



Biologically normal sleep in the mother-infant dyad

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Funding information

Durham University; Wenner-Gren Foundation; National Science Foundation

Abstract

Objectives: We examine infant sleep from evolutionary, historico-cultural, and statistical/epidemiological perspectives and explore the distinct conceptions of “normal” produced by each. We use data from the “Sleeping Like a Baby” study to illustrate how these perspectives influence the ideals and practices of new parents.

Methods: The “Sleeping Like a Baby” study investigated maternal–infant sleep in north-east England. Sleep data for exclusively breastfeeding (EBF) and formula-feeding (EFF) dyads were captured every 2 weeks from 4 to 18 weeks postpartum through actigraphy and maternal report. Mothers also reported their infant sleep ideals and practices. Results explore objective and maternally-reported infant sleep parameters, and concordance of maternal ideals and practices with public health guidance.

Results: Comparison of sleep measures showed that mothers overestimate infant sleep duration compared with actigraphy; EFF mothers' reports were significantly more inaccurate than those of EBF mothers. For infants moved to a separate bedroom, maternally-reported sleep increases were not borne out by actigraphy. Across the study period, concordance of maternal ideal sleep location with public health recommendations occurred on average for 54% of mothers, while concordance in practice fell from 75% at 4–8 weeks to 67% at 14–18 weeks. Discordance for EBF dyads occurred due to bedsharing, and for EFF dyads due to infants sleeping in a room alone.

Conclusions: Beliefs about “normal” infant sleep influence parents' perceptions and practices. Clinical and scientific infant sleep discourses reinforce dominant societal norms and perpetuate these beliefs, but biological and evolutionary views on infant sleep norms are beginning to gain traction with parents and health practitioners.

1 | INTRODUCTION

Managing pre-conceived expectations about infant sleep is a difficult task for which many new parents in Western¹ settings are ill-prepared. Pre-natal fantasies of a baby

sleeping soundly in his/her carefully prepared crib are rarely realized; yet unrealistic expectations are unintentionally reinforced by clinicians and well-wishers; even strangers take an interest in whether new babies they encounter are “good,” (meaning sleeping “through

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the night”). The Western cultural obsession with infant sleep leads parents to wonder, sooner or later, whether their infant’s sleep patterns are “normal,” what they could or should be doing differently, and whether something they are not doing (or buying) would help their baby to fall asleep more quickly, to sleep for longer, or more deeply, or through the night (Ball, 2020; Barry, 2020).

When infant sleep behaviors fail to meet social expectations parents begin to question whether their baby has a “sleep problem” that they must fix (Rudzik & Ball, 2016) or worse—is wilfully refusing to sleep—night-time becomes a battle-ground pitting the parental pursuit of a “decent night’s sleep” against babies’ needs for contact, comfort and regular night-time feeds (Ball, 2020). Consequently, babies may be medicalized, medicated, neglected and, in extreme cases, abused for displaying typical human-infant behavior (waking at night, requiring night-feeding, crying when left alone) (Douglas & Hill, 2011; Owens et al., 2003; Reijneveld, 2002).

In our infant sleep research, we seek to understand how the juxtaposition of parental expectations and babies’ biological norms around sleep are experienced and managed (Ball, 2017). In this article we draw on original data collected by AR during her postdoctoral fellowship at Durham University 2012–2014.

2 | HOW MIGHT WE UNDERSTAND “NORMAL” INFANT SLEEP?

Three constructions of normality are contemporaneously “in play” in discourse about infant sleep. Evolutionary normalcy invokes the evolved biology of mothers and babies based upon a functional physiological understanding of the mother-infant dyad. Epidemiological and medical recommendations rely on concepts of statistical normalcy and the “average or normative” range, which are assumed to reflect the sleep parameters of the majority of infants. Historical and cultural normalcy shapes the discourse around infant sleep among society at large— influencing not only the views of the “lay” public, but also “Western” medical and scientific discourse, biasing and constraining the scope and nature of medical and scientific perspectives on infant sleep. Below we elaborate on these three views of normal.

2.1 | The evolutionary norm

As biological anthropologists we approach normalcy from an evolutionary perspective, our starting point

being a comparative mammalian view of human infants. The defining characteristic of our taxonomic family is the production by mothers and consumption by infants of milk. All infant biological processes, including sleep, are shaped by this fundamental characteristic of our mammalian biology. However, as a species, humans also have other unique defining characteristics: bipedalism, and unusually large brains (Trevathan & Rosenberg, 2016). Understanding how human babies sleep involves appreciating how these features have shaped infancy and infant care.

Primates are placental mammals, with gestation supported via a uterus and placenta rather than an egg (monotremes) or a pouch (marsupials). Placental mammals produce two types of infants—altricial (born in litters after a short gestation, weak and with undeveloped sensory organs, e.g., mice, rabbits) and precocial (born singly or in pairs after a long gestation and more fully developed at birth, being able to see, hear, call, and maintain proximity to their mothers soon after birth, e.g., horses, chimpanzees) (Ball & Russell, 2012). Infant state at birth affects caring strategies: altricial newborns are cached in nests for safety and warmth. Mothers produce high-fat milk that satiates altricial babies for long periods while they leave to forage. When they have fully functioning sensory and locomotor abilities altricial infants begin to leave the nest. In contrast, precocial infants are carried by or follow their mother while she forages, and provides their safety and warmth. Mothers produce low-fat, high-sugar milk, providing infants with quick energy. Because they are in constant proximity to their mothers high-fat milk is not needed by precocial infants (Lozoff & Brittenham, 1979).

