The implications of breastfeeding for maternal time use

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Abstract

Breastfeeding is a long-standing, widely endorsed practice that is typically carried out in private; little is known about its time implications for the milk-producing parent (hereafter, mother). We analyze 203 million high-frequency, time-stamped nursing and pumping events logged for 246,157 infants in a smartphone tracking app to study how milk production shapes maternal time use. During the first 90 days postpartum, mothers spend a daily median of 137 minutes across 9 sessions, leaving the median mother with one uninterrupted three-hour daytime block and two nightly milk-production disruptions. Although daily minutes decline over the year, we estimate a cumulative total of 39,621 min ($\sim$ 17 standard work-weeks), with a median value of time of \$9,386. Replacing nursing with exclusive formula rarely reduces total feeding time because bottle-feeds tend to be slower, but for the average mother it converts about 93% of currently non-outsourceable time into shareable tasks. These findings make the hidden labor of lactation visible, offering quantitative baselines that can guide leave policy, workplace accommodations, and equitable caregiving within households.

1 Introduction

Breastfeeding is as old as humankind [Austin et al., 2013, Joannes-Boyau et al., 2019] and remains widely practiced and encouraged [UNICEF and World Health Organization, 2025, Centers for Disease Control and Prevention, 2023]. International and national health authorities, including the World Health Organization (WHO) and the American Academy of Pediatrics (AAP), recommend exclusive breastfeeding for the first six months, after which complementary foods can be introduced [World Health Organization, 2024]. In 2022, the AAP extended its guidance to support breastfeeding for at least two years [Meek et al., 2022], a benchmark likewise communicated by the WHO and other leading health organizations [World Health Organization, 2025]. While much research and discussion has focused on the consequences of breastfeeding for infants and the mother–child bond [Victora et al., 2016, Oster, 2013, Horta and Victora, 2013, Fitzsimons and Vera-Hernández, 2022], less is known about its direct implications for mothers.

This paper focuses on mothers' time use: how much time milk production takes—through direct nursing and pumped expression—and how it shapes mothers' ability to access uninterrupted time during the day and sleep at night. We estimate the economic value of this time and examine a counterfactual scenario in which feeding is outsourced via formula.

Understanding how milk production shapes mothers' time use is important as time is a finite resource with broad implications for maternal well-being (including postpartum depression), economic opportunities (notably the motherhood wage penalty), and family dynamics [Anderson et al., 2002, Heron et al., 2004, Gavin et al., 2005, Adams et al., 2025, Kleven et al., 2024]. Yet much of this production occurs in private, and where mothers' time has been considered, researchers and decision-makers have often had to rely on binary breastfeeding indicators at various infant age thresholds, crude approximations of time demands, or small samples of self-selected study participants which may lead to biased estimates [Smith and Forrester, 2013, Mahoney et al., 2023]. The existing evidence suggests that the choice to breastfeed affects mothers' income and labor force participation, highlighting the importance of understanding the time demands that might drive these outcomes [Lawler and Yewell, 2023, Rippeyoung and Noonan, 2012]. A systematic quantification of the temporal demands of milk production and how it shapes time use can directly inform policies, workplace practices, and intra-household arrangements [Oster, 2022, Baker and Milligan, 2008].

We leverage the availability of high-frequency, large-scale smartphone data, capturing millions of milk production events logged for 246,157 infants between 2012 and 2022. By tracking nursing and pumping in both private and public settings, we capture individuals' real-world behavior while minimizing observer effects. In the first 90 days postpartum, mothers logged a median of 137 minutes per day producing milk. During daytime, mothers had a median of one uninterrupted three-hour periods, and at night they experienced a median of two disruptions. Over the first year, daily milk production and frequency declined, while uninterrupted time increased and nighttime disruptions decreased; by year's end, the median time spent was 65 minutes per day, with three uninterrupted three-hour daytime periods and one milk production-related nighttime disruptions. The economic value of time in the first year is $10,520 on average (median $9,386), based on the 2020 median hourly earnings of women aged 25–34 ($15.93/hr) [U.S. Bureau of Labor Statistics, 2021]. By switching to exclusive formula-feeding and dividing feeding responsibilities according to a 71% (mother)–29% (partner) split in basic child care reported by Guryan et al. [2008], mothers could reduce their total feeding-related time (milk production and bottle feeding) by 27%, from 21,323 minutes to 15,556 minutes.

These results contribute to a growing literature on hidden labor and other sources of inequality [see, e.g., Babcock et al., 2017, England et al., 2020]. They come at a time when women face increasingly conflicting expectations—emanating from extended breastfeeding guidelines on one hand, and declining birth rates and rising labor force participation on the other [Goldin, 2006, Bhattacharjee et al., 2024].

2 Quantifying the Time Demands of Milk Production Using Smartphone Data

With widespread smartphone access among new parents [Pew Research Center, 2024], baby-tracking apps are now common, with feeding-related activities among the most frequently tracked activities [Dinour, 2022, Van Kollenburg et al., 2018, Cimino and Cerniglia, 2023]. Leveraging this shift to digital self-tracking, we analyze a high-frequency dataset of millions of nursing and pumping events, allowing minute-level measurement of the temporal demands of milk production in everyday settings. The source app, Baby Connect, a U.S.-based platform, was launched in 2010 and is

available on Android, iOS, and web browsers [Baby Connect]. Its basic tier is free and allows users to log feeding-related activities in real time or retrospectively, with the ability to add optional details such as milk volume or breast side. Records are time-stamped on the device at entry and synchronized to secure cloud storage, yielding a continuous digital log even when caregivers enter data from different devices for the same child.

Our primary unit of analysis is a child-day, defined as all feeding-related activities recorded for a given child within a calendar day (12:00 AM to 11:59 PM). We focus on milk-production activities—nursing and pumping—but later extend the counterfactual analysis to all feeding-related activities, including bottle feeding time. To limit measurement error, we restrict the sample to only child-days where reporting appears to be complete, yielding 175 million milk-production events from 246,157 infants recorded between 2012 and 2022. The analytical sample is predominantly from the United States (78% of country-identified observations) but includes children from 172 countries overall. See Appendix B for additional details on the data preparation and sample composition.

While the platform's large-scale, high-frequency smartphone data overcome many limitations of survey methods—small sample, observer effects—they also have important caveats. First, app users are self-selected parents who track caregiving activities. To gauge how this may shape our estimates, we exploit the decade-long span of the data—during which smartphone adoption moved from niche to near-universal—and report all results separately for the first half (2012 - 2017) and second half (2018 - 2022); our headline results remain stable (Appendix D). Second, Baby Connect does not collect demographic characteristics, preventing direct assessment of representativeness by parent age, income, or education. Third, logging habits vary across users: some may omit certain nursing or pumping sessions or cease tracking as routines stabilize.

3 Milk Production and Time Use During the First 90 Days

We begin by examining the time spent on milk production—direct nursing and pumped expression—during the infant's first 90 days (specifically, days 15–90; see Appendix B for sample construction). This window is when production demands are likely to be highest: milk volume rises rapidly in the early postpartum period and continues increasing as mothers establish full lactation [Neville et al., 1988], while they and their infants settle into effective feeding routines and address possible

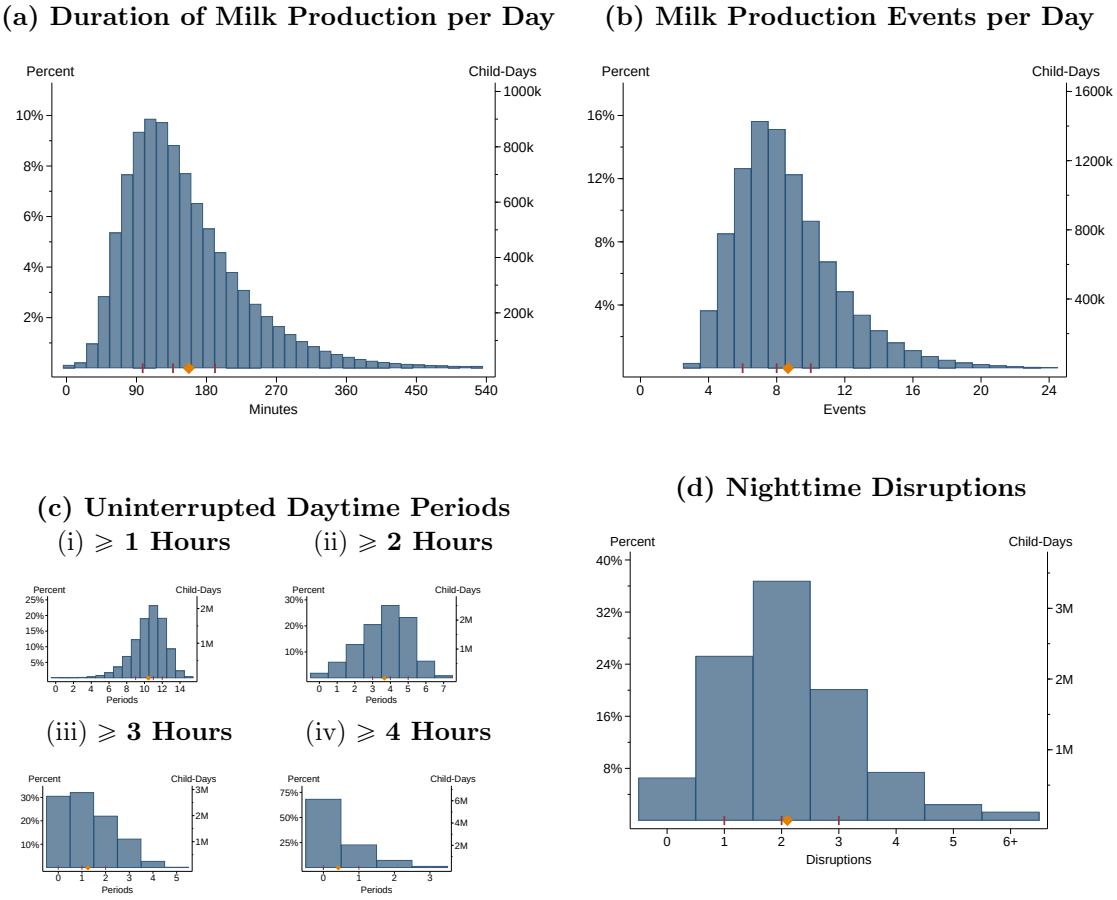


Figure 1: Milk Production

Notes. ◆ marks the mean, and | mark the 25th, 50th, and 75th percentiles. Day is defined as a 24-hour time window. Daytime is 06:00–22:00. Nighttime is 22:00–06:00. The sample spans infant ages 15–90 d. "k" in panels (a) and (b) refers to thousand (e.g., 700k = 700,000). "M" in panels (c) and (d) refers to million (e.g., 3M = 3,000,000). For clarity, durations > 540 minutes (panel a) and event counts > 24 (panel b) are excluded.

latching challenges.

