

Maternal Time Use and Nurturing: Analysis of the Association Between Breastfeeding Practice and Time Spent Interacting with Baby

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Abstract

Background: Breastfeeding supports child development through complex mechanisms that are not well understood. Numerous studies have compared how well breastfeeding and nonbreastfeeding mothers interact with their child, but few examine how much interaction occurs.

Subjects and Methods: Our study of weekly time use among 156 mothers of infants aged 3–9 months investigated whether lactating mothers spend more time providing emotional support or cognitive stimulation of their infants than nonbreastfeeding mothers, and whether the amount of such interactive time is associated with breastfeeding intensity. Mothers were recruited via mother’s and baby groups, infant health clinics, and childcare services, and used an electronic device to record their 24-hour time use for 7 days. Sociodemographic and feeding status data were collected by questionnaire. Statistical analysis using linear mixed modeling and residual maximum likelihood analysis compared maternal time use for those giving “some breastfeeding” and those “not breastfeeding.” Analysis was also conducted for more detailed feeding subgroups.

Results: Breastfeeding and nonbreastfeeding mothers had broadly similar socioeconomic and demographic characteristics. Breastfeeding was found to be associated with more mother–child interaction time, a difference only partially explained by weekly maternal employment hours or other interactive care activities such as play or reading.

Conclusion: This study presents data suggesting that lactating mothers spent significantly more hours weekly on milk feeding and on carrying, holding, or soothing their infant than nonlactating mothers; and on providing childcare. Understanding the mechanisms by which child mental health and development benefits from breastfeeding may have important implications for policies and intervention strategies, and could be usefully informed by suitably designed time use studies.

Keywords: breastfeeding, maternal–infant interactions, maternal time use, child care, oxytocin, weaning

Introduction

BREASTFEEDING IS RECOMMENDED by health authorities for promoting child and maternal health and wellbeing.^{1–7} A growing body of high quality research shows improved child neurological and cognitive development and mental health associated with breastfeeding in early life.^{8–11}

The mechanisms by which breastfeeding contributes to such outcomes are not well understood. Some argue that the link with cognitive development gains simply reflects breastfeeding as a proxy for more nurturing parenting and socioeconomic advantage.^{12,13} Nevertheless, recent investigations do not support the “nurturing hypothesis,”^{14,15} and have urged the

investigation of other mechanisms for the observed effect of breastfeeding on child development outcomes.

An alternative mechanism commonly cited is that unique biochemical components of human milk, such as fatty acids influence infant brain development and attachment (the “nutritional hypothesis”).¹⁴ However, the importance of epigenetic processes is also increasingly recognized.¹⁶ By altering maternal behaviors, lactation itself may influence the early social and environmental experience (the ecology) of the child.^{17–19} For example, maternal affectionate touch is known to be crucial for infant neurobiological, cognitive, and social-emotional growth,^{20,21} and it has been suggested that the physical and/or emotional act of breastfeeding may result

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in permanent physiologic changes that accelerate the infant's neurocognitive development.²²

Both animal and human studies show that lactation hormones such as oxytocin and prolactin affect maternal behaviors and increase maternal nurturing, including increasing proximity seeking.^{6,23–26} Mothers influenced by lactation hormones to seek proximity to their infant might spend more time interacting with the child. While existing research has compared the quality of interaction of breastfeeding and nonbreastfeeding mothers, there has been no study comparing how much time mothers spend interacting with their infants. A novel way to explore the potential bio-behavioral development pathway from breastfeeding to child development is therefore by investigating whether the amount of maternal time spent in interactive child-caring activities differs by infant feeding practice. The aim of this study was to investigate whether there are significant differences between breastfeeding and nonbreastfeeding mothers in the amount of time they spend in activities involving close physical interaction with their infant such as emotional support or cognitive stimulation. Because we expected that mothers spend less time on time-consuming interactive care activities such as feeding and carrying as their infant matures,^{27,28} our objectives for the study included distinguishing how the effects of infant feeding practice on maternal time use change as the infant gets older.

An important example is maternal employment, which is known to be associated with infant age and infant feeding practice.^{29,30} As physical separation of mother and infant limits the number of hours that mother and baby are together, our analysis explored how the interaction of infant age and feeding practice was related to maternal time use activities, including maternal employment hours.