Human babies, born singly or in pairs following a prolonged gestation and with well-developed sensory organs fit the precocial pattern and human mothers produce the expected high-sugar, low-fat milk. However, human babies are unusually helpless and cannot stand, walk or cling to their mothers. The neurologically premature timing of birth in humans is debated within biological anthropology in terms of (a) the necessity for the fetal head to pass through a maternal pelvic outlet shaped in response to the demands of human bipedal locomotion (Rosenberg & Trevathan, 2002; Trevathan, 1993); and (b) the limits of maternal metabolism which hits an energy through-put ceiling beyond which it is impossible for the mother to sustain continued growth of the fetus, particularly the energetically expensive fetal brain (Dunsworth et al., 2012). Whatever the evolutionary explanation, human babies are born more neurologically immature than any other primate (Trevathan & Rosenberg, 2016), and for the first year of life, as rapid brain growth continues (Martin, 2007), human babies are

incapable of the neuromuscular control required to undertake the “cling or follow” precocial strategy needed given the composition of human milk. It falls to the human caregiver to keep the baby fed and in close proximity during the first months of life until the baby is capable of independent locomotion.

The biology of early infancy therefore anticipates that (a) human babies should wake to feed regularly during the night throughout the first year of life due to the energetic needs of rapid brain growth, and (b) that they will spend a large proportion of sleep time in active (REM-like) sleep and less time in quiet sleep in early infancy, with the proportions changing as they mature. As babies are born with no circadian clock, and it takes several months for a day-night rhythm to become established (Joseph et al., 2015), biologically normal infant sleep involves frequent night-waking for feeding and interaction with a mother who sleeps in close physical proximity to her infant.

2.2 | The public health and biomedical norm

The use of statistical normalcy (i.e., central tendency) to define “normal infant sleep” is evident in public health and clinical settings via the charts and tables in parenting guidance and on the walls of baby clinics. Although parents may assume that “recommended sleep duration” for babies of different ages are based on research assessing infant sleep needs for “optimal development” this is not the case. Here, as in many aspects of infant and child growth and development (see other articles in this special issue), “normal ranges” for infant sleep are based on averages recorded for a given sample at predetermined time points. The earliest “scientific” studies of infant sleep published in the mid-20th century followed the model of adult sleep research in studying convenience samples of

volunteers, usually students (Wolf-Meyer, 2012). For the emerging science of infant sleep, participants were recruited from families to whom clinical and academic researchers had easy access (including their own). Historically, therefore, samples used to derive statistical “norms” were drawn from populations of well-off, Western, and White infants, for example (Emde & Walker, 1976; Moore & Ucko, 1957). Following the middle-class trends of the period such infants were predominantly fed artificial formula, slept in a room alone, and were placed prone for sleep (Hardyment, 1983). The life (and sleeping) conditions of these infants differed widely from those of most contemporary infants and indeed infants throughout the evolution of the human species.

Additionally, it is now clear that infant sleep needs are hugely variable, both between babies of the same age, and for an individual throughout its first year. Galland and colleagues’ systematic review and meta-analysis of data accumulated on normal infant and child sleep across 34 studies (Galland et al., 2012) combined prospective data on sleep duration from multiple countries and cultures to produce “international norms.” Wide variability in infant sleep duration was found across individual studies of infants in the earliest age groups (0–2 months, 3 months, 6 months) with individual study means varying from 12 to 16 h and SDs spanning 8.8–22 h, (Figure 1). Only at 12 months of age does consistency begin to appear between inter-study means for sleep duration, while intra-study variability indicates persistent differences in sleep duration between individuals until 4–5 years of age. One-size fit-all charts depicting statistical averages for infant sleep and statistically-based recommendations for how much sleep infants “should” achieve at any given age are therefore unlikely to reflect the behavior or needs of individual infant.

While recommendations regarding infant sleep timing and duration are based on descriptive data,

