



The Relation between Breast Milk Sodium to Potassium Ratio and Maternal Report of a Milk Supply Concern

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We report that, among exclusively breastfeeding mothers at day 7 postpartum, those with milk supply concerns were significantly more likely to exhibit biochemical evidence of less progress toward mature lactation (elevated ratio of breast milk sodium to potassium concentration). Furthermore, an elevated ratio of breast milk sodium to potassium concentration was predictive of early weaning. (*J Pediatr* 2017;181:294-7).

Low milk supply is one of the most frequently cited reasons for early breastfeeding cessation.¹ A previous analysis of the Early Lactation Success (ELS) cohort revealed that 27% of breastfeeding primiparas reported a low milk supply concern at 7 days postpartum, and this concern was associated significantly with stopping breastfeeding earlier than intended.² The extent to which a milk supply concern in the early postpartum is based on maternal misperception of normal lactation versus a valid perception of suboptimal mammary gland function is unknown.

The ratio of breast milk sodium to potassium concentrations (breast milk Na:K) dramatically declines in parallel with whole-transcriptome changes in mammary gene expression as lactation progresses through colostrum, transitional, and mature milk production stages³; thus, decreasing breast milk Na:K is an objective biomarker of mammary gland progress toward copious mature milk production over the first week postpartum.⁴

In this extension of a previous analysis,² our primary objective was to determine if elevated breast milk Na:K at day 7, as an objective biomarker of lack of progress toward mature milk production, is significantly more prevalent in mothers reporting a milk supply concern, even in the context of current exclusive breastfeeding. Our secondary objective is to determine whether elevated breast milk Na:K at day 7, in the context of exclusive breastfeeding, is predictive independently of stopping breastfeeding before day 60.

Methods

The ELS cohort was recruited from the University of California Davis Medical Center, Sacramento, California, as described in previous reports.^{2,5-7} Briefly, the ELS study enrolled expectant first-time mothers who were receiving prenatal care at University of California Davis Medical Center, spoke either English or Spanish, and lived within a predefined catchment area. Women with a known breastfeeding contraindication, with

multiple gestation, or who were <19 years old and unable to obtain parental consent were excluded from enrollment; in addition, mothers who delivered at <37 weeks' gestation, were separated from their infant in the immediate postpartum for >24 hours, or who did not initiate breastfeeding were excluded from postnatal interviews.² The University of California Davis Institutional Review Board approved the ELS study. Cincinnati Children's Institutional Review Board approved the continued analysis.

Data collection details have been described previously.^{2,5-7} Briefly, during a prenatal clinic visit, mothers were interviewed regarding sociodemographic variables and infant feeding attitudes and intentions.^{8,9} At day 7, participants were asked, "Please describe any problems or concerns you have had since our last interview or are currently having about feeding your infant, including breastfeeding problems, concerns or discomforts." The main category of "milk supply concern" is composed of the following subcategories of maternally reported concerns: (1) inadequate maternal production or milk supply, (2) infant not getting enough milk or unsure if getting enough milk, (3) infant shows signs of hunger, and (4) milk not in.²

Participants used an electric breast pump or hand expression to provide a 5 mL spot sample of breast milk from a single breast at day 7. Thawed milk samples were centrifuged at 15 000g for 10 minutes. Sodium and potassium concentrations were assayed in the aqueous fraction using flame photometry (Cole-Parmer Dual-Channel Flame Photometer, Vernon Hills, Illinois). Within each sample, mean breast milk Na:K was calculated from duplicate runs (mean of [sodium₁/potassium₁], [sodium₂/potassium₂]). Expressing sodium as a ratio to potassium adjusts for slight variations in the lipid-free purity of the aqueous fraction.¹⁰

ELS	Early Lactation Success
breast milk Na:K	Ratio of breast milk sodium to potassium concentrations
Na	Sodium

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Infant feeding status was determined at each follow-up interview, including at day 60 postpartum. Exclusive breastfeeding was defined as infant receiving only feedings at mother's breast and/or feedings of mother's expressed breast milk during the 24 hours preceding the interview. Stopped breastfeeding was defined as no breastfeeding or expressed breast milk feeding in the preceding 24 hours.²

Data Analyses

Formula use, by disrupting regular breast emptying, may inhibit milk production.⁷ The temporal relationship between early formula use and elevated breast milk Na:K could not be determined and, thus, examination of our objectives was restricted to the subset of mothers who were exclusively breastfeeding in the 24 hours before the day 7 interview. Furthermore, mastitis causes increased breast permeability, leading to elevated breast milk Na:K¹¹; therefore, mothers who reported a mastitis diagnosis at day 7 were also excluded. Thus, the analytic subset comprised those women who were exclusively breastfeeding at day 7 and without mastitis. We defined elevated breast milk Na:K as >75th percentile among the analytic subset. This cutoff was selected because breast milk Na:K, as a marker of progress toward mature milk production, likely exists along a continuum and this a priori definition is an unbiased approach to testing our hypotheses.