Methodology

Participants

The Time Use Survey of New Mothers (TUSNM) was a nationwide Australian study conducted through the Australian National University (ANU) between April 2005 and April 2006. All participants gave written informed consent before enrolment [Protocol 2005/51 approved on 10 March 2005 by the ANU Human Research Ethics Committee under the *National Statement on Ethical Conduct in Research Involving Humans* (1999)]. The survey purpose was described to participants as “measuring the time it takes to care for a baby.” Recruitment was through national playgroup and breastfeeding support organizations, maternal and child health professional networks, infant health clinics, and childcare centers. Mothers with infants up to age 9 months were eligible to participate in the survey and could participate in tracking sessions at time points when the target infant age was 3, 6, and/or 9 months.

Data collection and measures

Data on infant feeding method for the youngest child (the “target infant”) during 7 days of time use tracking were collected by questionnaire filled out by participant mothers. We excluded participants who recorded time use for less than one 24-hour day. Feeding method was self-categorized as (A) exclusive breastfeeding; (B) exclusive formula feeding; (C) mixed breast milk and formula milk—no solids; (D) breast

milk and solids; (E) formula milk and solids; (F) mixed breast milk and formula milk with solids. Self-report of feeding method was verified by cross checking against individual time use data on feeding activities. Mothers using breast pumps were instructed to record expressing breast milk as “preparing feeds”; these few mothers were categorized as breastfeeding mothers even though feeding this milk might be by someone other than the mother.

Data collected from the mother by questionnaire also included the number of hours and minutes another family member (usually her partner or husband) was caring for, and feeding the infant, and how many hours the infant spent in paid childcare. Fathers were not invited to participate in time use tracking mainly because of ethical concerns to limit response burdens on households. Sociodemographic data were also collected via the written questionnaire.

Participants were asked to track their time use for 7 days, 24 hours a day, using TimeCorder[®] time tracking devices. These were posted to the mothers along with the aforementioned questionnaire at each tracking time point, that is, within 2 weeks of the relevant anniversary of the target infant's birthdate. Participants could record at target infant age 3, 6, and/or 9 months. Data on the frequency, duration, and time of day of each activity was recorded through participants pressing one of 25 buttons on the device corresponding to their current activity.

Measures. The factor of interest was infant feeding practice and this was measured using two different categorizations. Maternal hours in “interactive feeding and emotional care” were compared for the six detailed feeding categories noted above (A to F). We also compared those giving “some” breastfeeding (A, C, D, F) with those “not” breastfeeding (B and E), that is, “lactating” with “nonlactating” mothers.

TUSNM design and measurement of time use was based on the official Australian Bureau of Statistics (ABS) Time Use Survey (TUS).³¹ The TUS defines “care of children” as comprising the sum of “physical” and “emotional” care, plus “all other interactive and noninteractive childcare” activities.* “Physical care” in TUS includes feeding, holding, bathing, dressing, changing, and teeth cleaning, while “emotional care” is cuddling, hugging, or soothing a child. The TUSNM created subcategories to these “main activity” categories in the TUS to more fully describe infant care activities. The relevant activity categories are illustrated in Figure 1. For example, consistent with TUS, time interacting with the infant to “breastfeed or give expressed milk” or “feed formula” was categorized under “physical childcare.” “Physical care” in TUSNM measures bathing, dressing, changing, and teeth cleaning, but not feeding. Time taken to “carry, soothe, hold” the infant was an interaction labeled “emotional care.” Other childcare activities recorded by TUS include “teaching, helping, reprimanding children,” and “playing with, reading, talking to the child”; corresponding interactive care activities in TUSNM included playing, reading, talking to, or teaching the infant (“play teach”), and teaching infants to eat solids (“solid feeding”).

Time use was measured for mothers of infants aged 3–9 months for all interactive care activities expected to involve

*This refers to household care and does *not* mean non-parental or out of home care.

TUS category and subcategory	TUSNM category and subcategory	TUSNM activity measure	Summary measure
'Care of children' comprises;			
Physical Care	Physical Childcare		
Carrying, holding, feeding, bathing, dressing, changing babies, putting to sleep; for older children, bathing, cleaning teeth, washing, washing and brushing hair, taking to toilet, feeding, getting up, putting to bed, supervising these activities; minor first aid – putting band aids on grazes, removing splinters	Bathing, changing, dressing Meals with children Nursing a sick child Preparing formula feeds	'Physical care'	'Interactive feeding and emotional care'
	Breastfeeding Giving formula feeds Teaching children to eat solids	'Milk feeding' 'Solid feeding'	
Emotional Care of children	Emotional Care of infant		
Cuddling, hugging and soothing child	Carrying, holding, soothing infant	'Emotional care'	
All other interactive and non-interactive childcare activities			
Playing/reading/talking with child/teaching/helping/reprimanding children	Playing/reading/talking with child/teaching/helping/reprimanding children	'Play teach'	
Minding children, visiting childcare establishment, associated communication, associated travel, childcare activities not elsewhere included, childcare activities, not further defined	Minding children, visiting childcare establishment, associated communication, associated travel, childcare activities not elsewhere included, childcare activities, not further defined		