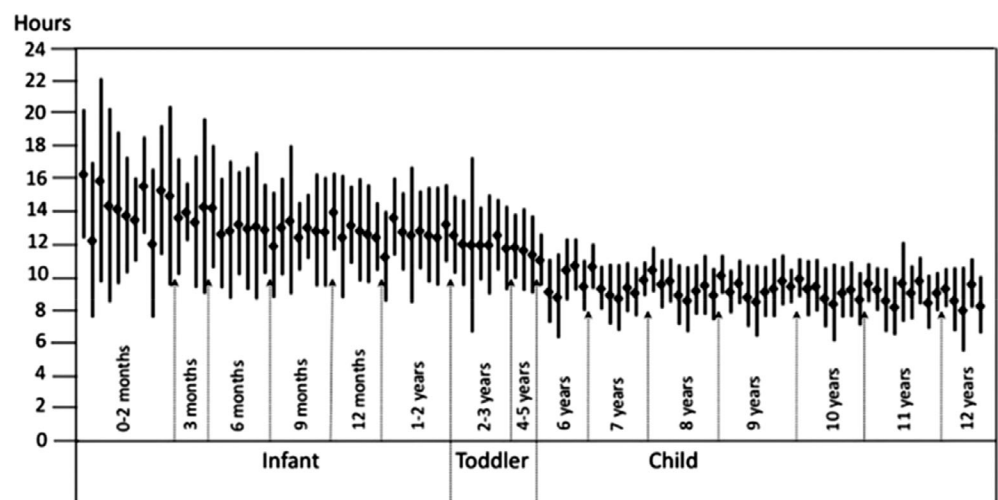


FIGURE 1 Sleep duration data across age categories from all studies reviewed by Galland et al. (2012)



recommendations for how parents should organize their infant's sleep environment are based on epidemiologic studies of differential infant mortality, where constructions of normality are also problematic. Public health recommendations on infant sleep safety rely on statistical quantification of the risk of Sudden and Unexpected Death in Infancy (SUDI) during sleep, represented as odds ratios comparing outcomes for infants sleeping in different scenarios.

SUDI researchers use case-control studies to compare cases (babies who died) with matched controls (babies who lived). The goal of these studies is to ascertain which behavioral deviations from the "normal or reference group" are associated with a greater relative risk of death. Public health recommendations are then built around the factors which were associated with increased risk. Recommendations provide advice to parents on infant care practices such as sleep position, sleep location, and thermal environment in order to reduce infant mortality. However, the "reference behaviors," from which other practices are framed as deviating, are often selected due to their prevalence in the control sample being studied, and designated as the "normal" condition. The control sample is generated using a systematic selection process (e.g., next baby in the local birth registry, next baby born at the same maternity hospital, or next baby on the Health Visitor's case-load). It is intended to represent accurately the community of babies to which the case baby belonged and the practices of parents in that community. However, though families of case infants must provide details of their infant care practices—as the result of statutory investigation of infant deaths—control families are invited to provide information but have the option to decline. Those who decline are more likely to be young and/or single mothers, non-native speakers, families at the lower end of the income and education scales, for example (Vennemann et al., 2005). Families decline to be provide control data when they anticipate their lifestyle or infant care practices may be met with criticism. Therefore, in most SUDI case-control studies the reference group is "middle-class," reasonably well educated, and White. As a result, the "reference behaviors" against which other practices are assessed for risk reflect a "normality" that is constructed based on the behaviors of a biased sample leading to creation of inappropriate recommendations for the intended recipients.

2.3 | The cultural or historical norm

Cultural expectations of infant sleep in most Western societies differ greatly from the biological view of

"normal infant sleep." Although parents and carers in the majority of world cultures carry their infants during the day and sleep in close proximity to them at night, dominant models of infant care in WEIRD settings (Western, educated, industrial, rich and democratic) emphasize the importance of separation and minimizing bodily contact, particularly at night (Ball, 2008; Ball & Russell, 2012; Jones & Ball, 2012; Trevathan & Rosenberg, 2016). Beliefs that crying is "good for babies," that babies will be "spoiled" if picked up, or will be "clingy" if allowed access to their parents at night have been shaped over the past century by cultural and political perspectives emphasizing early independence, self-control and self-reliance (Ball, 2007; Jones & Ball, 2012; Tomori, 2014). Despite the lack of supporting data from developmental biology (Ball et al., 2019; Hardymont, 1983), they have become embedded within cultural beliefs and practices (e.g., Ball, 2013; Valentin, 2005).

These well-known ideologies of infant sleep are not only at odds with the biology of infant sleep, but are predicated on culturally specific assumptions about how, when, and where babies should sleep (Ball, 2013). The "good baby" who "sleeps through the night" from an early age is a cultural construct in the United Kingdom that reinforces the notion that prolonged infant sleep is important to achieve early, and that a night-waking baby is aberrant (Ball & Russell, 2012; Rudzik & Ball, 2016). Emphasis on industrialization in the mid-late 19th century drove a requirement for the working-classes to be capable of delivering a full 12-h workday unencumbered by the needs of their offspring; obtaining sufficient sleep in a constrained night-time period became vital (Hardymont, 1983). Reinforced by the early 20th century era of "scientific baby-care" the desirability for babies to be independent and self-reliant from an early age was a consequence of industrialization and the changing social and economic nature of family life. The resulting mismatch between culturally aligned family sleep expectations and the biological constraints of human babies, exacerbates inequalities, threatens parental resilience, and compromises family well-being. Wolf-Meyer (2012) has noted the importance of solitary infant sleep as a cultural value in the United States, reinforced through children's literature as well as medical recommendations. Wolf-Meyer's insights highlight how thoroughly infant sleep science is influenced by Euro-American cultural assumptions that are presumed by the psychological and clinical researchers who have conducted most infant sleep research to be universally valid. As we have argued elsewhere (Ball et al., 2019), infant sleep science is well overdue a Kuhnian paradigm shift—and anthropology

is uniquely placed to advance understanding of human infant sleep in diverse cultural settings and to investigate the varied sleep issues affecting parents and babies in contemporary societies. The interplay of these different constructions of normal, and how they influence clinical and public perceptions is conceptualized within the new framework? of biological normalcy (Wiley, 2021; Wiley & Cullin, 2020).