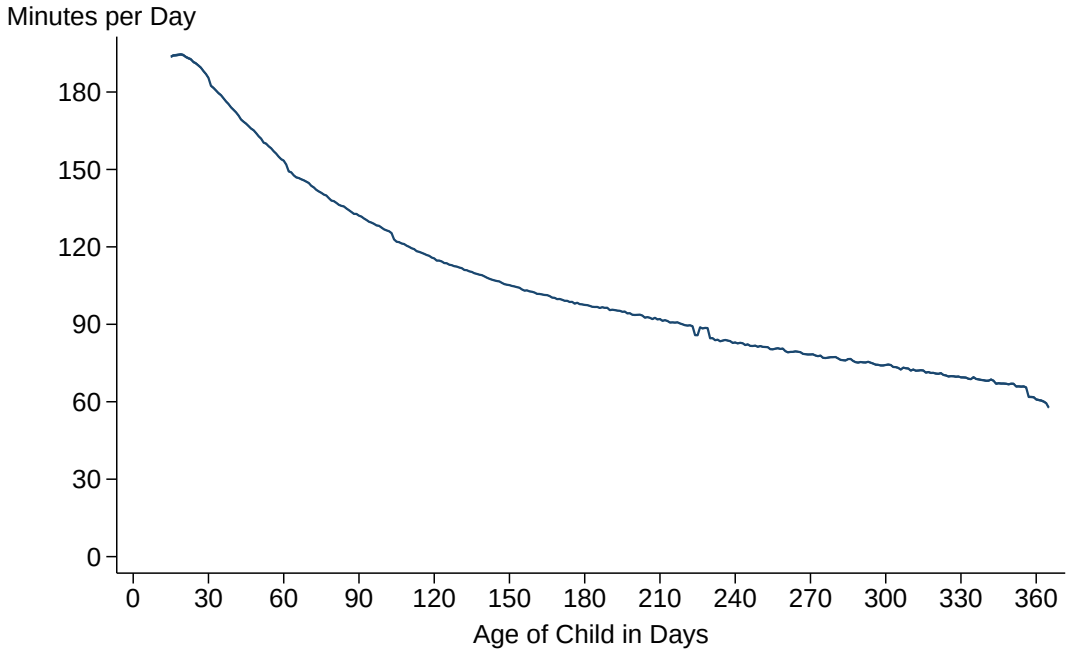
Figure 1a plots the distribution of total minutes spent on milk production per 24-hour period, based on 9,132,708 child-days. Mothers spend an average of 157 minutes producing milk (median = 137 minutes). The distribution is right-skewed: on 29% of child-days, mothers log more than three hours of milk production—equivalent to more than 21 hours per week, or over half of a full-time work-week of 40 hours when aggregated to seven days.

We next consider how milk production shapes mothers' access to uninterrupted time during the day and night. Milk production fragments schedules in ways that may affect work, leisure and household activities. Regular, frequent milk removal is physiologically required—infants require frequent feeding, and clinical guidance stresses consistent emptying of the breasts to establish and maintain supply and to prevent milk stasis, engorgement, or mastitis [Centers for Disease Control and Prevention (CDC), 2025, La Leche League International, 2025, Kent et al., 2012, Berens et al., 2016, Amir and of Breastfeeding Medicine Protocol Committee, 2014].

Figure 1b depicts the distribution of milk-production events per child-day. Mothers log a mean of 9 distinct milk production sessions per 24 hours (median = 8 sessions). To quantify daytime fragmentation, we count—for each child-day—uninterrupted blocks of at least 1, 2, 3, and 4 hours between 06:00 and 22:00 (see Appendix B for details). Figure 1c shows that the median mother records several one- and two-hour windows, but only one uninterrupted three-hour period and zero four-hour periods per child-day.

Finally, we quantify time fragmentation at night. Figure 1d shows the number of milk-production events logged between 22:00 and 06:00 for each child-day. The median mother records two interruptions per night, whereas those at the 95th percentile experience four or more production-related interruptions (excluding other causes). To the extent these nocturnal interruptions fragment or shorten sleep, they may adversely affect maternal well-being and cognitive performance, as indicated by the broader sleep literature [Van Dongen et al., 2003, Dinges et al., 1997, Finan et al., 2015, Leong and Chee, 2023].

Figure 2: Relationship Between Child Age and Duration of Milk Production



Notes. The figure presents the estimates from a regression of daily milk production time on child age, controlling for child fixed effects. 95 % confidence intervals are shown, but are too narrow to be visually discernible at this scale.

Milk Production Over the First Year While our foregoing analysis focuses on the first 90 days of lactation, many parents continue producing milk for considerably longer. Historically, the AAP recommendation was to exclusively breastfeed for six months, followed by continued breastfeeding alongside complementary foods through the first year. As infants' nutritional needs and feeding behavior evolve, mothers' milk-production time also changes.

Figure 2 shows the estimated relationship between a child's age and the average daily time spent on milk production. We estimate this relationship with a regression that includes child fixed effects, so the curve reflects how feeding time changes for the same child as they age rather than differences across children. See Appendix B for details.

On day 15 of an infant's life, mothers spend an average of three hours per child-day producing milk. This duration gradually falls with the child's age, averaging 1.8 hours in month five and 61 minutes by the end of the first year. The decline likely reflects several factors: increased efficiency in milk removal, partial substitution of formula for breast milk in some dyads, and the gradual introduction of solid foods.

We extend the analysis of time use during the first year in Appendix C, where Figure 10 reproduces the four panels of Figure 1 for age bands 91–180 d and 181–365 d. The patterns parallel those in Figure 2: as children grow older, the average minutes and event counts for milk production fall, daytime fragmentation eases, and night-time disruptions become less frequent.

4 Economic Value of Time Spent on Milk Production

As documented in Section 3, milk production requires substantial time. To make the value of this largely hidden contribution explicit—and to inform policies, workplace supports, and intra-household arrangements—we translate this time into dollars. Logged minutes are converted using a standard opportunity-cost, value-of-time (VoT) approach, which assigns each minute the wage the mother could have earned in paid work instead of producing milk ([Becker, 1965]). We value the opportunity cost of this time using the 2020 U.S. median hourly pay for women aged 25–34 ($15.93; U.S. Bureau of Labor Statistics, 2021), the demographic closest to our sample.

Because many mothers do not log every single child-day for an entire year, we predict daily milk-production minutes for missing child-days using the child fixed effects model introduced in

Figure 3: Duration and Economic Value of Milk Production in the First Year



Notes. ◆ marks the mean, and | mark the 25th, 50th, and 75th percentiles. Histogram of cumulative milk-production time and its value of time (VoT) for the first year. VoT is calculated at \$15.93/h—the 2020 U.S. median hourly wage of working women aged 25–34 (BLS, Table 8; U.S. Bureau of Labor Statistics [2021]). Axis ticks use "k" for thousand (e.g., 10k = 10,000).

Section 3. This yields a complete daily series for each child-day across the first year. Multiplying these minutes by the shadow wage gives individual annual VoT estimates. Appendix B discusses this approach and details the imputation procedure, and appendix D reports robustness checks that (i) restrict the sample to fully recorded child-days and (ii) apply alternative wage benchmarks.

Figure 3 shows the model-based distribution of cumulative milk-production time for the first year and its economic value. Complete estimation details are given in Appendix B. The median mother generates a VoT of $9,386; the interquartile range spans $7,342–$12,354, and more than 5% of mothers exceed $19,524. These totals are substantial and likely conservative. Milk-production sessions are scattered across the day and night rather than consolidated into a single block, and they are relatively inflexible, creating appreciable interference with work, leisure, and sleep (section 3). Jobs that demand such fragmented, round-the-clock commitments typically pay a scheduling premium—a margin not captured by the flat shadow wage used here.

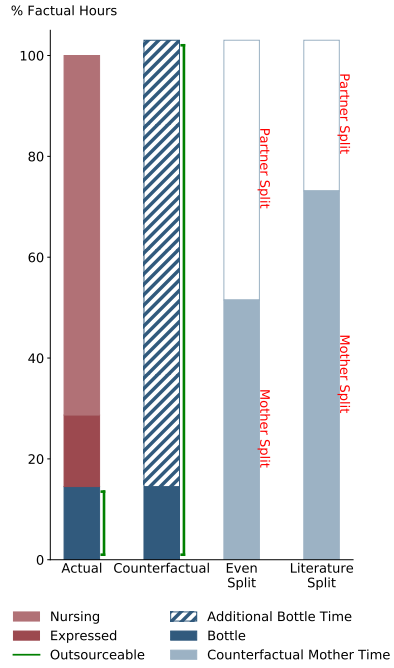
5 Counterfactual: Time Costs and Outsourcing Potential under Formula-Feeding

Unlike nursing, bottle-feeding with infant formula can be shared with a partner or other caregiver. We therefore simulate a counterfactual in which all nursing and pumping stop and the infant is fed exclusively with formula.[1] Milk-production minutes fall to zero, and bottle-feeding minutes are replaced with the predicted feeding time implied by our conversion model.

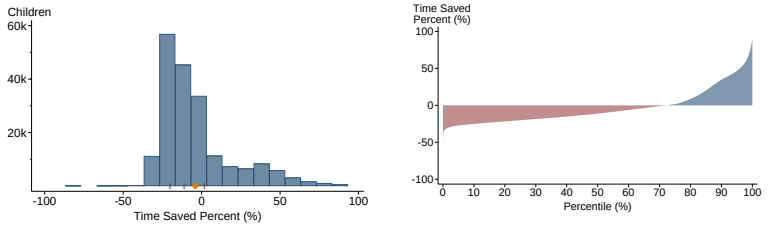
Figure 4a compares mothers' observed feeding-time allocation (left bar) with three counterfactual bars: an exclusive-formula counterfactual and two alternative redistributions of the now outsourceable bottle-feeding time. In the factual data, mothers spend 71% of feeding-related time nursing, 14% pumping (expressed), and 15% bottle-feeding. Under exclusive formula (second bar), total feeding-related time rises slightly to 103% of baseline, yet all of that time becomes outsourceable—whereas before, only 15% was (green bracket). Allocating the outsourceable minutes evenly between parents (third bar) or at a 71:29 mother–partner ratio (fourth bar, ratio from Guryan et al., 2008) reduces the mother's feeding-related time commitment to 52% and 73% of baseline, respectively.

[1] In the counterfactual we assume lactation ceases physiologically; expressed-milk minutes drop to zero.

(a) Counterfactual Conversion of Feeding Times to Fully Outsourceable Activities



(b) Distribution of Feeding Time Difference After Converting to Bottle Activities



(c) Distribution of Feeding Time Spent on Non-Outsourceable Milk Production

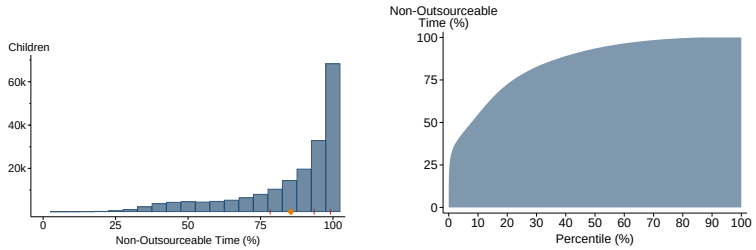


Figure 4: Time Adjustments to Switching to Bottle Feeding

Notes. ◆ marks the mean, and | mark the 25th, 50th, and 75th percentiles. (a) Stacked bars compare mothers' observed allocation of feeding-related minutes across nursing, expressing and bottle-feeding ("Actual") with an exclusive-formula counterfactual ("Counterfactual") and with two hypothetical redistributions of the now-outsourceable bottle minutes: a 50:50 and a 71:29 mother–partner split (71% ∼7.69/(7.69 + 3.17); Guryan et al., 2008). (b) Time Saved Percent is calculated as 100 × (observed - counterfactual)/observed; values are bounded between –100% and 100% for display. A value of +100% means all feeding-related time would be eliminated, whereas –100% is an arbitrary lower bound—if counterfactual time more than doubles, the increase can exceed –100%. The left panel shows a histogram of time-saved percentages; the right panel orders the same values from lowest to highest (x-axis = percentile rank). (c) Non-Outsourceable Time (%) is the share of feeding-related time spent nursing or expressing under the milk-production regime; under exclusive formula this share would drop to zero. Axes in panels (b) and (c) use "k" for thousand (e.g., 60k = 60,000).

Figure 4b examines heterogeneity by ranking children according to the percentage of total feeding-related time their mothers would save if nursing and pumping were replaced by exclusive formula during the first year; potential savings from outsourcing are excluded. The median time saved is −11%, and the 10th–90th-percentile range spans −25% to 35%. Negative values indicate that exclusive formula would increase the mother's feeding-related time. Two factors drive this dispersion. First, our data imply that bottle-feeding is typically slower than nursing, even though the "exchange rate" between the two activities varies across mother–infant dyads. Second, mothers differ in the share of baseline time spent pumping: where that share is large, eliminating expression can offset more of the extra minutes required for bottle-feeding. In most cases, though, the greater time demand of bottle-feeding more than cancels the minutes saved from ending expression, so most mothers would see a small increase in total feeding-related time, whereas only those whose nursing is unusually long or who spend much time pumping may realize net savings. Thus, the main time-use benefit of formula feeding lies not in minutes saved but in its potential to reallocate feeding duties to other caregivers, reducing the mother's own time burden and increasing her scheduling flexibility.