FIG. 1. Relevant TUS and TUSNM time use activity categories, and summary measures. TUS, Time Use Survey; TUSNM, Time Use Survey of New Mothers.

emotional support and/or cognitive stimulation. A dependent variable was created and labeled “interactive feeding and emotional care,” measured as the sum of maternal time spent interacting with the infant through breastfeeding, feeding formula, breast milk, or solids (“interactive feeding”), plus “emotional care” (time recorded as “carrying, holding, soothing, or hugging the infant”); it excluded “preparing feeds.”

To provide context for differences in time spent on these activities, we also report analyses of data on maternal time spent in playing with or teaching the infant, other physical care, childcaring activity in total, and hours of paid employment, and how much time others had spent caring for, or feeding the infant during the tracking period.

Data analysis. *T*-tests, chi-square and analysis of variance techniques were used to compare sociodemographic characteristics of the two infant feeding groups. Characteristics of participants who provided time tracking data records at one, two, or three time points (i.e., at infant ages 3, 6, and/or 9 months) were also compared, using the same techniques.

We used a residual maximum likelihood (REML) analysis in GenStat³² to perform a linear mixed effects analysis of the relationship between infant feeding category, and the specified maternal time use activities, for participants observed at three time points. Data for time use variables were transformed by taking the square root before analysis, to stabilize the variance.

A repeated measures approach to statistical analysis was appropriate because at least one but up to three successive time use and sociodemographic data observations were provided by participants when the target infant was aged 3, 6, and/or 9 months, and because the numbers of observations in the cells of the two-way tables were highly variable. A REML mixed effect model was preferred over traditional approaches such as repeated measures analysis of variance. This technique addresses the repeated measures and unbalanced nature of the data, exploiting all available observations for each

participant at the three time points, rather than omitting information from participants with missing data. With the focus of the study being the effect of infant feeding practice on maternal time use, mixed effect modeling allowed us to estimate the separate (main) effects of feeding category and infant age, while also exploring how the interaction of these two (fixed) factors affected maternal time use.

REML analyses were conducted for the two factors of interest described earlier; “detailed feeding category” (six levels), and breastfeeding (including mixed) versus nonbreastfeeding (two levels). The fixed terms in the model were “infant age” × “factor of interest,” and the interaction between these. The random terms were “target infant”/“infant age” (which expands to “target infant” and “infant age” within “target infant”).

The significance of fixed effects ($p < 0.05$) was assessed on the transformed data using Wald statistics and approximate *F*-statistics. This is appropriate for assessing the significance of both the main effects and the interaction term in the model for fixed effects specified above.

Results

Of 185 mothers giving consent, 162 participated in post-natal time use tracking, and 156 successfully contributed time use and sociodemographic data records, generating 327 usable data records of maternal time use activities and sociodemographic data. The number of data records/observations exceeds the number of participants because most provided time use tracking data at more than time point.

Table 1 summarizes the dataset presenting information on the age of the target infants at the maternal time use tracking time points, the feeding categories of the target infants at that time point, and tracking categories (describing the number of participants who tracked at one, two or three points). The dataset of 327 data records contains 86 observations for mothers whose infant was 3 months old at time of tracking

TABLE 1. SUMMARY OF DATA RECORDS/OBSERVATIONS: DETAILED FEEDING GROUP BY AGE OF TARGET INFANT, AND TRACKING CATEGORY

Detailed feeding group	Data records/observations by age of target child (months)			Data records/observations, n (%)
	3	6	9	
A. Breastfed only	79	15	1	95 (29.1)
B. Formula only	4	0	1	5 (1.5)
C. Breastfed and formula fed	2	1	0	3 (0.9)
D. Breastfed and solids	1	101	83	185 (56.6)
E. Formula fed and solids	0	11	11	22 (6.7)
F. Breastfed and formula fed and solids	0	6	11	17 (5.2)
All feeding groups, n (%)	86 (26.3)	134 (41.0)	107 (32.7)	327 (100)
Tracking category				
One tracking	9	15	7	31 (9.5)
Two trackings	23	65	46	134 (41.0)
Three trackings	54	54	54	162 (49.5)
All tracking categories, n (%)	86 (26.3)	134 (41.0)	107 (32.7)	327 (100)