In general, we categorized study variables as described previously.⁵ Because only a small number of women who were exclusively breastfeeding at day 7 had weak feeding intentions, we collapsed feeding intention into 2 categories representing those without, versus with, a strong intention to exclusively breastfeed for ≥ 3 months.

Within the analytic subset, we examined whether elevated breast milk Na:K status was predicted by maternal report of a milk supply concern at day 7 (primary objective) and if stopping breastfeeding before day 60 postpartum was predicted by elevated day 7 breast milk Na:K (secondary objective) using logistic regression analysis. For each model, we first examined the unadjusted odds ratio, then adjusted for sociodemographic variables associated ($P < .10$) with the dependent variable. From these models, we report the OR and 95% CI. Analyses were performed with SAS 9.3 or SAS JMP 12 (SAS Institute, Cary, North Carolina).

Results

The flow diagram leading to the analytic subset of 196 participants included in the present analysis is shown in the [Figure](#) (available at www.jpeds.com). The characteristics of mothers who were interviewed on day 7, stratified by the inclusion criteria for the analytic subset, are compared in [Table I](#) (available at www.jpeds.com). Among the 196 in the analytic subset, median breast milk Na:K (quartile range) was 0.62 (0.48-0.80), and median timing of the day 7 sample collection (quartile range) was 7.4 (7.2-7.8) days postpartum. Breast milk Na:K was not correlated with timing of the day 7 sample collection and thus we did not adjust for it in subsequent analyses.

Table II. Logistic regression model predicting the odds of elevated breast milk Na:K according to presence of a milk supply concern among mothers exclusively breastfeeding on day 7*

Milk supply concern at day 7 [†]		Number (%) with elevated breast milk Na:K	Elevated breast milk Na:K, OR [95% CI]	
Category	Number		Model 1 [‡]	Model 2 [§]
No	160	33 (21)	1.0 (reference)	1.0 (reference)
Yes	36	15 (42)	2.7 [1.3-5.9]	3.4 [1.5-7.9]

*Defined as maternal report of exclusive breastfeeding during the 24 hours before the day 7 interview.

[†]Defined as breast milk Na:K > 75th percentile (>0.80) on day 7 for the analytic subset.

[‡] $P = .01$.

[§] $P = .003$, adjusted for ethnic group.

Day 7 Milk Supply Concern as a Predictor of Elevated Day 7 Breast milk Na:K

In the analytic subset, neither infant feeding intention nor previous breastfeeding exclusivity was associated with elevated breast milk Na:K. However, elevated day 7 breast milk Na:K occurred in 42% of mothers with a day 7 milk supply concern, compared with 21% of mothers without a day 7 milk supply concern (unadjusted relative risk, 2.0; $P = .008$) ([Table II](#)). The unadjusted odds of elevated Na:K were 2.7 greater (95% CI, 1.3-5.9) with maternal report of milk supply concern (reference = no concern, $P = .01$) and further increased after adjustment for maternal ethnicity (3.4; 95% CI, 1.5-7.9; $P = .003$) ([Table II](#)).

Risk of Stopping Breastfeeding by Day 60 Postpartum According to Day 7 Breast milk Na:K Status

Of the 192 mothers in the analytic subset for objective 2, 18 (9%) had stopped breastfeeding by day 60 postpartum. Sociodemographic variables significantly associated with stopping breastfeeding were younger maternal age ($P < .001$), public health insurance ($P = .026$), and weaker infant feeding intentions ($P = .048$).

In a χ^2 analysis of the 192 in this analytic subset, 8 of 46 (17%) with elevated day 7 breast milk Na:K, as compared with 10 of 146 (7%) without elevated day 7 breast milk Na:K, stopped breastfeeding by day 60 postpartum (unadjusted relative risk, 2.5; $P = .03$) ([Table III](#)). The unadjusted odds of stopping breastfeeding by day 60 postpartum were 2.9 (95% CI, 1.1-7.8) with elevated day 7 breast milk Na:K (reference = normal breast milk Na:K; $P = .04$) and further increased after full adjustment for significant sociodemographic variables (3.3; 95% CI, 1.1-9.7; $P = .03$) ([Table III](#)).

Discussion

If concerns about milk supply among exclusively breastfeeding women were primarily owing to a lack of knowledge about the signs of abundant milk production, then the expected outcome would be no difference in breast milk Na:K as compared with

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