Figure 4c shifts the focus to the share of feeding-related minutes that *cannot* be handed off under the observed milk-production regime—namely, nursing plus pumping. The left panel plots a histogram of this non-outsourceable share for every infant's mother; the right panel orders the same values by percentile. The median mother must currently perform 93% of all feeding-related minutes herself (i.e., this time is non-outsourceable under the milk production regime); the 10th–90th-percentile range spans 55%–100%. Switching to exclusive formula would eliminate this sizable share of non-outsourceable time. Combined with the modest—or even negative—time savings shown in Figure 4b, this pattern underscores that the chief advantage of formula feeding is redistributive: it converts a median 93% of all feeding-related minutes into time that can, in principle, be handed off to another caregiver.

6 Discussion

Milk production is a largely one-sided form of caregiving—usually performed exclusively by the birthing parent, often behind closed doors, and on a rigid schedule—yet its temporal footprint has

seldom been studied. Drawing on approximately 203 million time-stamped nursing, pumping, and bottle-feeding events, we quantify how milk production shapes mothers' time use. During the first 90 days postpartum, mothers devote a mean of 157 minutes per child-day across approximately nine milk production sessions. The median mother has only one uninterrupted three-hour block and zero uninterrupted four-hour blocks during daytime, and experiences about two milk-production–related nighttime disruptions. Although daily minutes decline over the year, the cumulative commitment remains substantial—an estimated 39,621 minutes (about 660 hours, or 17 standard workweeks). Valued at prevailing wages, this amounts to a median economic value of $9,386 (interquartile range $7,342–$12,354). Switching to exclusive formula seldom cuts total feeding-related time because bottle-feeding is often slower than nursing; its chief benefit is redistributive, converting a median 93% of non-outsourceable feeding-related minutes into time that can be shifted to other caregivers.

These estimates give policymakers, employers, and households a quantitative baseline for evidence-based decision-making and support-system design. In the first 90 postpartum days—the window many maternity-leave statutes aim to protect—a mother typically spend $2\frac{1}{2}$ hours of milk production each child-day. Even if a mother is on leave, this fixed commitment leaves little unbroken time for sleep, recovery, or paid work. When the leave is unpaid or shorter than 90 days, a mother faces a direct trade-off between lactation and income. Over the full year, the median value of the time spent on milk production alone ($9,386) falls within the same order of magnitude as the United Kingdom's flat-rate Statutory Maternity Pay and Canada's maternity benefit, but it exceeds the cash support available in U.S. without paid leave [OECD, 2024].[2]

At work, the cadence of milk production in the first 90 days leaves the median mother with no uninterrupted blocks longer than three hours. For knowledge workers in particular, the lack of multi-hour focus windows may limit the tasks they can undertake and could influence sorting toward roles and tasks that tolerate frequent interruption. Standard half-day work segments, extended meetings, or rigid shift rotations can therefore conflict with lactation needs. Offering short, protected pumping breaks every 2–3 hours—together with flexible scheduling or remote-work arrangements that permit brief off-camera intervals—can allow mothers to meet these physiological

[2]These quantified opportunity costs complement evidence that long-duration breastfeeding is associated with larger and more persistent earnings penalties for mothers [Rippeyoung and Noonan, 2012], and that breastfeeding-promoting hospital regulations increase maternal child-care time while reducing formal-work hours in the first three months postpartum [Lawler and Yewell, 2023]. Together, these findings suggest that the time demands documented here may be one mechanism behind the "child penalty."

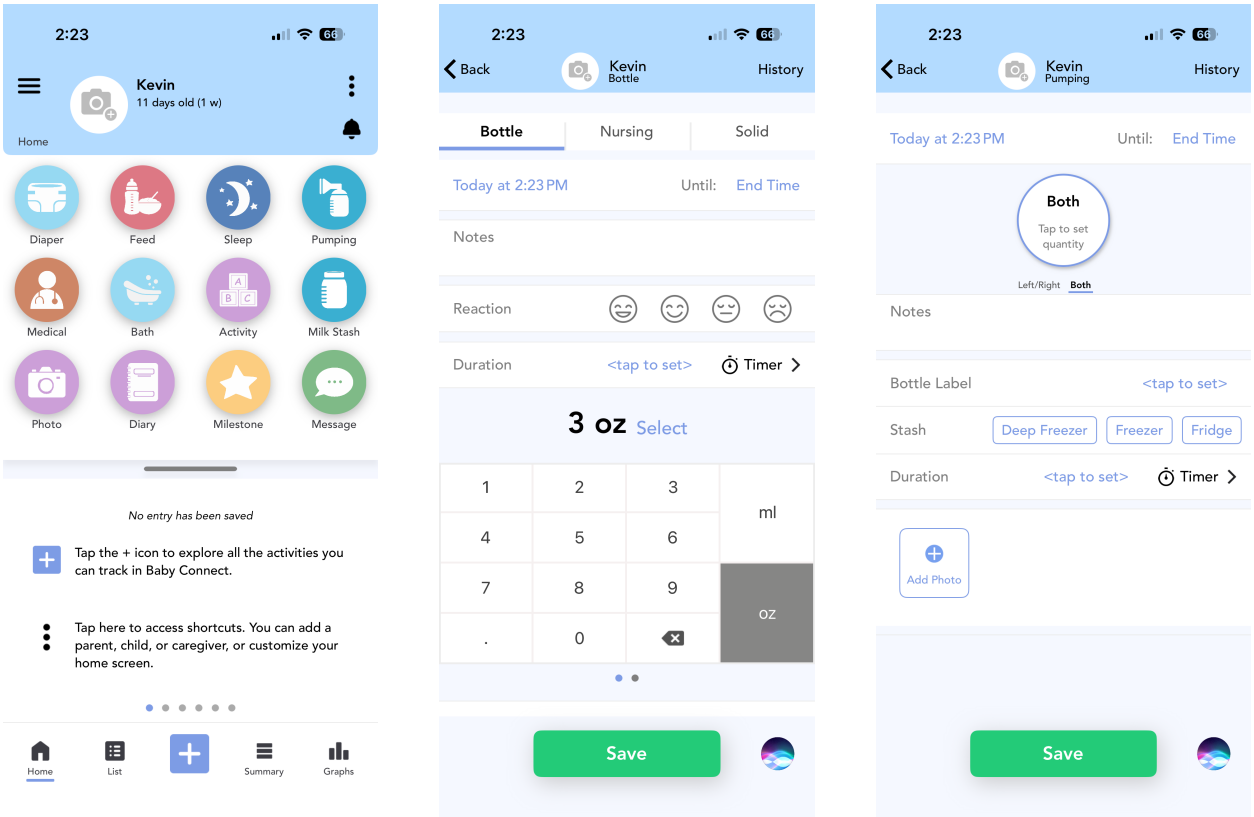
demands without having to withdraw from the labor force or incur wage penalties. Finally, the fact that milk production leaves the median mother solely responsible for roughly 93% of feeding-related time, and for about two milk-production disruptions each night, these estimates provide families with concrete parameters for deciding how partner leave, shared duties, or later feeding choices can be arranged to distribute early child-care evenly.

Our analysis presents opportunities for future research. The minute-level detail afforded by these real-time logs provides empirical information unavailable in datasets that record only whether and how long mothers breastfeed, and the self-initiated nature of logging helps minimize observer effects. Nonetheless, app users are self-selected and any demographic information they may enter is not included in the research extract, so generalizability across income or cultural groups remains uncertain. Despite sample filters designed to maximize completeness, logs may miss multitasked sessions, feeds performed when the phone is out of reach, or unsuccessful latch attempts and ancillary tasks such as sterilizing pumps and bottles, so the minutes we capture likely represent a lower bound on total lactation effort. Our data also omit time spent managing lactation-related health issues, overall maternal health, and long-run labor-market outcomes. Future work could link high-frequency logs with representative surveys, biometric sleep trackers, health records, and administrative earnings data, and use policy variation—such as differences in paid-leave length or partner-leave take-up—to test how institutional and household supports shape mothers' time use and related outcomes. Such studies would provide evidence to further guide household decisions and public and workplace policies that acknowledge—and better support—this largely invisible labor.

Appendix

A Baby Connect Mobile Phone Application

The data come from the mobile application BabyConnect, which allows parents to track various caregiving activities, including nursing, pumping, bottle-feeding, sleep, and developmental milestones. Each recording includes a start and end timestamp, along with activity-specific categorical data. Unique IDs identify each child and each parent account. To simplify our analysis, we focus exclusively on the child ID. This means that all results are at the child level and do not account for how multiple children may affect a parent's experience. Figure 5 provides example screenshots from the BabyConnect interface, illustrating the activity categories and logging options available to users.



(a) Home screen with activity categories **(b) Feeding options (bottle, nursing, solids)** **(c) Pumping/expression screen**

Figure 5: Screenshots from the BabyConnect application

Notes. These panels illustrate the interface of the BabyConnect app used for activity logging. (a) The main landing page presents the set of activity types that a user can record. (b) Selecting the *Feeding* icon opens options to log bottle feeding, nursing, or solid food intake. (c) The *Pumping* screen allows users to record milk expression sessions.

We verified that the smartphone data reproduced trends that were broadly consistent with prior survey-based studies. Using test-weighing to measure milk transfer, prior physiological studies of exclusively breastfeeding mothers with infants aged 1 to 6 months report roughly 11 feeds per day and an implied 150 to 170 minutes of daily milk-removal time [Kent et al., 2006]. Our estimates of 157 minutes and 9 sessions per day fall within this range, indicating that the app-based records align with established clinical benchmarks.

B Sample Restrictions and Data Cleaning

Our data restrictions follow a series of steps, summarized in Figure 6. We describe each step in detail below.

In the data restrictions, we start by removing any activities that have a reported duration of over 12 hours, which likely reflect cases where users forget to end tracking. We also exclude infants whose first recorded activity occurred prior to 2012, as only a small fraction of infants enter before this point, which raises concerns that these users are a non-representative subset. We further exclude the first two weeks after child birth due to inconsistent logging and limit the analysis to the first year of life.

Our primary analysis focuses on feeding-related activities—nursing, bottle, and expressed milk events. Since our analysis is primarily conducted at the child-day level, to address concerns about incomplete daily logging, we limit the sample to child-days with at least one daytime feeding.

Missing durations for focal activities (bottle feeding, expression, or nursing) are imputed using linear regression after winsorizing durations at the 99th percentile. For expression and bottle feeding events, the regression includes child age (in days) and its interaction with reported quantity (in milliliters). For nursing events, where quantity is not observed, the model includes child age alone.

We exclude all recorded child-days with any formula use (a subset of bottle-feeding activities). Because formula feeding often reflects days when milk production differs from usual patterns, retaining these observations could distort estimates of typical breastfeeding and pumping behavior.