3 | HOW HAS “NORMAL INFANT SLEEP” BEEN MEASURED?

The vast majority of infant sleep research is based upon parental report captured via surveys or standardized questionnaires (Goh et al., 2017; Hughes et al., 2015; Sadeh et al., 2009; Symon & Crichton, 2017), sleep logs or diaries (Hiscock & Wake, 2002; Price et al., 2014), or, more recently, smartphone apps (Mindell et al., 2016). These methods assume two things: (a) that parents are able to report accurately on their infant's sleep, even though they may be asleep during much of what they are reporting on; and (b) that even if parental reports are inaccurate, they will vary consistently across families so that discrepancies will have no systematic effect on outcomes.

Given the implications of using research findings as the basis for recommendations on optimal infant/child sleep it is essential that infant sleep studies employ objective and transparent measurement techniques (Tham et al., 2017). Validation studies of parent-reports of infant sleep parameters with actigraphy find that parents reliably report infant sleep schedules (e.g., sleep and wake onset), but poorly estimate infant total sleep time, night-wake frequency and duration (Acebo et al., 2005; Asaka & Takada, 2011; Sadeh, 1996; Simard et al., 2013). The accuracy of parental reporting may also be tied to other parenting practices, such as infant feeding (Rudzik et al., 2018). This has implications for the outcome validity and applicability of recommendations that are based on studies solely reporting parent-derived data. Some studies fail to acknowledge the limitations of parental report data while relying on these data to judge the efficacy of behavioral sleep interventions that target infants (Hiscock & Wake, 2002). Others, while listing parental report as a limitation of the research design, nevertheless draw conclusions about typical infant sleep from these data (e.g., Goh et al., 2017; Price et al., 2014). In our work we seek to triangulate data on parents' opinions, their reported practices, and objective outcomes using actigraphy, video, and in-depth interviews as appropriate to the research question being addressed.

4 | CONTEXT OF OUR RESEARCH: EMBEDDED CULTURAL ASSUMPTIONS ABOUT MOTHERS AND BABIES AT NIGHT IN UNITED KINGDOM

Our earliest studies of infant sleeping and feeding in Northeast England revealed a discordance between the expectations and experiences of new parents with regard to infant sleep (Ball, Hooker, & Kelly, 1999; Hooker, Ball, & Kelly, 2001). Throughout the twentieth century sleep independence was a developmental goal to be fostered by parents and achieved rapidly by infants; a testament to good parenting skills (Kagan, 1984; Spock, 1976). Successful parenting was gauged by proficiency in sleep management, with a “good” baby who slept right through the night indicating a firm mother who put up with no night-time “nonsense.” A mid-20th century door-step interview study in a Midlands city (Newson & Newson, 1966) found that inexperienced mothers in Britain were told “don't pick him up all the time,” “you'll spoil him” and “leave her cry and she'll eventually go to sleep.” Three decades later our studies found these cultural ideologies persisted in UK parents' attitudes and practices regarding infant sleep, reinforced by and embedded in familial norms. The notion that babies should sleep deeply and for prolonged periods from an early age was prevalent, as was the use of formula or formula with added baby rice or cereal to promote prolonged sleep (Ball, 2002, 2003). Encouraging babies to sleep alone at night was also common, and many parents felt that the official recommendation for room-sharing until 6 months was too long, that their babies would become accustomed to sleeping near their parents, with mothers commenting that their babies would be in their own rooms at night by 6 weeks of age (Hooker, Ball, & Kelly, 2001). Developmental milestones such as sleeping through the night, elimination of night-feeds, and “establishing a routine” were all used as markers for when a baby should be moved from the parents' bedroom into a nursery.

In 2012–2014 Rudzik conducted focus groups with mothers in the Northeast and Midlands (Rudzik & Ball, 2016), exploring maternal care strategies and mothers' perceptions of the relationship between infant feeding methods and infant sleep. Although the public health recommendations vigorously promote breastfeeding, continuation rates were low. Women's decisions about how to feed their babies reflected the struggle to balance competing priorities, including how to obtain adequate sleep. The focus groups showed that public opinion in the UK associates breastfeeding with poor night-time sleep. New mothers are frequently advised to introduce formula or solid foods to promote



sleep. However, breastfeeding and formula-feeding mothers held different beliefs about infant sleep. Breastfeeding mothers felt that fragmentary infant sleep was biologically normal while formula feeding mothers viewed it as a problem in need of a solution. Each group employed strategies to promote infant and maternal sleep that aligned with their underlying perception of infant sleep. Breastfeeding mothers chose to sleep in close proximity to their infant and feed frequently during the night in order to respond to the infant's night-time cues. Formula feeding mothers imposed a routine in the early weeks postpartum and minimized parental contact after the infant's bedtime, to prioritize the resumption of their pre-baby lives.

