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Breast-feeding and Overweight in Adolescence: Within-family analysis

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Abstract

Background—Previous reports have found associations between having been breast-fed and a reduced risk of being overweight. These associations may be confounded by sociocultural determinants of both breast-feeding and obesity. We addressed this possibility by assessing the association of breast-feeding duration with adolescent obesity within sibling sets.

Methods—We surveyed 5614 siblings age 9 to 14 years and their mothers. These children were a subset of participants in the Growing Up Today Study, in which we had previously reported an inverse association of breast-feeding duration with overweight. We compared the prevalence of overweight (body mass index exceeding the age-sex-specific 85th percentile) in siblings who were breast-fed longer than the mean duration of their sibship with those who were breast-fed for a shorter period. Then we compared odds ratios from this within-family analysis with odds ratios from an overall (ie, not within-family) analysis.

Results—Mean $\pm$ standard deviation breast-feeding duration was 6.4 ± 4.0 months, and crude prevalence of overweight was 19%. On average, siblings who were breast-fed longer than their family mean had breast-feeding duration 3.7 months longer than their shorter-duration siblings. The adjusted odds ratio (OR) for overweight among siblings with longer breast-feeding duration, compared with shorter duration, was 0.92 (95% confidence interval = 0.76–1.11). In overall analyses, the adjusted OR was 0.94 (0.88–1.00) for each 3.7-month increment in breast-feeding duration.

Conclusion—The estimated OR for the within-family analysis was close to the overall estimate, suggesting that the apparent protective effect of breast-feeding on later obesity was not highly confounded by unmeasured sociocultural factors. A larger study of siblings, however, would be needed to confirm this conclusion.

Breast-feeding promotion might be an effective way to blunt the worldwide epidemic of obesity.¹ Two recent metaanalyses show that having been breast-fed is associated with

approximately a 15% to 20% decrease in the risk of later obesity.^{2,3} Many,^{4–8} but not all,^{9–11} studies also show that increased duration of breast-feeding is associated with lower risk of obesity. The possibility remains, however, that these observed associations could be explained by sociocultural factors underlying both the decision to breast-feed and risk of obesity.

Within-family analysis is one way of controlling for such confounding. Because siblings grow up in similar social, economic, and cultural environments, studies of siblings minimize the variation in several of the noncausal factors that could explain why breast-feeding appears related to lower risk of obesity.

The purpose of this study was to estimate the odds of overweight status among siblings who had been breast-fed for longer versus shorter duration in infancy and then to compare these results with results from an overall (not within-family) analysis of breast-feeding duration in the same study population.

METHODS

We drew the study sample from the Growing Up Today Study, an ongoing cohort study of 16,539 U.S. girls and boys age 9 to 14 years at baseline in 1996, from which we previously reported an inverse association of breast-feeding duration with overweight status.⁵ We obtained ethical approval from the Institutional Review Boards of Harvard School of Public Health, Brigham and Women's Hospital, and Children's Hospital Boston.

For this analysis, we excluded 156 participants whose mothers reported a gestation of less than 34 completed weeks, 168 with medical conditions interfering with growth, 800 with missing breast-feeding information, and 901 with incomplete covariate information. We also excluded 433 participants with missing or outlying values for height (>3 standard deviations [SD] beyond the age–sex-specific mean height) or body mass index (BMI) (<12.0 kg/m² or >3 SD beyond the age–sex-specific mean log BMI). Of the remaining 14,081 participants, 5868 had a sibling in the study. To ensure that no participating family contained twins, we excluded twins from families with 2 participants and a random twin from any family with at least 3 participants ($n = 85$). After further exclusion for different father (based on maternal report of biologic father's height, $n = 169$), 5614 participants remained for analysis.

As previously described,⁵ participants' mothers, who are registered nurses, reported in 1997 each child's breast-feeding duration in the categories 0, less than 1 month, 1 to 3 months, 4 to 6 months, 7 to 9 months, and greater than 9 months. We converted each of these categories to the values 0, 0.5, 2, 5, 8, and 11 months, respectively, for analysis. Mothers also reported length of gestation in categories and birth weight. On the baseline questionnaire in 1996, the children reported their own heights and weights, dietary intake,¹² physical activity and inactivity,¹³ Tanner pubic hair sexual maturity rating, and (for girls) menarcheal status.

The main outcome variable was overweight, defined as BMI (kg/m²) exceeding the 85th percentile for age and sex.¹⁴ In the within-family analysis, the main exposure variable was whether a participant was breast-fed for longer or shorter than the mean breast-feeding duration of his or her participating sibship. The 3242 participants who were breast-fed for the same duration as their siblings did not contribute useful information. Therefore, we based the within-family analyses on the remaining 2372 with discordant breast-feeding status. Our base logistic regression model included age, sex, Tanner stage, and (for girls) menarcheal status. In subsequent models, we added birth weight and birth order (first vs later birth), then physical activity/inactivity, and finally energy intake, which could be in the causal pathway between breast-feeding and obesity rather than a confounder.

We then compared results from this within-family analysis with an overall analysis of the 5614 subjects, in which the exposure was duration of any breast-feeding as a continuous variable. We adjusted for the same covariates, plus additional ones that were the same within but not between families: mean neighborhood household income (U.S. Census data), maternal smoking, and maternal BMI. For both sets of analyses, using generalized estimating equations, we also adjusted for clustering among siblings. In a secondary analysis, we computed the odds ratios (ORs) and 95% confidence intervals (CIs) for participants who had been breast-fed at least 7 months compared with those breast-fed for 3 months or less.