To further ensure adequate daily recording, we exclude days in which an infant's total number of feeding events falls below the age-specific 20th percentile. These thresholds are calculated separately for each age (in days), and the filter is applied on a day-by-day basis—so an under-recorded day

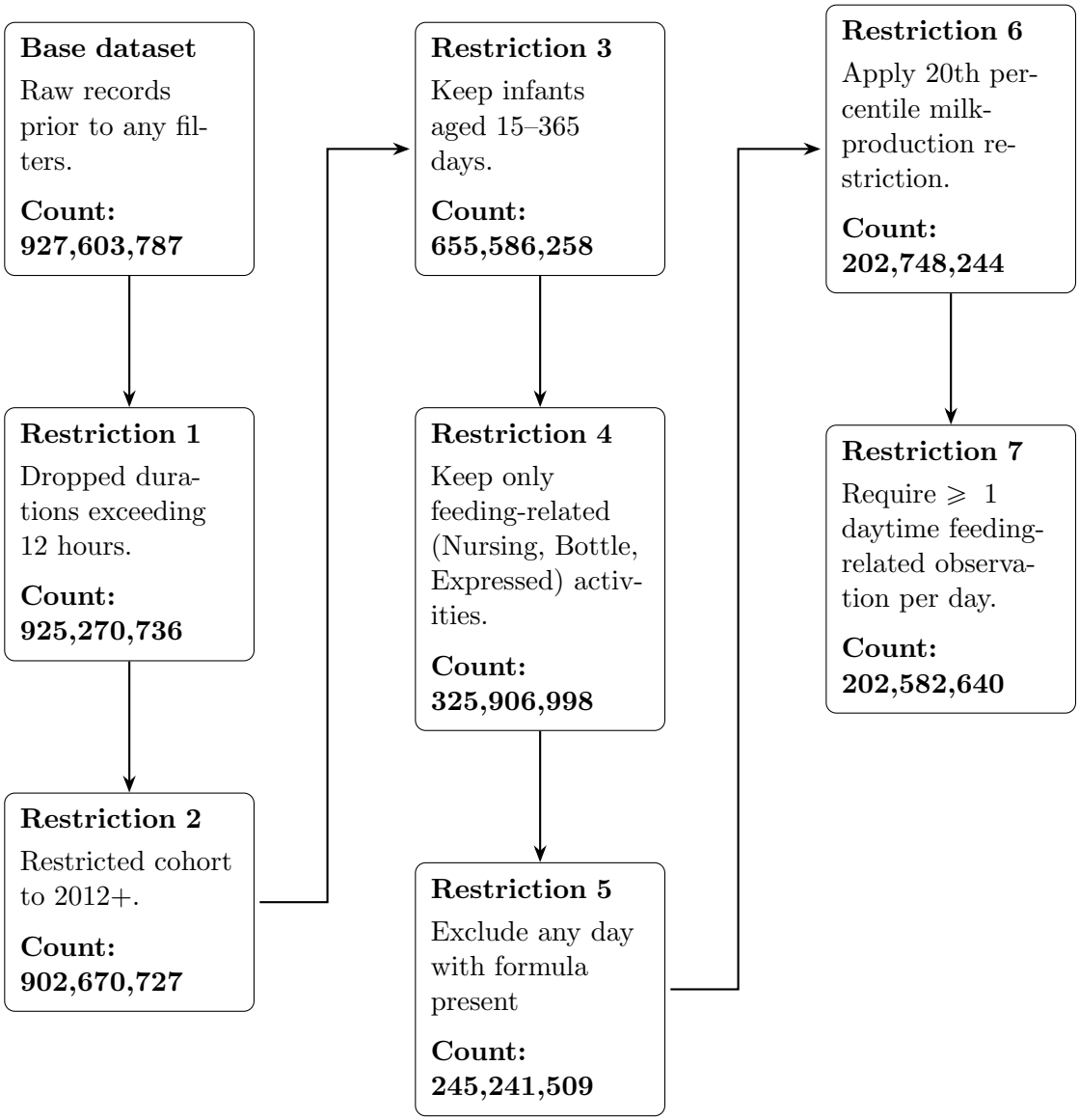


Figure 6: Flow of dataset restrictions.

is removed even if other days for the same child are above the 20th-percentile threshold. We also require at least one feeding-related activity during daytime hours (08:00 - 20:00) to screen out days with incomplete logging.

Figure 7 shows the age-specific 20th-percentile cutoffs, with excluded days highlighted in red. Applying these criteria produces an analytic dataset of approximately 203 million observations spanning two weeks to one year of age.

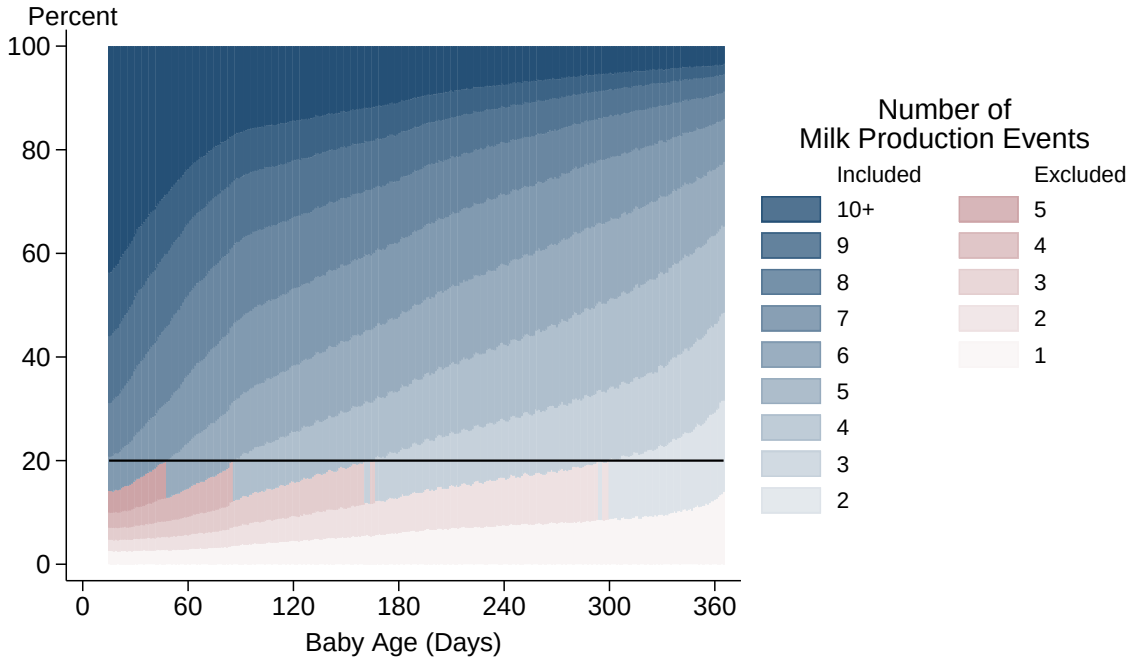


Figure 7: Milk Production Activity Count Percentile Graph

Notes. The figure shows, for each infant age (in days), the percentile distribution of daily milk-production events. For a given age, each vertical slice represents the spread of event counts across all infants. The black line marks the 20th-percentile cutoff used for our sample restriction: days with event counts below this line are excluded (shown in red), and those above it are retained (shown in blue). For example, the median infant record at 15 days of age is nine milk-production events while the 20th percentile is six. The cutoff gradually declines with age, from about five to six events per day in early infancy to around 2 events per day later in the first year.

After applying these restrictions, the dataset includes observations from 172 countries, with approximately 78 percent of observations with recorded country data originating from the United States. Table 1 presents summary statistics for infants aged between 15 and 365 days. On average, users were associated with 1 infants and 6 feedings per day. Notably, US infants represent more than

half of our observations, with a quarter of the data not categorized under a country. Differences in the recorded variables across the countries are modest.

Table 1: Milk Production Statistics by Country

Country	*Duration per Day*	*Count per Day*	*Duration per Record*	*Average Age*	*ChildID Count*	*% of Observations*
US	120.89	6.99	18.43	32.37	112,828	57.4
CA	115.14	7.66	15.88	44.28	5,761	2.9
GB	125.90	8.11	16.33	41.43	4,300	1.9
AU	119.99	7.22	17.47	55.33	3,969	1.8
BR	126.32	7.18	18.53	39.04	2,775	1.3
FR	113.34	7.02	16.82	29.05	3,370	1.2
Other	117.34	7.47	16.72	44.92	16,646	7.5
Missing	123.84	7.08	18.52	45.88	101,316	26.1

Notes. Duration per Day and Count per Day is defined as the average duration and count per child-day. Duration per Record is defined as the average duration per recorded event per child-day. Average age is in number of days and is at the child-level. ChildID count refers to the number of distinct ChildIDs recorded in that year. % of Observations corresponds to the fraction of total observations in the respective year. We group all countries that account for less than 1% of the total observations under the label "Other".

We also evaluate trends in the data by year in table 2. We see minor changes in our sample composition over time, where there is a slight decrease in average age over time as well as an increase in duration per record.

Table 2: Milk Production Statistics by Year

Year	*Duration per Day*	*Count per Day*	*Duration per Record*	*Average Age*	*ChildID Count*	*% of Observations*
2012	129.53	7.54	17.90	42.15	20,920	4.7
2013	116.72	7.06	17.23	45.71	37,491	10.2
2014	119.17	7.15	17.44	41.44	41,612	11.5
2015	118.02	7.08	17.67	40.30	41,479	12.6
2016	121.71	7.18	18.01	35.20	36,144	11.1
2017	121.90	7.16	18.18	37.55	34,133	11.0
2018	122.49	7.04	18.64	38.04	30,619	10.1
2019	123.26	7.02	18.82	37.97	29,065	9.3
2020	126.12	7.15	19.01	35.58	28,479	9.6
2021	119.18	6.78	19.00	38.64	19,755	7.3
2022	121.52	6.87	19.16	35.67	8,274	2.7

Notes. Duration per Day and Count per Day is defined as the average duration and count per child-day. Duration per Record is defined as the average duration per recorded event per child-day. Average age is in number of days and is at the child-level. ChildID count refers to the number of distinct ChildIDs recorded in that year. % of Observations corresponds to the fraction of total observations in the respective year.

Figure 8 is a margins plot that tracks the model predicted average milk production events with

baby age. We note that apart from the initial data fidelity issues at the very youngest ages (roughly the first month), the subsequent trend is as expected, where the amount of milk production events per day decreases with time, with approximately 9 events at 1 month, 5.2 events at 6 months, and 2.6 events at 1 year.

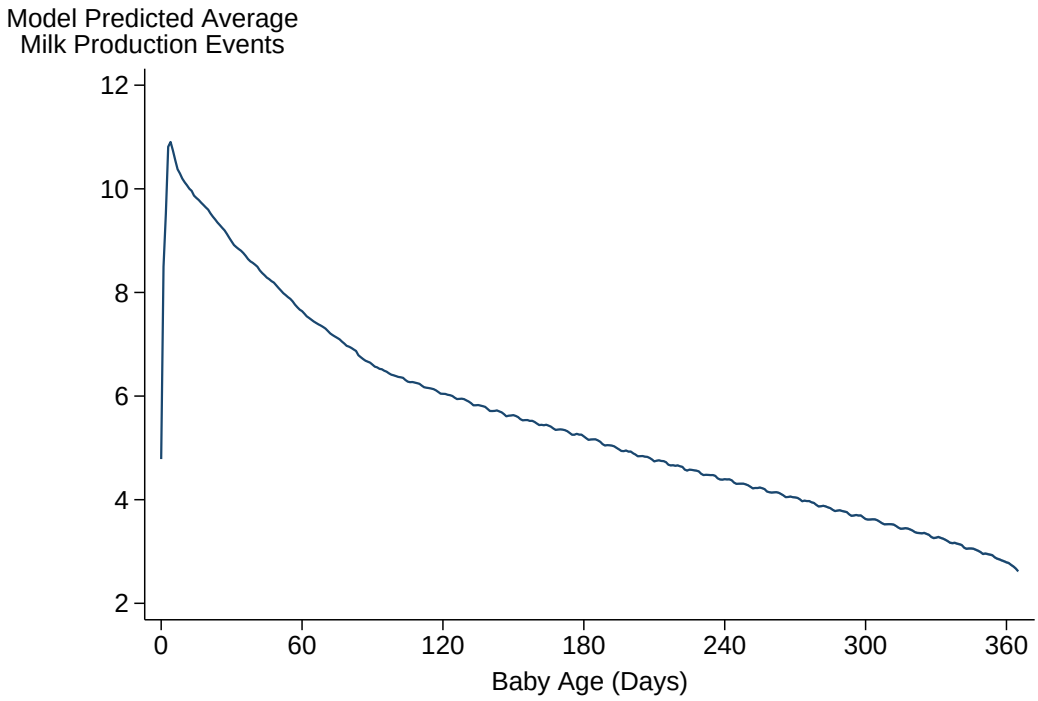


Figure 8: Margins Plot for Milk Production Events

Notes. This figure plots the model-predicted average number of daily milk production events (nursing or expressed) by a baby's age in days, controlling for child-fixed effects. The vertical axis shows the predicted daily count and the horizontal axis tracks baby age from birth to 360 days. Shaded areas represent 95% confidence intervals around the predictions but are difficult to see due to their narrow range.