Below we draw upon a combination of novel and previously published data from the Durham "Sleeping Like a Baby" study conducted in the United Kingdom in 2012–2014 to illustrate how parental perceptions and behaviors are influenced by cultural and statistical norms, and how these contrast with biological norms for infant sleep.

5 | METHODS

Mother-singleton infant dyads were approached on the postnatal ward at James Cook University Hospital, a large teaching hospital in the North East of England. Women 18–45 years of age who were intending to breastfeed or formula-feed exclusively for 18 weeks were invited to participate in the study. At 2 weeks postpartum a researcher followed up with those who had expressed interest in the study and those who were willing to participate scheduled their first data collection. At that time participants provided written informed consent and completed a demographic questionnaire.

A researcher visited each participating dyad at home every 2 weeks from four to 18 weeks postpartum. At each data collection point women completed a sleep questionnaire that provided data about their own and their infant's night-time sleep, as well as infant feeding practices. Several questions were included to determine the infant sleep practices and ideals of each family. Mothers recorded all locations where the infant spent any part of the night, as well as where the infant slept for the majority of the night, using closed-ended questions with an "Other" option. These questions specified whether the infant slept with a parent or on a separate sleep surface, as well as whether the infant slept alone or in the same room as the parents. Women were also asked their opinion of the best location for infant night-time sleep.

Infants were classified at each time point as exclusively breastfed (EBF) or exclusively formula fed (EFF)

based on maternal report of all categories of foods consumed by the infant. Infants who were not EBF or EFF (fed breast milk + formula, breast milk + solids, formula + solids) were categorized as mixed fed and were excluded from any analyses that compared EBF and EFF infants.

Women completed a sleep diary to record maternal and infant sleep and wake periods between 6 p.m. and 8 a.m., using 15-min increments. Women recorded their own sleep periods upon awakening. Subjective sleep data were calculated from the sleep increments reported in the sleep diary. Total sleep time (TST) was calculated by adding together every 15-min period between 6 p.m. and 8 a.m. during which the participant indicated that she/the infant had slept. Longest sleep period (LSP) was calculated by adding the longest continuous set of increments recorded as "asleep" that occurred between 6 p.m. and 8 a.m. Infant night-wakings were determined by counting "awake" increments that occurred between the initial onset of sleep and the last 15-min period of sleep. Subjective wake after sleep onset time (WASO) was calculated by adding all "awake" increments that occurred after initial onset of sleep and before the last period of sleep.

At each data collection point, participants were provided with Micro Motionlogger actigraphic watches (Ambulatory Monitoring Inc., Ardsley, NY) to be worn by the mother and infant from 6 p.m. to 8 a.m. Women wore the watch on their non-dominant wrist and placed the infant watch on the left thigh. Participants were shown how to properly position the watches at the first research visit. Watches were pre-programmed to start recording in 1-min epochs at 6 pm and to continue to record until a researcher downloaded the data. Actigraphic data were analyzed using Sadeh's sleep scoring algorithms for adults and infants (Sadeh et al., 1994, 1995). Infant actigraphic TST was calculated by adding together the epochs scored as sleep or light sleep, as exported from the software. The software automatically calculated maternal TST, infant and maternal LSP, number of long wake episodes, and WASO.

6 | RESULTS

In order to explore how different concepts of "normal infant sleep" affect infant outcomes we examine specific sub-groups of mother-baby dyads. We begin below with a comparison of actigraphic and maternal report data for infants by feed-type and then assess the role of infant sleep location in maternal perceptions of infant sleep patterns. How maternal perceptions of infant sleep patterns are related to maternal sleep ideals are then examined,

along with concordance of maternal practices and ideals with infant safe sleep recommendations. A total of 61 mother-infant dyads were recruited and participated in the study. The study sample was overwhelmingly White, UK-born and married. Educational level was higher among EBF women, but household income did not differ between EBF and EFF women. Full participant demographics are reported elsewhere (Rudzik et al., 2018).

6.1 | Maternal perceptions of night-time infant sleep

As previously reported (Rudzik et al., 2018), maternal perceptions of night-time infant sleep differed by infant age and feed type. In early infant life maternal reports of infant sleep were closely aligned with actigraphic data. However, as infants reached 8–18 weeks of age discrepancies appeared and differences in values increased between maternal reports and actigraphic data (Figure 2).

When compared with actigraphy, EFF women significantly overreported their infants' TST at 14 weeks, and LSP from week 10 through 18. EFF mothers

underestimated infant WASO from week 8 to the end of the study period. In contrast EBF mothers were found to overestimate LSP compared with actigraphy to a lesser extent than EFF mothers and were more accurate in reporting infant TST.

When analysis controlled for infant sleep location, EFF mothers still overestimated TST at 10 weeks and LSP at 10, 12 and 18 weeks (Rudzik et al., 2018).

6.2 | Maternal perceptions of night-time infant sleep by sleeping location

To assess whether there was an impact on infant or maternal sleep when infants were moved to sleep in a separate room, we analyzed data from a sub-set of 14 mother-infant dyads. Dyads were included in the sub-set if (a) the infant initially slept in the parental bedroom but was moved into a separate room between 8 and 18 weeks and (b) subjective and objective sleep data were available for the data collection points immediately before and immediately after the infant was moved.