Detailed feeding group	Data records/observations by tracking category			No. of trackings (n)
	One tracking	Two trackings	Three trackings	
(A) Breastfed only	11	27	57	95
(B) Formula only	1	1	3	5
(C) Breastfed and formula fed	1	1	1	3
(D) Breastfed and solids	15	88	82	185
(E) Formula fed and solids	3	8	11	22
(F) Breastfed and formula fed and solids	0	9	8	17
All feeding groups, n (%)	31 (9.5)	134 (41.0)	162 (49.5)	327 (100)

(26.3%), 134 for those with 6-month-old infants (41.0%), and 107 for those with 9-month olds (32.7%). Of the 327 observations, 95 (29.1%) were from mothers when they were exclusively breastfeeding, 185 (56.6%) from those when breastfeeding with solids, and the rest (14.3%) were when the child was mixed breastfed and formula fed (20) or formula fed, with or without solids (27). These observations are for 156 individual infants who may be in different feeding groups at different ages, for example, being exclusively breastfed at 3 months, but contributing an observation in the "breastfeeding with solids" feeding group when time use is tracked at 6 or 9 months. Regarding tracking categories, those (mothers) who did a single tracking contributed 31 observations, 134 observations were from those who tracked twice, and 162 of the 327 observations (49.5%) were from a participant who tracked three times.

The TUSNM sample population had characteristics similar to the Australian population of mothers of infants on most key sociodemographic variables, though participants were more likely to be first-time mothers, and more highly educated. TUSNM also contained a higher prevalence of breastfeeding mothers than would be expected from population-based studies of breastfeeding in Australia.^{33,34}

Table 2 reports analyses comparing sociodemographic characteristics of participants by infant feeding group during the week of time use tracking. Maternal age, number of children, and age of second youngest child were not significantly different between the breastfeeding and nonbreastfeeding groups, although a difference in mean infant age approached statistical significance ($p=0.10$). There was no significant difference between the breastfeeding and nonbreastfeeding groups in the proportion with only one child. Differences between the feeding groups in maternal employment, education

levels, and family income were also not significant, though there was a trend for maternal education differences ($p=0.06$). Comparison of sociodemographic characteristics for those doing one, two, and three time use trackings also showed no statistically significant differences in age of the target child, age of the second youngest child, number of children, mother's age, mother's education, or mother's employment status between mothers who provided data at one, two, or three time points. However, there was a trend for a difference between groups in family income category ($p=0.05$).

Table 3 reports predicted means (with back-transformed means in parentheses) for maternal time spent in various activities, by detailed infant feeding group, and by infant age. On average, mothers spent 38–49 hours a week on childcare.[†] There were statistically significant differences ($p<0.01$) of several hours a week between feeding groups in maternal weekly hours spent on emotional care. Those exclusively breastfeeding spent the most time (8.3 hours weekly) and those who were formula feeding with solids spent least time (3.2 hours) in emotional care activity. Differences between the six feeding groups in total interactive feeding and emotional care time ($p<0.01$) mainly arise from differences in weekly hours spent on milk feeding, and on emotional care, as time spent in feeding solids was not large and did not differ

[†]Note that back-transformed means will be similar, but not the same as the means for the original data, due to the transformation and the unbalanced nature of the data. Hence, for example, "interactive feeding and emotional care" is the sum of time spent feeding the infant (i.e., "milk feeding" + "solid feeding") plus "emotional care," but the figures for each of these individual activities do not add up exactly to the total mean value for the combined activities.

TABLE 2. SOCIODEMOGRAPHIC CHARACTERISTICS OF PARTICIPANTS

Comparison by feeding group: t-test and chi-square analyses	No breastfeeding (feeding groups 2 and 5), obs=27	Some breastfeeding (feeding groups 1, 3 4, and 6), obs=299	p
Age of target child (months), mean	6.9	6.1	0.10
Age of second youngest child (years), mean	3.7	3.7	0.98
No. of children (N), mean	1.9	1.7	0.39
Target infant is only child (%)	40.7	48.3	0.45
Mothers age (years), mean	31.7	32.8	0.17
Mothers education (N) ^{a,b}			
≤12 years	4	17	0.06
>12 years	23	282	
Mothers employment status (N) ^b			
Full time or part time	10	85	0.34
Unemployed/not in labor force	17	215	
Family income (A\$ weekly) ^b			
0–899	13	113	0.53
900–1,199	5	79	
1,200+/no answer	8	102	

^aExcludes one record with missing data for these variables.

^bOne cell has expected count less than 5, minimum expected is 1.74.

greatly between feeding groups. For example, the mothers who were breastfeeding with solids spent 22.5 hours a week on interactive feeding and emotional care, while those who were formula feeding with solids spent 12.1 hours a week in these activities. Small cell sizes for formula fed infants ($n=3$, $n=5$, $n=17$), some of whom were also breastfed, suggest the need for caution in interpreting differences, as differences between any particular detailed feeding group categories may or may not be statistically significant.