In subfigures 1c and 1d, uninterrupted periods and nighttime disruptions are defined solely with respect to milk-production events, and other activities are not treated as interruptions. An uninterrupted period is defined as the interval between the end of one milk-production event and the start of the next. For each duration threshold (e.g., 1+, 2+, 3+, or 4+ hours), we count the number of full, non-overlapping blocks of that length that can be placed within an uninterrupted period. For example, a 9 hour uninterrupted interval contributes nine 1+ hours, four 2+ hours, three 3+ hours, and two 4+ hours. Overlapping milk-production activities are merged into a single event, reflecting occasional inconsistencies in timestamp entry, and do not generate uninterrupted

intervals.

Nighttime disruptions are defined as milk-production events that occur during nighttime hours. We use 22:00–06:00 as the nighttime window and 06:00–22:00 as daytime. When an uninterrupted interval spans the daytime-nighttime boundary, only the portion falling within daytime contributes to the daytime uninterrupted measure, and any portion occurring after 22:00 is counted as a nighttime disruption. For example, an uninterrupted period from 20:30 to 23:30 contributes 1.5 hours to daytime uninterrupted time, and the 22:00–23:30 segment is classified as a nighttime disruption. Overlapping milk-production activities, which are due to occasional inconsistencies in activity entry, are merged into a single event, are not counted as additional uninterrupted intervals.

We also run a series of robustness checks in Appendix D using feeding instead of milk production (Figures 11) as well as redefining daytime as 08:00 to 20:00 instead of 06:00 to 22:00 (Figures 12).

B.1 First Year VOT Prediction

For Figures 2 and 3, the dataset is further restricted to observations with at least 30 days recorded per child to ensure reliable estimation. To estimate the relationship between the child's age and milk production duration, we use the following fixed-effects regression model:

$$\log(\text{duration}_{it}) = \alpha_i + \sum_{d=15}^{365} \beta_d \times \mathbf{1}\{\text{age}_{it} = d\} + \varepsilon_{it}, \tag{1}$$

with i and t indexing the child and age in days. duration_{it} is the number of minutes that the mother of child i spent producing milk on day t, α_i captures child-specific fixed effects, and indicator variables represent each child's age in days. Then, we generate model-based predicted values of milk-production duration for each child-day within the first year of life, using the estimated fixed effects and age-day coefficients. These predicted durations are aggregated at the child level across the first year to obtain a model-based estimate of each child's cumulative milk-production time (a full year comprises 660 hours). The economic value of mothers' time dedicated to milk production is computed using the median wage rate of \$15.93 per hour (see U.S. Bureau of Labor Statistics, 2021). Appendix Figure 17 presents results using an alternative value-of-time estimate of \$19.38 per hour [Goldszmidt et al., 2020]. Total predicted durations per child are multiplied by this wage rate to estimate economic costs associated with breastfeeding duration.

B.2 Exclusive Bottle-Feeding Counterfactual

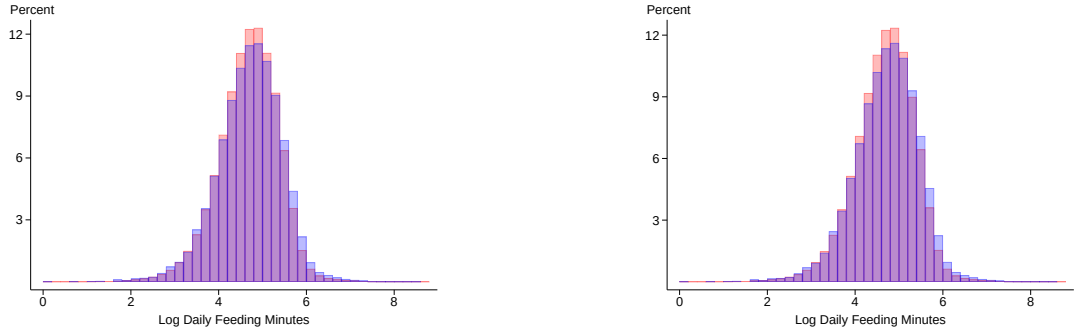
To conduct our counterfactual analyses in subfigures 4b and 4c, we prepare a separate data sample to estimate the conversion rate in time usage between nursing and bottle-feeding. To prepare the conversion rate sample, we use a modified set of data restrictions. In particular, we (1) restrict to *only* nursing and bottle events, (2) allow for formula events, (3) impute missing nursing and bottle durations, (4) apply the 20th percentile restriction but to only bottle and nursing events, and (5) remove the one observation per daytime requirement. When estimating the conversion rate, the sample is restricted to children between ages 15 and 365 days. The conversion rate regression is given by

$$\begin{aligned}\log(\text{total_time}_{it}) = \beta_0 &+ \sum_w \gamma_w \cdot \text{age_weeks}_{iw} \times \text{share_bottle_time}_{it} + \sum_d \delta_d \cdot \text{dayofweek}_{id} \\ &+ \sum_d \lambda_d \cdot \text{day_within_ageweek}_{id} + \sum_{f,w} \theta_{fw} \cdot \text{total_feeding_events}_{if} \times \text{age_weeks}_{iw} \\ &+ \alpha_{it} + \epsilon_{it}\end{aligned}$$

with i and t indexing the child and age in days, respectively. $\log(\text{total_time}_{it})$ is the logarithm of total time spent feeding, age_weeks_{iw} is the child's age in weeks, $\text{share_bottle_time}_{it}$ is the proportion of feeding time spent using a bottle, dayofweek_{it} captures trends in the specific day of the week (e.g., Monday, Tuesday, etc.), $\text{day_within_ageweek}_{id}$ captures the day's position within an age week (e.g., first, second, etc.), $\text{total_feeding_events}_{if}$ is the total number of feeding events in a day, and α_{it} represents fixed effects for each child-week combination. Due to sparseness of observations above 20, we group all total feeding event counts of 20 or more into a single category in the regression.

The conversion rate equation captures the relationship between total feeding time and various factors, including infant age, bottle-feeding proportion, feeding frequency, and time-fixed effects. We use it to estimate total feeding time per child-day under a counterfactual scenario of exclusive bottle-feeding. To this end, we compute the difference between the model-predicted feeding time at the observed bottle share and the predicted feeding time under 100% bottle use. This difference gives the model-predicted change in feeding time. Because only a share of children in the analysis sample are used in estimation (98% matched to at least one estimated child-week), child-week fixed effects are not available for unmatched observations; we set these to zero. Figure 9 compares actual

feeding times with model-predicted actual times for both the full sample and the matched subset. Given that the distributions are nearly identical, we conduct the analysis using the full sample.



(a) Full Sample **(b) Matched Sample**

Figure 9: Predicted vs Actual Log Feeding Times

Notes. Observed, Predicted. The left panel includes the entire sample, while the right panel includes only matched observations.

We then express counterfactual total feeding time as

$$\text{Counterfactual Time} = \text{Factual Time} + \widehat{\Delta\text{Time}} - \text{Factual Expressed Time}.$$

where Factual Time is the observed sum of nursing, expressing, and bottle-feeding time, and $\widehat{\Delta\text{Time}}$ is the model-predicted change under exclusive bottle-feeding. Expressed time is subtracted because expression is assumed to cease once nursing is discontinued.

C Extended Results for Figure 1 (Full-Year Analysis)

The duration of daily milk production may vary over time, as solid foods get introduced (generally recommended no earlier than 4 months of age [Centers for Disease Control and Prevention, 2025]), as mother and infant become more efficient, and as some mothers re-enter the labor force. Figure 10 examines trends in milk production across three age cohorts, namely 15-90 days (similar to the prior section), 91-180 days, and 181-360 days.

We observe a steady decline in the duration of milk production activities as a child ages. The average daily duration of milk production differs meaningfully across these cohorts, with mothers of children aged 15–90 days spending 158 minutes per day compared to 115 minutes for the 91–180 day

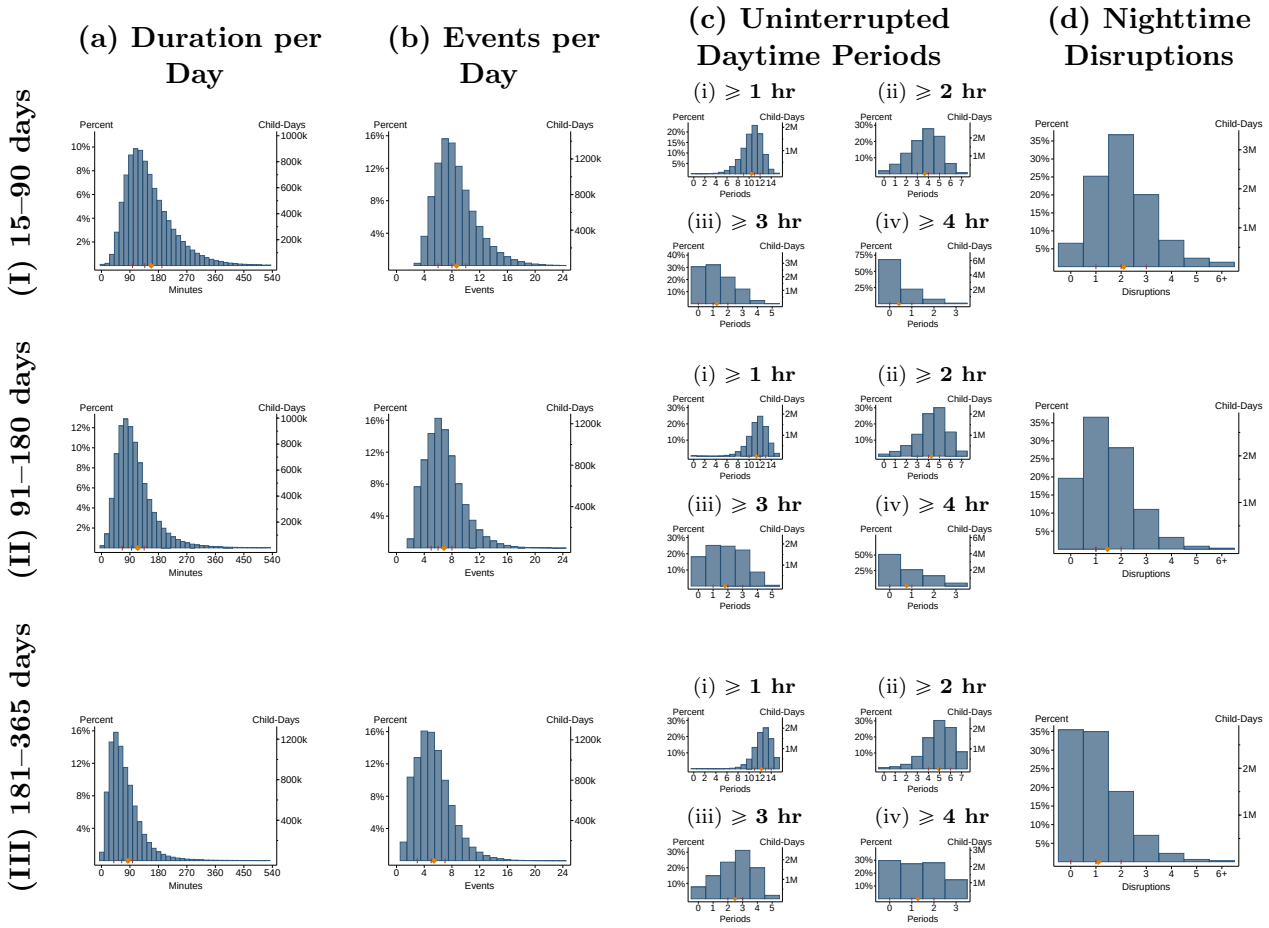


Figure 10: Milk Production by Age Cohort

Notes. ◆ marks the mean, and | marks the 25th, 50th, and 75th percentiles. Daytime is 06:00–22:00; nighttime is 22:00–06:00. "k" in panels (a) and (b) refers to thousand (e.g., 700k = 700,000). "M" in panels (c) and (d) refers to million (e.g., 3M = 3,000,000). Durations > 540 minutes (panel a) and event counts > 24 (panel b) are excluded.

cohort and 85 minutes for the 181–360 day cohort (Figure 15a). These differences are statistically significant (ANOVA, $F(2,\ 24{,}809{,}877) = 1{,}196{,}987$, $p < 0.001$), with mothers of 91–180-day-old infants spending 42 fewer minutes per day, and those of 181–360-day-olds spending 73 fewer minutes, compared to the youngest cohort.