No differences in actigraphic sleep measures occurred from before to after the infant was moved from the parental bedroom for maternal or infant TST, LSP, or

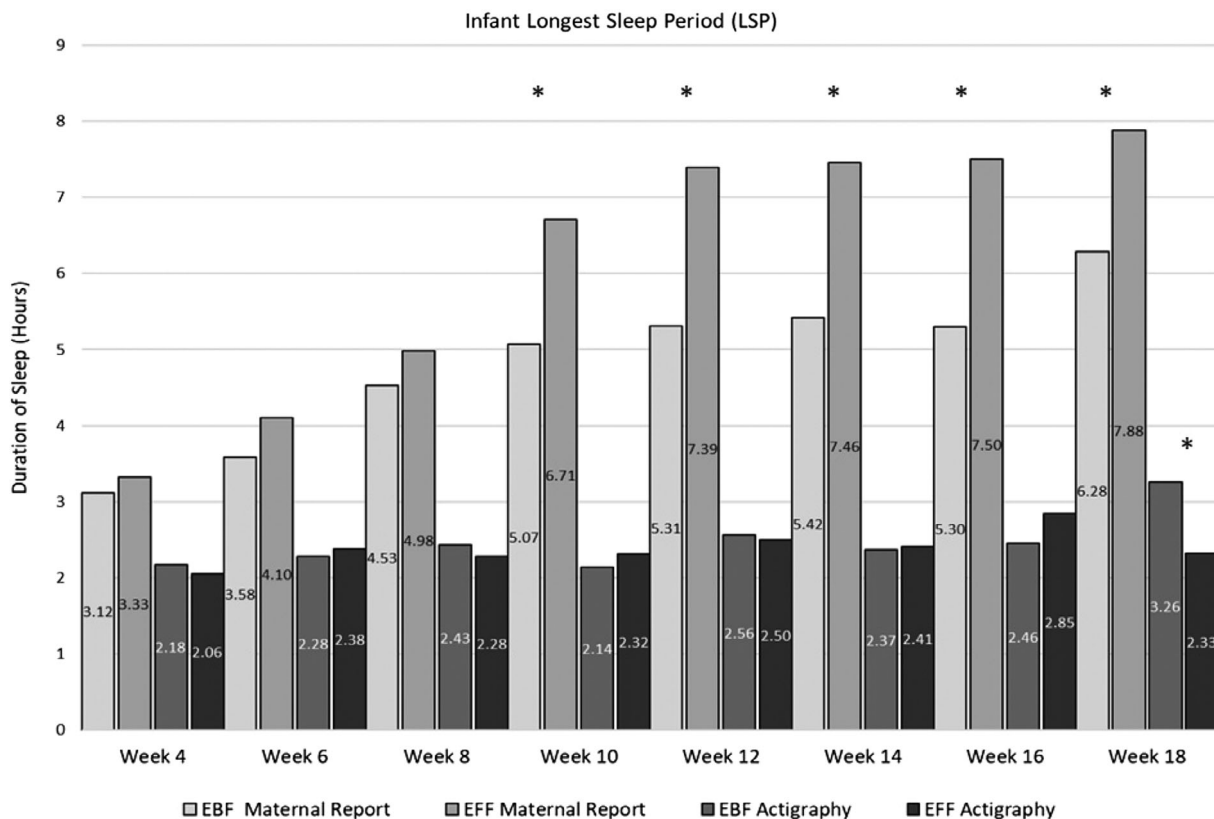


FIGURE 2 Infant longest sleep period as reported by mothers and measured by actigraphy for exclusively breastfed and formula fed infants redrawn from Rudzik et al. (2018)

WASO or frequency of infant night wakings. However, women subjectively reported significantly longer infant TST and LSP after the infant was moved (Figure 3).

6.3 | Concordance of infant sleep location ideal with public health recommendations

During the period this study was conducted, UK recommendations were that babies should sleep in the same room as their parent(s) until 6 months of age and parents were advised against bed-sharing with their infant (Department of Health, 2009). Responses to an open-

ended question about ideal infant sleep location were categorized as concordant or discordant with these public health recommendations, or ambiguous. There was no significant change through time in the number of women in each category. The mean percentage across study weeks of women expressing an infant sleep location ideal concordant with public health recommendations was 54% (Table 1).

Ambiguous responses made up 28% of all responses; of these 87.7% mentioned only that the infant should sleep on a surface separate from their parents (e.g., in a crib, cot or Moses basket) without specifying that the infant should be in proximity to the parents. 12.3% mentioned that the infant should sleep in proximity to the