Overall, there were also no statistically significant differences between the feeding groups on time spent on playing with the infant, or on maternal childcaring activity as a whole. Nor were there any significant differences when maternal education was included as a covariate in the analyses in Tables 3 and 4.

Maternal time spent in infant care activities was clearly affected by infant age. Time spent with infants in interactive feeding and emotional care activity was significantly less ($p<0.001$) for older than for younger infants (15.5 hours vs. 22.5 hours weekly).

Table 4 compares lactating mothers with nonlactating mothers. It shows that lactating mothers spent more hours on milk feeding (12.6 hours, $p<0.001$) and emotional care (7.3, $p<0.01$) than nonlactating mothers (6.2 vs. 3.9). Lactating mothers also spent 8.5 hours more weekly in childcare activity ($p<0.01$). Maternal time in other interactive care of infants (feeding solids, playing or reading, and physical care) did not differ significantly. Average weekly employment hours were higher for lactating mothers (2.7 hours vs. 1.2 hours, $p<0.01$).

The time that infants were cared for by someone other than the mother was not large, as shown in Table 4. Differences in weekly time that other family members cared for the infant were not statistically significant, though infants of non-breastfeeding mothers spent more time in paid childcare (average of 119.5 minutes weekly vs. 6.2, $p<0.001$). Notably, but not unexpectedly, nonbreastfed infants spent more time being fed by other family members and the difference was statistically significant (52 minutes weekly vs. 12 minutes).

Mothers of older infants spent less time on milk feeding, more time solid feeding, and less time in emotional care than those with younger infants ($p<0.01$). Mothers of older infants also spent less time in physical care, and in childcare overall, and more time in employment (0.7 hours at 3 months compared to 4.2 hours at 9 months).

Testing using Wald statistics and approximate F-statistics did not reveal statistically significant interactions of target infant age and feeding group in effects on maternal time use activities, except for employment. Infant feeding category interacted significantly with age of infant for maternal employment hours ($p=0.006$). We therefore calculated predicted means for maternal employment hours to explore how this related to age of target infant and feeding group (Table 5). Notably, employment hours were low for all the mothers of younger infants regardless of feeding group, with less than 1 hour a week on average for those with infants aged 3 months. At 9 months, however, those breastfeeding with solids spent 1.3 hours weekly in employment whereas those feeding formula and solids spent 5.9 hours. Mothers who were both breastfeeding and formula feeding also had high hours in employment at this age (8.0 hours weekly). Exclusively formula feeding mothers had the highest employment hours at 9 months, averaging around 48 hours weekly. Likewise, looking at the combined feeding groups, at younger ages the differences between lactating and nonlactating mothers in hours of employment were not substantial. However, at infant age 9 months, mothers who were not breastfeeding spent around 7.6 hours a week in employment while mothers who were still breastfeeding spent 1.8 hours weekly in employment.

The above analysis shows that mothers in the breastfeeding groups spent several hours a week more in close feeding-related interactions with their infant, than did mothers who were not giving any breast milk. This was not offset by time in other interactions with the infant such as through playing, reading, or physical care. Differences in overall time spent on childcare activity between the feeding groups, of 8 hours a week, were also not accounted for by small differences in employment hours, which averaged around 2 hours weekly.

TABLE 3. RESIDUAL MAXIMUM LIKELIHOOD ANALYSIS OF MATERNAL WEEKLY HOURS SPENT IN INTERACTIVE CARE AND OTHER ACTIVITIES, BY DETAILED FEEDING GROUP AND BY AGE OF TARGET INFANT, USING LINEAR MIXED MODEL