A similar pattern emerges when examining the frequency of daily milk production activities. As shown in Figure 15b, the average number of events declines across age cohorts, from 8.7 among infants aged 15–90 days to 6.9 for those aged 91–180 days and 5.5 for those aged 181–360 days. This reduction is statistically significant (ANOVA, $F(2,\ 24{,}809{,}877) = 2{,}569{,}701$, $p < 0.001$), indicating a consistent decrease in milk production frequency as children age.

We also observe a substantial increase in the number of longer uninterrupted time periods during the day (Figure 15c). Among infants aged 15–90 days, the median number of daytime intervals lasting at least three hours is one; this figure triples to three for those aged 181–360 days. A similar increase is seen for four-hour intervals, rising from zero to one.

At night, we find a corresponding decline in interruptions linked to milk production (Figure 15d). The median number of nighttime disruptions due to milk production activities falls by half—from two interruptions for mothers of children aged 15-90 days to just one for those with children aged 181-360 days. Additionally, uninterrupted nights become increasingly common, with the proportion of disruption-free nights rising from 7% to 20% and reaching 35% in the oldest cohort.

To ensure that these observed patterns are not driven by sample composition, we conduct a robustness check (see Appendix D) using a restricted sample that includes only individuals present in all age cohorts. We find that the trends remain largely consistent, with only minor deviations that do not meaningfully affect the main conclusions.

D Robustness Checks

D.1 Robustness for Figure 1:

This section evaluates the robustness of the descriptive patterns documented in Figure 1 and the extended results in Appendix C.

We first examine an analogous set of descriptive patterns for all feeding-related activities, including milk production, nursing, solid foods, and formula feeding, to assess the broader feeding

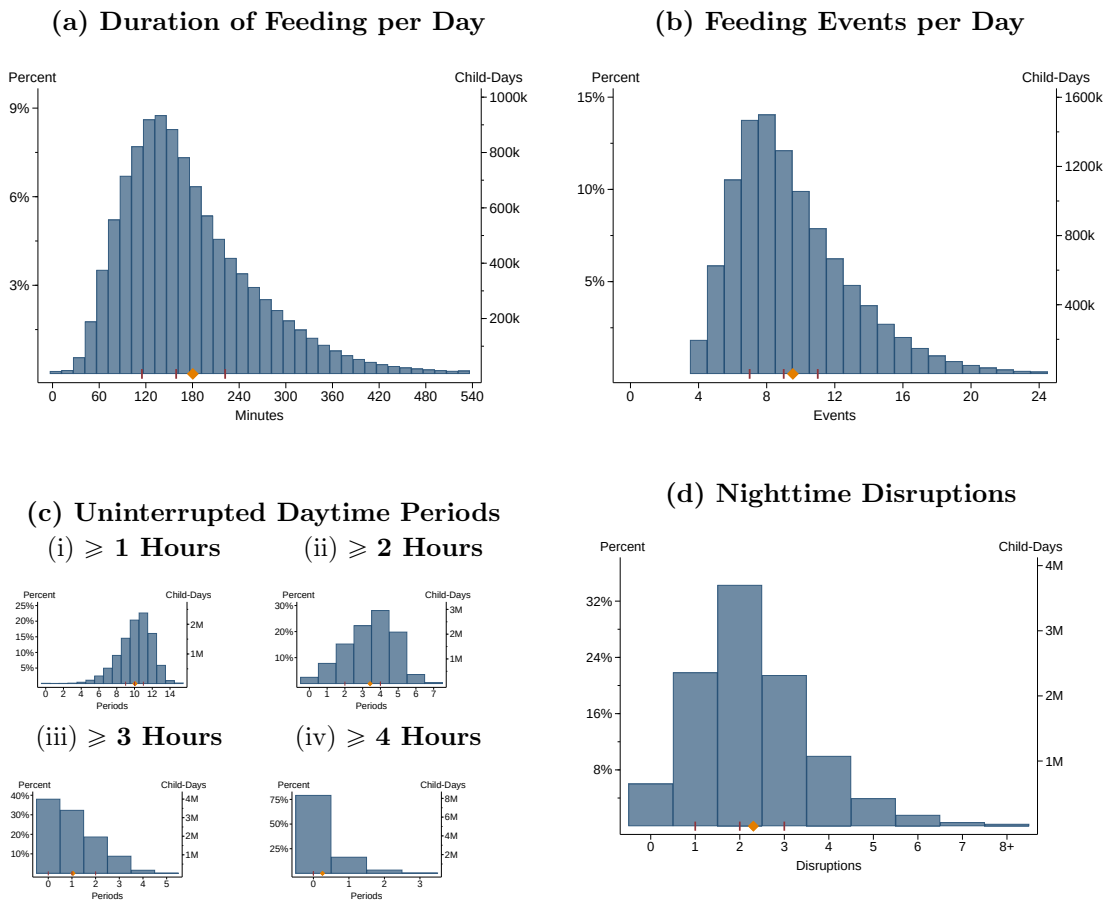


Figure 11: Feeding (Robustness)

Notes. ◆ denotes the mean, and | denotes the 25th, 50th, and 75th percentiles. Day is defined as a 24-hour day. Daytime is defined as being from 6am to 10pm. Nighttime is defined as being from 10pm to 6am. The age range of this sample is between 15 days and 84 days (12 weeks). "k" in panels (a) and (b) refers to thousand (e.g., 700k means 700,000). "M" in panels (c) and (d) refers to million (e.g., 3M means 3,000,000).

environment. These results appear in Figure 11.

Daily feeding duration, event frequency, uninterrupted daytime intervals, and nighttime disruptions all exhibit the same qualitative structure observed when focusing solely on milk-production activities.

Next, we assess the sensitivity of the daytime-interval measures to an alternative definition of daytime (08:00–20:00 rather than 06:00–22:00). Because Figures 1a and 1b do not depend on the daytime cutoff, only the uninterrupted daytime intervals and nighttime disruptions are affected. As shown in Figure 12, the patterns remain largely unchanged under the narrower window.

We also verify that the results are stable over time by splitting the sample into two periods, 2012–2017 and 2018–2022 (Figure 13). The patterns are similar across both halves of the study

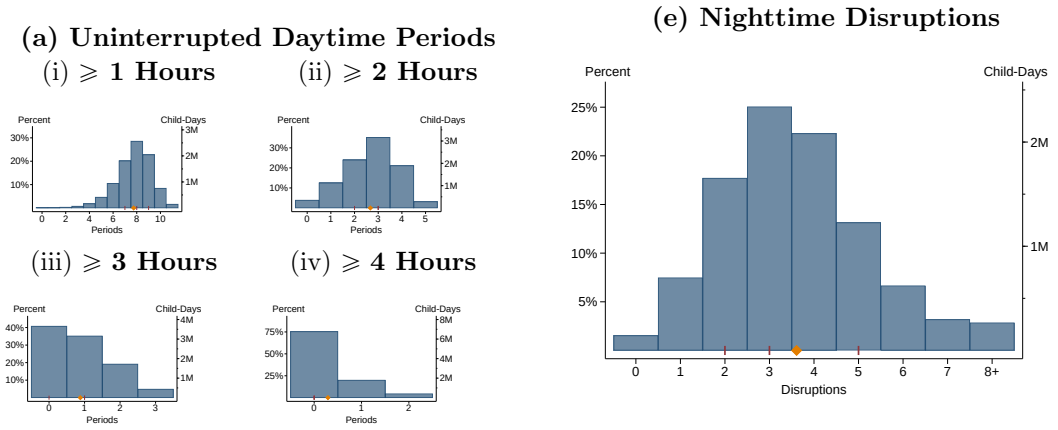


Figure 12: Milk Production (8 AM to 8PM Robustness)

Notes. ◆ denotes the mean, and | denotes the 25th, 50th, and 75th percentiles. Day is defined as a 24-hour day. Daytime is defined as being from 8am to 8pm. Nighttime is defined as being from 8pm to 8am. The age range of this sample is between 15 days and 84 days (12 weeks). "k" in panels (a) and (b) refers to thousand (e.g., 700k means 700,000). "M" in panels (c) and (d) refers to million (e.g., 3M means 3,000,000).

window, suggesting that the main takeaways are not driven by changes in smartphone or app use over time.

Finally, we examine whether the age gradients in Figure 10 reflect genuine within-child changes or shifts in sample composition across age groups. While the figure shows clear differences across the 15–90, 91–180, and 181–360 day cohorts, it does not distinguish whether these patterns arise from aging or from changes in which children appear in each cohort. Figure 14 documents this by showing entry and exit across age groups.

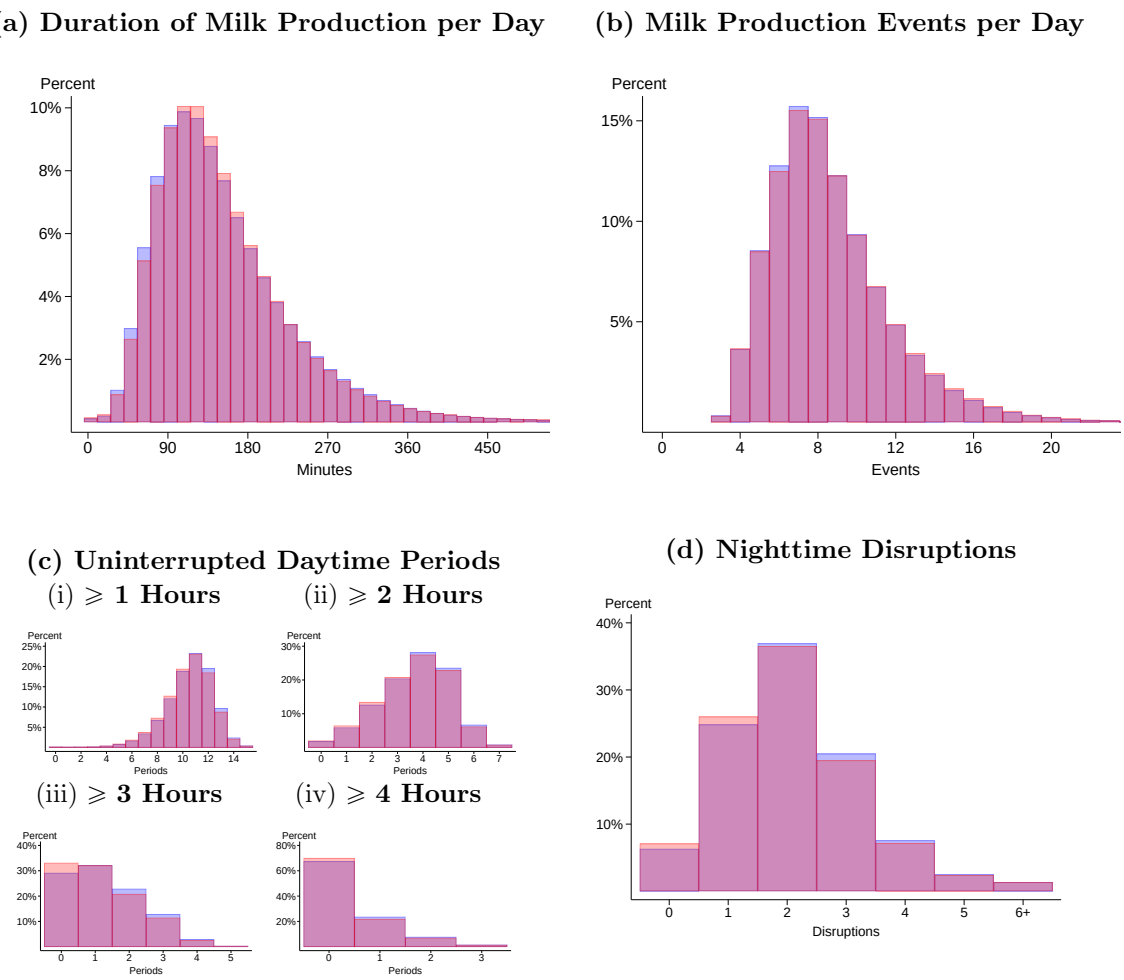


Figure 13: Milk Production Across Two Periods

Notes. First half (2012–2017), Second half (2018–2022). ◆ marks the mean, and | mark the 25th, 50th, and 75th percentiles. Day is defined as a 24-hour time window. Daytime is 06:00–22:00. Nighttime is 22:00–06:00. The sample spans infant ages 15–90 d. "k" in panels (a) and (b) refers to thousand (e.g., 700k = 700,000). "M" in panels (c) and (d) refers to million (e.g., 3M = 3,000,000). For clarity, durations > 540 minutes (panel a) and event counts > 24 (panel b) are excluded.