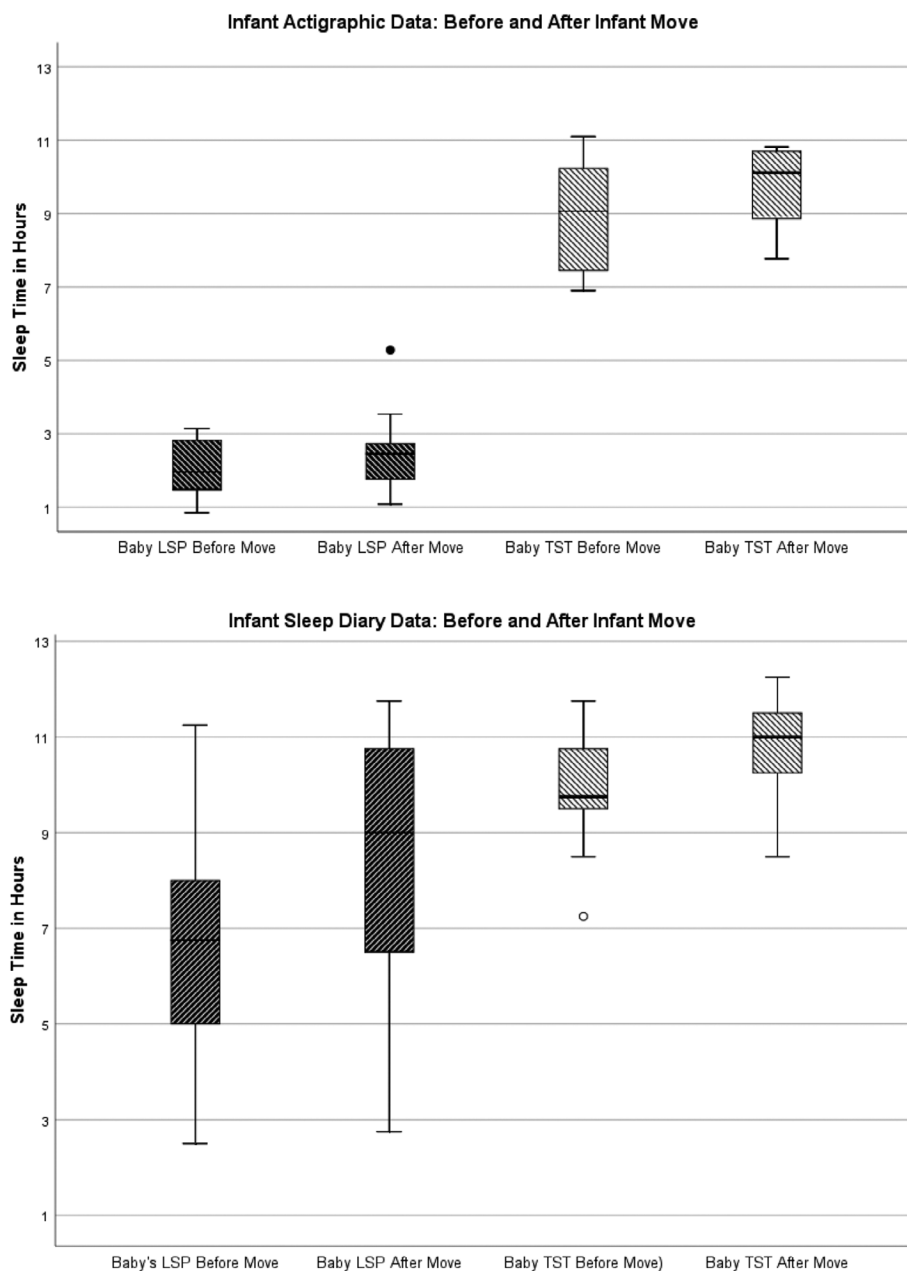


FIGURE 3 Box plots showing (A) actigraphic data and (B) maternally reported sleep diary data for night-time longest sleep period (LSP) and night-time total sleep time (TST) before and after baby was moved from parental room to own room for night sleep

TABLE 1 Percentage of women expressing infant sleep ideals that were discordant, concordant or ambiguous with respect to public health infant sleep location guidelines at each time point

	Week 4 <i>n</i> = 49	Week 6 <i>n</i> = 52	Week 8 <i>n</i> = 50	Week 10 <i>n</i> = 49	Week 12 <i>n</i> = 49	Week 14 <i>n</i> = 49	Week 16 <i>n</i> = 46	Week 18 <i>n</i> = 48
Concordant (%)	59.2	51.9	68	42.9	53.1	57.1	52.2	50.0
Discordant (%)	8.2	5.8	6	6.1	12.2	12.2	15.2	18.8
Ambiguous (%)	32.7	42.3	26	51	34.7	30.6	32.6	31.3

parents (same bedroom) without specifying that the infant should be on a separate sleep surface. EFF women were significantly more likely to give an ambiguous answer than EBF women (likelihood ratio $p = .003$).

6.4 | Concordance of maternal practices with public health recommendations

Based on the questionnaire data at each collection point, night-time sleep practices were mostly concordant with two key public health recommendations regarding infant sleep location in the early postpartum weeks: to place the infant to sleep in the same room as the parents and to have the infant sleep on a sleep surface separate from the parent or parents.² More than three-quarters of families that provided data were concordant with recommendations at the 4, 6, and 8 week time-points. As time passed, more women reported night-time infant sleep practices that were discordant with public health guidelines for at least some portion of the night ($\chi^2 = 15.490$, $p = .03$). Concordance with recommendations fell to around two-thirds of families who provided data at 14, 16 and 18 weeks (Table 2).