<i>A. Maternal weekly hours spent in activity, by detailed feeding group (for all target infant ages)</i>								
Activity	A. Breastfed only (obs=95)	B. Formula only (obs=5)	C. Breastfed and formula fed (obs=3)	D. Breastfed and solids (obs=185)	E. Formula fed and solids (obs=22)	F. Breastfed and formula fed and solids (obs=17)	Average standard errors of differences	p
Physical care	2.369 (5.61)	2.216 (4.91)	2.415 (5.83)	2.373 (5.63)	2.220 (4.93)	2.255 (5.09)	0.252	NS
Milk feeding	3.812 (14.5)	3.233 (10.5)	3.173 (10.1)	3.422 (11.7)	2.218 (4.92)	3.219 (10.4)	0.394	<0.001
Solid feeding	0.2039 (0.0416)	0.3041 (0.0925)	0.7021 (0.493)	1.352 (1.83)	1.416 (2.01)	1.496 (2.24)	0.356	<0.001
Emotional care	2.876 (8.27)	2.211 (4.89)	2.526 (6.38)	2.650 (7.02)	1.794 (3.22)	2.296 (5.27)	0.464	0.036
Interactive feeding and emotional care	4.996 (25.0)	4.242 (18.0)	4.176 (17.4)	4.740 (22.5)	3.484 (12.1)	4.374 (19.1)	0.410	<0.001
Play teach	2.480 (6.15)	2.652 (7.03)	2.610 (6.81)	2.620 (6.86)	2.582 (6.67)	2.289 (5.24)	0.470	NS
Childcare	7.034 (49.5)	6.228 (38.8)	6.437 (41.4)	6.899 (47.6)	6.172 (38.1)	6.581 (43.3)	0.448	NS
<i>B. Maternal weekly hours spent in activity, by age of target infant (for detailed feeding group)</i>								
Activity	Age of target infant (months)						Average standard errors of differences	p
	3 (obs=86)	6 (obs=134)	9 (obs=107)					
Physical care	2.357 (5.56)	2.368 (5.61)	2.200 (4.84)	0.1118	NS			
Milk feeding	3.568 (12.7)	3.196 (10.2)	2.774 (7.7)	0.1775	<0.001			
Solid feeding	0.7299 (.5328)	0.9556 (.9132)	1.052 (1.128)	0.1639	NS			
Emotional care	2.724 (7.42)	2.378 (5.65)	2.074 (4.30)	0.202	0.004			
Interactive feeding and emotional care	4.742 (22.49)	4.326 (18.7)	3.939 (15.5)	0.1807	<0.001			
Play teach	2.581 (6.66)	2.456 (6.03)	2.583 (6.67)	0.2077	NS			
Childcare	6.731 (45.3)	6.546 (42.9)	6.399 (40.9)	0.1967	NS			

Predicted means with back-transformed means in parentheses. Note that back-transformed means will be similar, but not be the same as the means for the original data, due to the transformation and the unbalanced nature of the data.

TABLE 4. RESIDUAL MAXIMUM LIKELIHOOD ANALYSIS OF MATERNAL WEEKLY HOURS SPENT IN INTERACTIVE CARE AND OTHER ACTIVITIES, BY SOME OR NO BREASTFEEDING AND BY AGE OF TARGET INFANT, USING LINEAR MIXED MODEL

<i>Maternal weekly hours spent in activity, by some or no breastfeeding</i>					
	<i>Breastfeeding including mixed</i>			<i>Average standard errors of differences</i>	<i>p</i>
	<i>No breastfeeding (obs=27)</i>	<i>Breastfeeding (obs=300)</i>			
Activity					
Physical care	2.365 (5.59)	2.233 (4.99)		0.129	NS
Milk feeding	2.493 (6.22)	3.553 (12.62)		0.1977	<0.001
Solid feeding	1.003 (1.006)	.9355 (.875)		0.169	NS
Emotional care	1.983 (3.93)	2.708 (7.33)		0.253	0.004
Interactive feeding and emotional care	3.732 (13.93)	4.805 (23.08)		0.219	<0.001
Play teach	2.610 (6.81)	2.550 (6.50)		0.242	NS
Childcare total	6.276 (39.39)	6.920 (47.89)		0.238	0.007
Employment	1.106 (1.223)	1.651 (2.726)		0.418	0.036
Context					
Care by father (weekly minutes)	10.28 (105.7)	12.28 (150.80)		2.3	NS
Feeding by father (weekly minutes)	7.21 (51.98)	3.46 (11.97)		1.11	<0.001
Time in paid childcare (weekly minutes)	10.93 (119.5)	2.49 (6.20)		2.38	<0.001
<i>Maternal weekly hours spent in activity, by age of target infant (for some or no breastfeeding)</i>					
	<i>Age of target infant (months)</i>			<i>Average standard errors of differences</i>	<i>p</i>
	<i>3 (obs=86)</i>	<i>6 (obs=134)</i>	<i>9 (obs=107)</i>		
Activity					
Physical care	2.352 (5.53)	2.360 (5.57)	2.184 (4.77)	0.0624	0.004
Milk feeding	3.677 (13.5)	2.930 (8.58)	2.462 (6.06)	0.0981	<0.001
Solid feeding	.086 (.0073)	1.301 (1.69)	1.517 (2.30)	0.0992	<0.001
Emotional care	2.838 (8.05)	2.273 (5.17)	1.924 (3.70)	0.1069	<0.001
Interactive feeding and emotional care	4.862 (23.6)	4.189 (17.5)	3.755 (14.1)	0.0977	<0.001
Play teach	2.561 (6.59)	2.530 (6.40)	2.648 (7.01)	0.112	NS
Childcare total	6.863 (47.1)	6.555 (43.0)	6.376 (40.7)	0.105	<0.001
Employment	0.828 (0.686)	1.253 (1.57)	2.055 (4.22)	0.368	0.003

Predicted means with back-transformed means in parentheses. Note that back-transformed means will be similar, but not be the same as the means for the original data, due to the transformation and the unbalanced nature of the data.