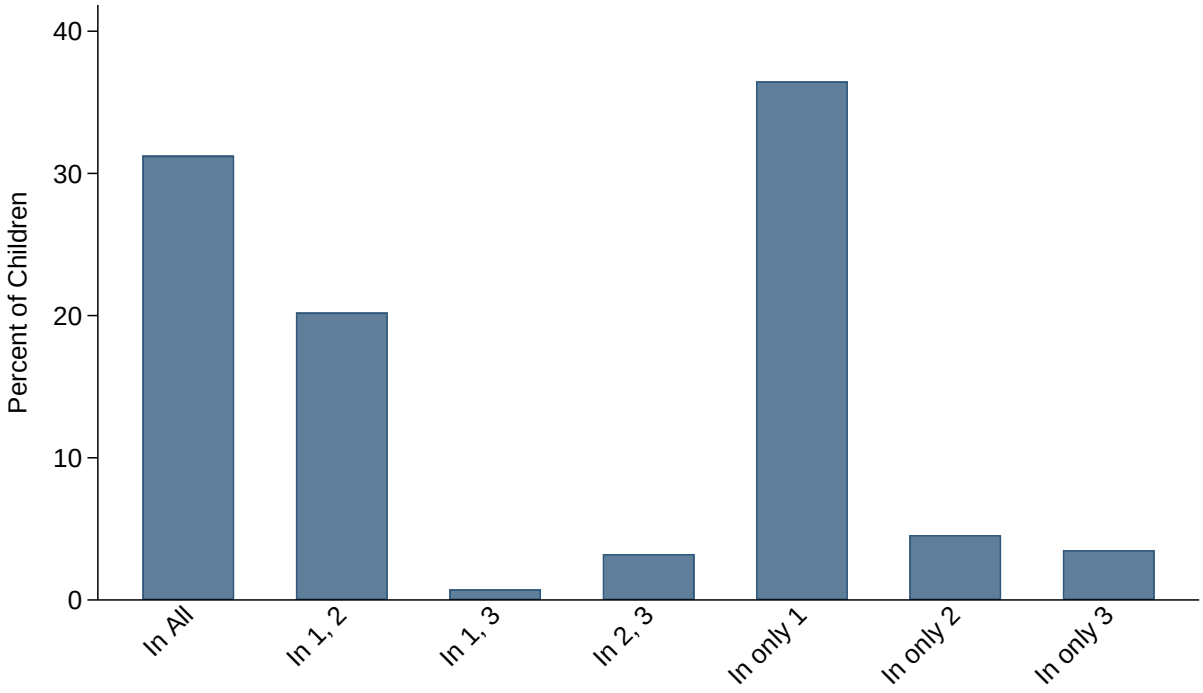


Figure 14: Entry and Exit by Age Cohort

To gauge the influence of this turnover, we limit the analysis to children observed in all three age cohorts. Only 31% of children meet this criterion, whereas 37% appear exclusively in the youngest cohort, indicating substantial attrition as children age. Although this restriction substantially reduces the sample, it enables us to focus on within-child patterns.

Figure 15 shows that restricting the sample to children observed in all three cohorts yields patterns that closely parallel those in the full dataset (Figure 10). The age gradients in daily duration and event frequency (Figures 15a–15b) reproduce the same age gradient with mean levels that differ only modestly from the unrestricted estimates. A similar conclusion holds for uninterrupted daytime intervals (Figure 15c) and nighttime disruptions (Figure 15d), where we see the same qualitative decline in interruptions and increase in longer daytime intervals as children age.

Mean levels are somewhat higher in the restricted sample, consistent with the fact that families who continue recording at older ages tend to log more activity overall. While this restriction isolates within-child patterns, it may understate the true rate of decline if mothers exit the dataset after ceasing milk production, as their later (unobserved) values would effectively be zero.

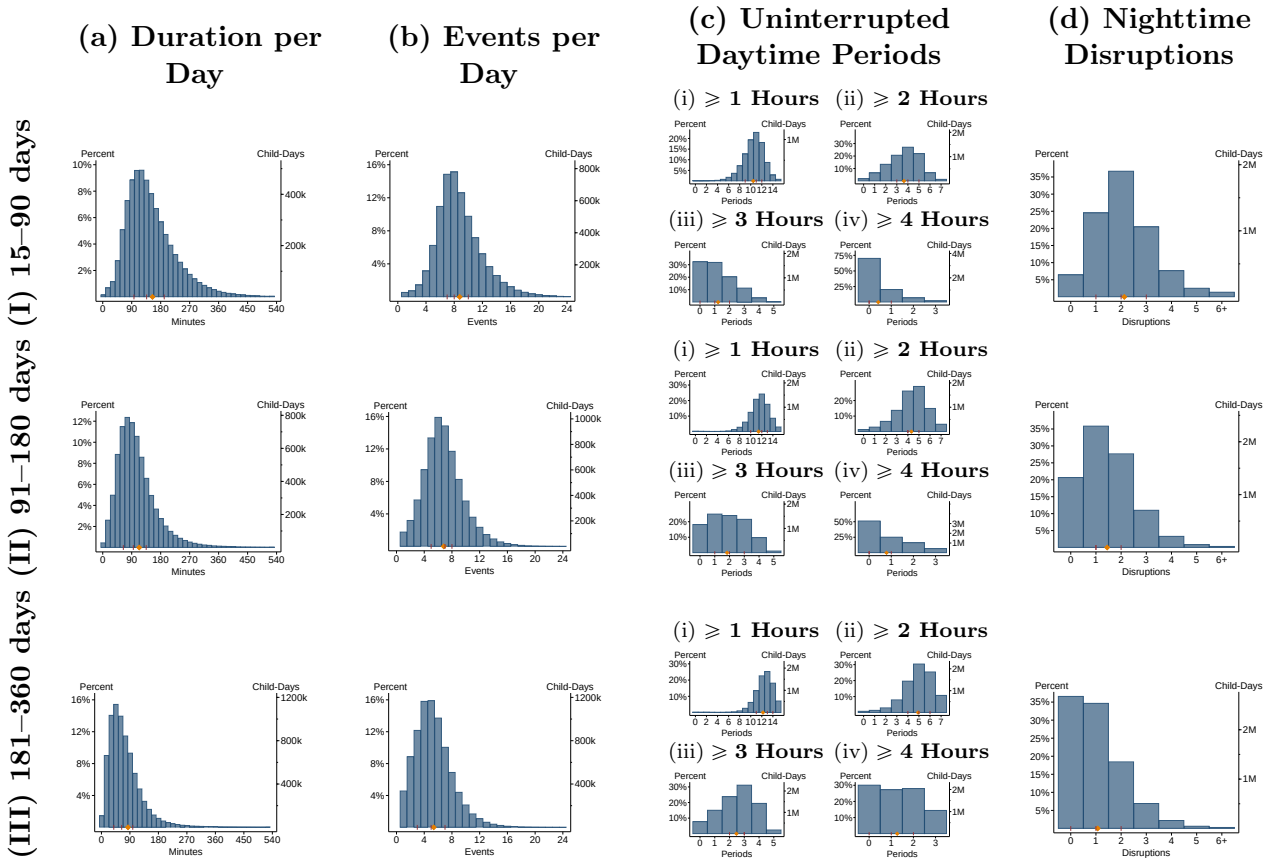


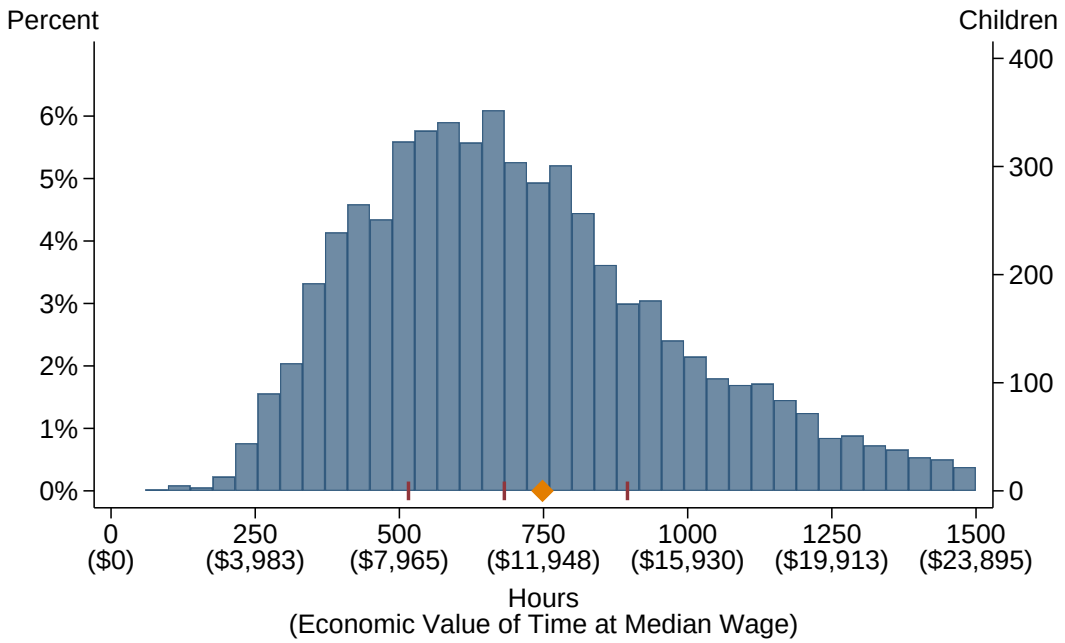
Figure 15: Milk Production by Age Cohort (Intersection Appendix)

Notes. ◆ denotes the mean, and | denotes the 25th, 50th, and 75th percentiles. Daytime is 6am–10pm; nighttime is 10pm–6am. "k" in panels (a) and (b) refers to thousand. "M" in panels (c) and (d) refers to million.

D.2 Robustness for Figure 3:

To evaluate whether incomplete recording affects our findings, we repeat the primary analyses, restricting the sample to children with a milk-production activity recorded every day from day 15 through day 365 (N = 5,777 vs. N = 192,147 in the full sample). Figure 16 displays the results under this restriction. The observed patterns remain qualitatively similar, with the distribution shifted slightly upwards, indicating that the main conclusions are not driven by partial reporting.