RESULTS

The 5614 participants came from 2709 families: 2521 families had 2 siblings, 181 families had 3 siblings, 6 families had 4, and one had 5. Overall, mean $\pm$ SD age was 12.0 ± 1.6 years, and 95% of participants were white. Overall mean $\pm$ SD breast-feeding duration was 6.4 ± 4.0 months, and among the 2372 siblings who differed in breast-feeding duration, the mean difference was approximately 3.7 months. In only 137 families with discordant breast-feeding duration was at least one sibling not breast-fed at all. Among the 3242 participants from 1580 families with concordant breast-feeding duration, only 369 participants (from 181 families) were never breast-fed.

Among the 5614 total participants, 5095 (91%) initiated breast-feeding; 2834 participants (50%) were breast-fed for at least 7 months, and 1552 (28%) for 3 months or less. At 6 months of age, 1829 (33%) were exclusively breast-feeding. Crude prevalence of overweight at age 9 to 14 years was 19%.

The adjusted ORs for the association of breast-feeding duration with adolescent overweight were similar in the within-family and overall analyses—approximately a 6% to 8% decrease in the odds of overweight for a 3.7-month increment in breast-feeding duration (Table). Although the within-family estimates did not change much after addition of a number of covariates, the overall estimates were attenuated by adjustment for factors that can vary between families.

To provide a categorical approach to the overall analysis, we also compared the odds of overweight among the 2834 participants who had been breast-fed for at least 7 months with the 1552 who were breast-fed for 3 months or less. The fully adjusted OR was 0.85 (95% CI = 0.71–1.00). An analogous within-family analysis (restricted for simplicity to 2 siblings per family) was limited to the 172 families in which one sibling was breast-fed for at least 7 months and the other for 3 months or less. The resulting odds ratio was 0.89, similar to the other within-family and overall results. With the smaller sample, however, the 95% CI was substantially wider (0.50–1.59).

DISCUSSION

After adjustment for a wide set of potential confounders, including maternal BMI in the overall analysis, the odds ratios from the overall and within-family analyses were similar to each other. This similarity suggests that the adjusted breast-feeding–overweight association from the overall analysis was not highly confounded by unmeasured sociocultural factors. However, because siblings are more likely than unrelated individuals to have been breast-fed for similar durations, the effective sample size for the within-family analysis was less than half of that for the overall analyses. Thus, within-family estimates were less precise.

Although within-family analyses minimize many aspects of confounding, they cannot control for reasons that a mother would breast-feed one sibling longer than another, some of which might also be related to obesity risk. However, adjustment for birth weight and birth order,

which some studies have correlated with breast-feeding behavior,¹⁵ did not materially change our estimates.

To make the within-family and overall analyses comparable, we chose a 3.7-month increment as the unit for the odds ratios in the overall analyses, in which we used a continuous exposure variable. This increment was equivalent to the average difference between siblings with longer and shorter breast-feeding duration than the family mean. Because of the discrete nature of the reported data, we were able to use breast-feeding duration only as a categorical variable in the within-family analysis. In a second evaluation, we used breast-feeding duration as a categorical variable in the overall analyses, and we obtained similar results.

Nelson et al¹⁶ have also used a within-family approach to address the potential link between breast-feeding and obesity among adolescents. Although they did not find an inverse association, their sample was limited to 112 sibling pairs with discordant breast-feeding status. In contrast, our within-family analyses used information from 2372 participants discordant for breast-feeding duration.

A limitation of this study is that height and weight were self-reported, but recent work suggests minimal misclassification of overweight status by adolescent self-report.¹⁷ Because this study population had relatively high breast-feeding rates and was largely racially homogeneous, generalizability may be limited.

This study supports the hypothesis that breast-feeding protects against later obesity. Future studies could benefit from larger numbers of siblings, careful measurement of a wider range of potential confounders, and prospective ascertainment of breast-feeding duration. Further follow up of a randomized trial of breast-feeding promotion¹⁸ would also be useful.

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TABLE 1

Within-Family and Overall Associations of Breast-Feeding Duration With Overweight Status at the Age of 9 to 14 Years*

Model Covariates	Within-Family OR [†] (95% CI)	Overall OR [‡] (95% CI)
1. Age, sex, Tanner stage, and (for girls) menarcheal status	0.94 (0.78–1.14)	0.87 (0.82–0.93)
2. Model 1 + birthweight and birth order	0.93 (0.77–1.12)	0.87 (0.81–0.93)
3. Model 2 + inactivity and physical activity	0.92 (0.76–1.11)	0.88 (0.83–0.94)
4. Model 3 + energy intake	0.92 (0.76–1.11)	0.88 (0.82–0.94)
5. Model 4 + maternal body mass index and smoking, and household income	Not applicable	0.94 (0.88–1.00)

* Multiple logistic regression analysis of 5614 siblings participating in the Growing Up Today Study.

[†] Odds ratio of overweight for comparison of siblings breast-fed longer than the family mean vs siblings breast-fed shorter than the family mean. The average difference between “longer” and “shorter” siblings was 3.7 mo.

[‡] Odds ratio of overweight for a 3.7-mo increment in breast-feeding duration.