TABLE 5. RESIDUAL MAXIMUM LIKELIHOOD ANALYSIS OF MATERNAL WEEKLY HOURS SPENT IN EMPLOYMENT USING A LINEAR MIXED MODEL

<i>Feeding group</i>	<i>Age of target infant (months)</i>		
	<i>3 (obs=86)</i>	<i>6 (obs=134)</i>	<i>9 (obs=107)</i>
Interaction between age of target infant and detailed feeding group ($p=0.006$, Average standard error of difference (SED)=1.172)			
A. Breastfed only (obs=95)	0.888 (0.789)	1.445 (2.088)	2.150 (4.62)
B. Formula only (obs=5)	0.675 (0.456)	—	6.915 (47.8)
C. Breastfed and formula fed (obs=3)	0.04 (0)	4.063 (16.51)	—
D. Breastfed and solids (obs=185)	0.504 (0.254)	1.043 (1.09)	1.127 (1.27)
E. Formula fed and solids (obs=22)	—	1.285 (1.65)	2.432 (5.91)
F. Breastfed and formula fed and solids (obs=17)	—	1.097 (1.203)	2.821 (7.96)
Interaction between age of target infant and some or no breastfeeding ($p=0.079$, Average SED=0.5677)			
Some breastfeeding (obs=300)	0.855 (0.731)	1.117 (1.248)	1.346 (1.812)
No breastfeeding (obs=27)	0.800 (0.640)	1.390 (1.932)	2.765 (7.645)

Predicted means with back-transformed means in parentheses. Note that back-transformed means will be similar, but not be the same as the means for the original data, due to the transformation and the unbalanced nature of the data.

Discussion

This study is the first to address the question of how lactation status relates to maternal time use, and contributes new data on maternal time spent in interactive care of their infants. On average mothers of infants aged 3–9 months spent the equivalent of a full time working week on childcare activity, regardless of feeding method. The key finding from our primary analysis is that time spent in interactive infant feeding or emotional care activities differed significantly by infant feeding group. Specifically, lactating mothers spent 8.5 hours a week more time feeding, carrying, holding, soothing, or hugging the infant than nonlactating mothers. This was not compensated by additional time in other interactive care activities such as feeding solids, or playing with the infant.

Our findings of differences of around 4.6 hours weekly in emotional care time by breastfeeding mothers of infants aged 6 months are consistent with an Australian population-based study of nearly 3000 infants' time use, which showed using multivariate analysis that infants who had ceased breastfeeding by around 5 months of age spent 3–4 hours fewer hours each week being cuddled or held by their mother than infants still breastfed at this age.³⁵

Previous analyses have shown that exclusively breastfeeding mothers spend more time milk-feeding²⁷ and cuddling, holding, or soothing their infants²⁸ than mothers who are not exclusively breastfeeding. Not addressed in existing research, however, is how the amount of time that mothers spend touching their infants varies with the intensity of breastfeeding (i.e., the relationship of breastfeeding “dose” to the amount of interactive activity) at key time points during infancy. A second important finding is on the relationship between the intensity of breastfeeding and the number of weekly hours of interactive feeding and emotional care time. In this study, exclusively breastfed infants experienced the most hours of this interactive care time with their mother, and exclusively formula fed infants on solids experienced the least, though small cell sizes limit strong conclusions about comparisons for some mixed feeding categories. This is consistent with how lactation hormones may be expected to alter maternal behavior toward proximity seeking.

Third, our consideration of maternal time use context showed that employment of mothers of older babies is related to feeding method and may influence, or be influenced by, the amount of time that mothers are in close interaction with their infant. Maternal labor force participation is well established as influencing infant feeding practices.^{30,27,36} The nonlactating mothers in this Australian study spent slightly more time in employment than lactating mothers, but this small difference did not fully account for the substantial difference in maternal interactive care time.

Our other important finding that other family members helped less with the feeding of breastfed infants is not surprising, but it reinforces that excessive time demands on the mother may result in early weaning from breastfeeding if the mother has unsupportive family (or employment) arrangements.