Figure 16: Duration and Economic Value of Milk Production in the First Year (restricted to daily recorders)

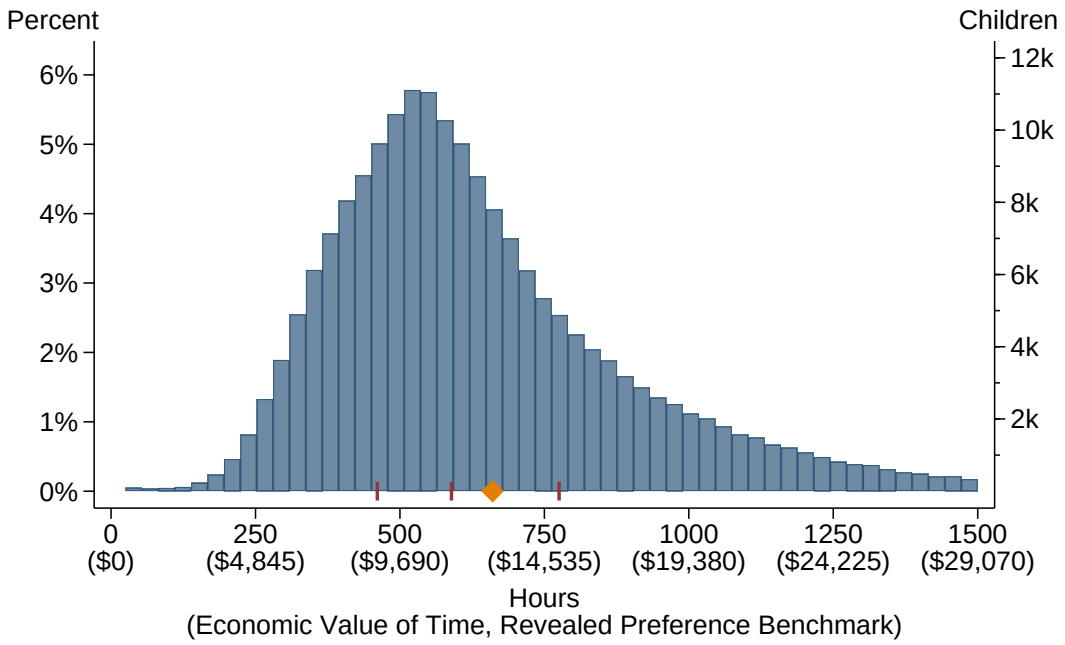


Notes. ◆ marks the mean, and | mark the 25th, 50th, and 75th percentiles. Histogram of cumulative milk-production time and its value of time (VoT) for the first year. VoT is calculated at \$15.93/h—the 2020 U.S. median hourly wage of working women aged 25–34 (BLS, Table 8; U.S. Bureau of Labor Statistics [2021]). Axis ticks use "k" for thousand (e.g., 10k = 10,000). Sample restricted to children with daily recording.

We also assess the sensitivity of the economic value estimates to alternative wage rates. Specifically, we recalculate the economic value of mothers' time using a value-of-time benchmark of \$19.38 per hour (2015 dollars) that has been estimated from large-scale natural field experiments with Lyft [Goldszmidt et al., 2020]. This benchmark is estimated using revealed-preference evidence on how people trade off money and time in real-world decisions. Figure 17 summarizes these results. While the absolute dollar values change, the relative patterns and main findings are robust to the choice

of wage benchmark.

Figure 17: Duration and Economic Value of Milk Production in the First Year (restricted to daily recorders)



Notes. ◆ marks the mean, and | mark the 25th, 50th, and 75th percentiles. Histogram of cumulative milk-production time and its value of time (VoT) for the first year. VoT is calculated at $19.38/h—a revealed-preference benchmark [Goldszmidt et al., 2020]. Axis ticks use "k" for thousand (e.g., 10k = 10,000).

D.3 Robustness for Figure 4:

The results in the main text summarize outcomes over the full first year. To assess whether effects differ earlier in infancy, we repeat the analysis for the first 90 days. As shown in Figure 18, the benefits of formula feeding remain heterogeneous in the first 90 days, with a slight decline in the percent time saved (median −10 and mean −3.2, compared with −11 and −4.1). Although the exchange rate is lower in the 15–90 day window, meaning that shifting from nursing to bottle feeding results in a smaller change in total time, the lower expression share in this period means that eliminating expression contributes less to total savings. The net effect is ambiguous at the individual level, but in aggregate we observe a slight reduction in the overall time-saved measure.

As an additional robustness check, we restrict the analyses in Figure 4 to the subset of child-weeks used in the conversion rate estimation dataset (the sample shown in Figure 9b). The corre-

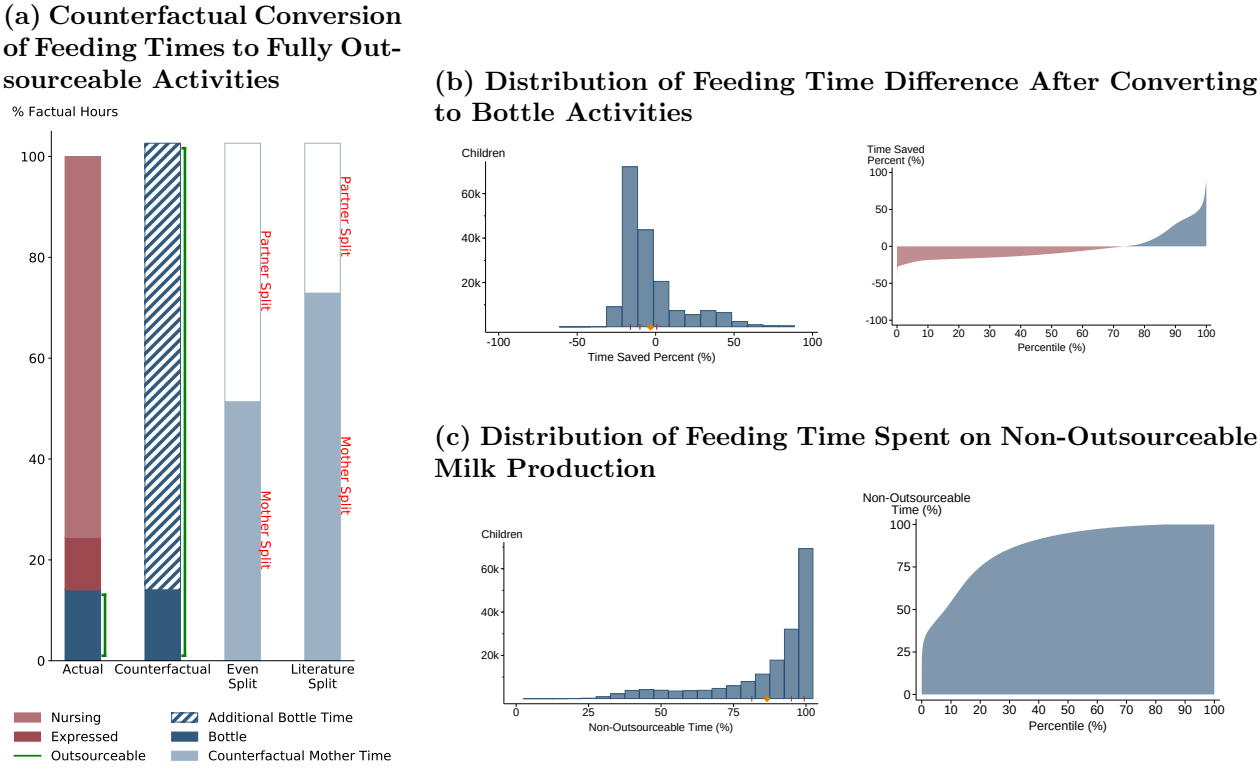


Figure 18: Time Adjustments to Switching to Bottle Feeding (15-90 days)

Notes. ◆ marks the mean, and | mark the 25th, 50th, and 75th percentiles. (a) Stacked bars compare mothers' observed allocation of feeding-related minutes across nursing, expressing and bottle-feeding ("Actual") with an exclusive-formula counterfactual ("Counterfactual") and with two hypothetical redistributions of the now-outsourceable bottle minutes: a 50:50 and a 71:29 mother–partner split (71% ∼7.69/(7.69 + 3.17); Guryan et al., 2008). (b) Time Saved Percent is calculated as 100 × (observed - counterfactual)/observed; values are bounded between –100% and 100% for display. A value of +100% means all feeding-related time would be eliminated, whereas –100% is an arbitrary lower bound—if counterfactual time more than doubles, the increase can exceed –100%. The left panel shows a histogram of time-saved percentages; the right panel orders the same values from lowest to highest (x-axis = percentile rank). (c) Non-Outsourceable Time (%) is the share of feeding-related time spent nursing or expressing under the milk-production regime; under exclusive formula this share would drop to zero. Axes in panels (b) and (c) use "k" for thousand (e.g., 60k = 60,000).

sponding results, presented in Figure 19, closely mirror those in the main analysis.

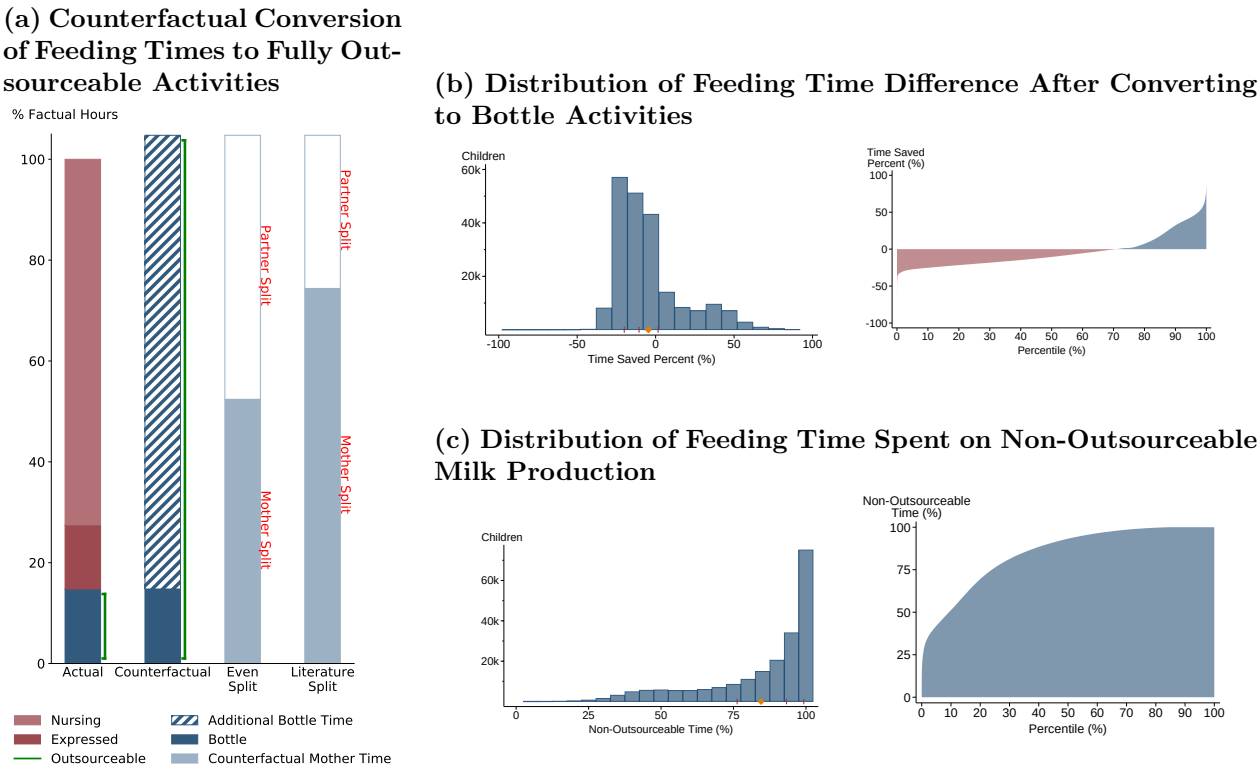


Figure 19: Time Adjustments to Switching to Bottle Feeding (Intersection Appendix)
Notes. ◆ denotes the mean, and | denotes the 25th, 50th, and 75th percentiles. Subfigure (a) contrasts the factual time expenditure for nursing, expressed, and bottle within the first year to the counterfactual time expenditure when switching fully to bottle. The third and fourth bars are hypothetical examples, where time is split evenly (50-50) and based on the literature (71-29) between the mother and the partner. The 71% is computed using $7.69/(7.69 + 3.17) \sim 71\%$, using values from Guryan et al., 2008. (b) Time saved percent is calculated by taking the proportional difference in time after switching fully to bottle feeding. (c) Non-outsourceable time percent is calculated by taking the fraction of time on activities that could be outsourced. "k" in panels (b) and (c) refers to thousand (e.g., 60k means 60,000).

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