in growth patterns and rapid weight gain during infancy.
- Further research will include breast milk macronutrient composition in relation to infant growth trajectories in the larger SKP2 sample, which will include a greater number of formula-fed infants.
- Analysis of rapid weight gain in terms of other feeding factors, such as breastfeeding duration and introduction of solids may also provide relevant findings.

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