The statistical analysis shows that the observed differences between feeding groups are very unlikely to be explained by chance. Nor do they reflect socioeconomic and demographic differences (such as number of siblings, family type, maternal age or education, workforce status, family income, and state and rural-urban residence) between feeding groups.

The importance of this study is that no previous research has used maternal time use data to explore potential mechanisms for differences in developmental outcomes for breastfed and nonbreastfed infants.³⁷ Existing time use studies of mother and infant interactions compare the quality, rather than the amount, of mother–infant interactions; for example, the study by Lavelli and Poli compared 20 breastfed and 12 bottle-fed newborns and found different mother–infant interactions during and just after feeding.³⁸

The dearth of research on maternal time use and infant feeding is partly because suitable time use data on mother–infant dyads is rare.³⁹ Population-based stratified sample surveys of time use do not identify activities of specific relevance to mothers with infants, such as feeding, while the few existing studies of infants' time use focus on activities such as playing, crying, or sleeping and lack data on general activities needed to give context.⁴⁰ Infant studies of this kind are also often limited to very small, nonrepresentative samples; some large time use datasets for infants and older children exist but often do not allow comparison by infant feeding method,⁴¹ and have not been used to examine infant feeding.⁴² The Australian Longitudinal Study of Australian Children (LSAC) collects comprehensive data on both infant time use and breastfeeding status, but not maternal time use.³⁵

The strength of this study is that it draws on a unique dataset that provides information on sociodemographic characteristics and feeding status along with comprehensive data on maternal time use for 24 hours a day over a full week, for a sizable sample of 156 mothers of infants. The use of time tracking devices rather than relying on written logs of activities or retrospective reports is a major strength of this study. Previous studies of such mother–child interactions lacked contextual data to explore, for example, how employment hours influence how much time a mother can spend interacting with the infant. Our analysis was able to include the interplay of such care time with the number of hours mothers spent in employment. Recent research also illustrates the important role of fathers in supporting breastfeeding, including by sharing housework and child care^{43,44}; using contextual data on time use of other caregivers from the TUSNM, we could explore and compare associations between maternal time interacting with the infant, and time contributed by other family caregivers, for breastfeeding and nonbreastfeeding mothers.

Our study has several limitations. It does not measure health or development outcomes arising from maternal time use differences; such a study could provide important new insights. Nor was it practicable to measure oxytocin or prolactin levels in TUSNM participants. The study's generalizability to different populations may be limited by self-selection bias, as participation was voluntary. The small sample size limits the conclusions that can be drawn about the statistical significance of comparisons between particular feeding subgroups. Time use of other family members was by maternal report and may differ from time use measured through self report or tracking using a time tracking device. Also, results from Australia where paid parental leave (PPL) is 18 weeks and statutory job protection is for 12 months might differ in other country settings having different maternal employment patterns and maternity leave access; the average age of babies when their mothers return to employment in Australia is around 7 months.⁴⁵ While participants in the

TUSNM had broadly homogenous socio-demographic characteristics, there is potential confounding from missing variables, as mothers self-select into breastfeeding based on a complex combination of personal and social characteristics. These may include parenting efficacy, mental health variables such as anxiety or depression, or the availability of social and health services support. Reverse causation is also an alternative explanation of our findings—the amount of time a mother spends interacting with her infant may increase the likelihood of maintaining exclusive or partial breastfeeding.

In conclusion, to explore potential mechanisms behind differential child development and mental health outcomes for breastfed and non-breastfed infants, we presented data showing that lactating mothers spent significantly greater time interacting with the infant than nonlactating mothers, and such interaction increased with more exclusive breastfeeding. This is consistent with lactation hormones influencing the amount of time mothers provide important interactive emotional support or cognitive stimulation of their infant.

Future research—with study designs that combine time use data collection with neuroimaging and physiological data, in larger, randomly selected populations, and with follow-up of relevant outcomes—would be of value to confirm whether lactation-driven maternal behavior is an important causal pathway through which breastfeeding contributes to child development and health.

If our findings are generalizable, there are potentially major implications. Programs or interventions to reduce child development disadvantage and promote child mental health might achieve improved outcomes by including breastfeeding support for new mothers. Policies and practices such as paid maternity leave or breastfeeding breaks that give mothers more time for close positive interactions with their baby may be needed to protect appropriate development of infants. Our study also suggests the importance for health professionals working with new mothers to advise of the need to ensure that weaning from exclusive or partial breastfeeding does not prematurely reduce the mother's time spent interacting positively with an infant.

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Disclosure Statement

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