As infant feeding method has been associated with differences in infant sleep practices in previous studies (Anuntaseree et al., 2008; Blair et al., 2010), we examined the relationships of discordance by feed type. We found that the increase in discordance with public health guidance regarding infant sleep location was driven by the practices of EFF mothers. Concordance with public health guidance fell significantly over time among EFF women (92% concordance to 68%, likelihood ratio $p = .03$), whereas EBF women showed lower concordance from the outset but the rate of discordance within the EBF group remained stable over time (62% concordance to 63%, $p = .42$) (Figure 4).

The nature of the discordance with public health guidelines differed between EBF and EFF women; the former was primarily due to bedsharing with their infant, whereas the latter was due to placing the infant to sleep in a separate room ($\chi^2 = 6.312$, $p = .012$) (Figure 5).

7 | DISCUSSION

Normal infant sleep is a heterogeneous collection of behaviors and processes that change during the course of infant development, exhibit inter-individual variability, and continue to be perceived through a range of historical and cultural lenses; as such it defies standardization. Using our original research data we have illustrated four examples of how heterogeneity is apparent.

7.1 | Maternal perceptions of night-time infant sleep

Actigraphy data showed that from 4 to 16 weeks mean total sleep time increased for both EBF and EFF infants, while longest sleep period remained consistent for both groups. The lack of a difference between breastfed and formula-fed infants in total sleep time and longest sleep period between 6 p.m. and 8 a.m. during this age range replicates previous findings (Tikotzky et al., 2015). We did not find actigraphic measures of night-time infant sleep to be associated with sleep location across the sample as a whole.

In contrast to this objective picture of infant sleep, maternal reports aligned closely with actigraphy only at the outset of the study, diverging from the objective data, and from each other by feed type after infants attained 8 weeks of age. EFF mothers over-reported their infant's total sleep time and longest night-time sleep period from 10 weeks of age, and underestimated infant wake after sleep onset during the night at all data collection points from 8 weeks. EBF mothers also overestimated night-time LSP compared with actigraphy, but not to the same degree as their formula-feeding counterparts. EBF mothers assessed their infant's TST more accurately than EFF mothers.

This discrepancy in parental reports of infant sleep by feed type may have multiple explanations—the primary one being the potential role of sleep location, with breastfeeding dyads sleeping in closer proximity. However, when we controlled for infant sleep location in the

TABLE 2 Concordance of infant sleep practice with public health guidance by week

		Week of study								Total
		4.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	
Is infant sleep practice concordant with public health guidance?	No	11	10	10	5	14	15	15	20	100
	Yes	38	43	41	45	39	34	33	31	304
Total		49	53	51	50	53	49	48	51	404

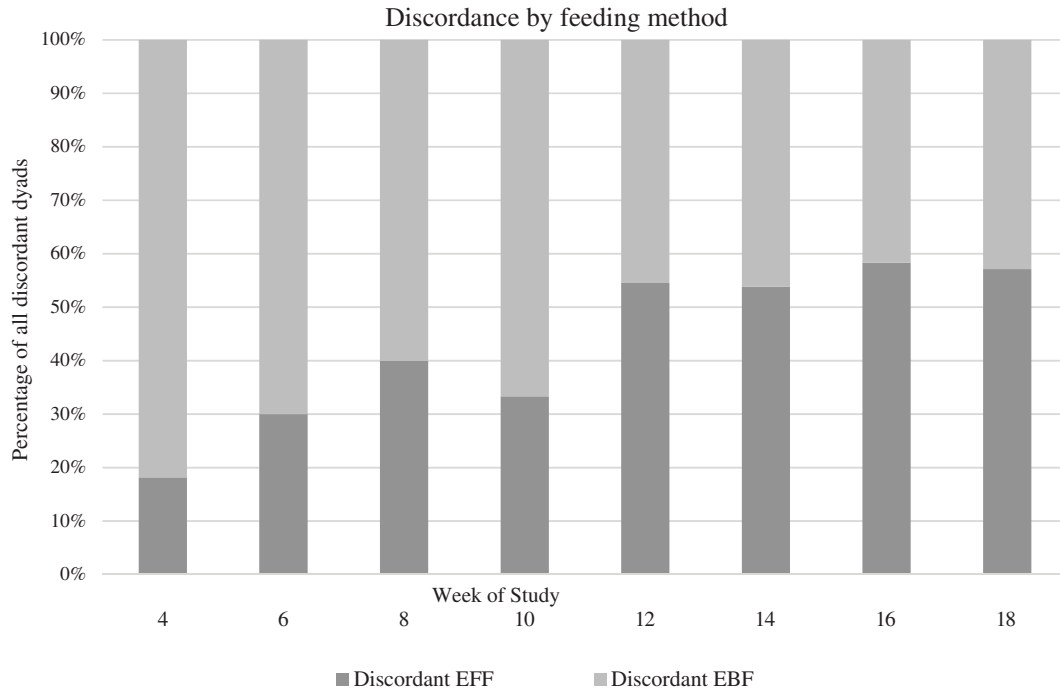


FIGURE 4 Discordance of infant sleep location with safe sleep guidance, by feeding method over time

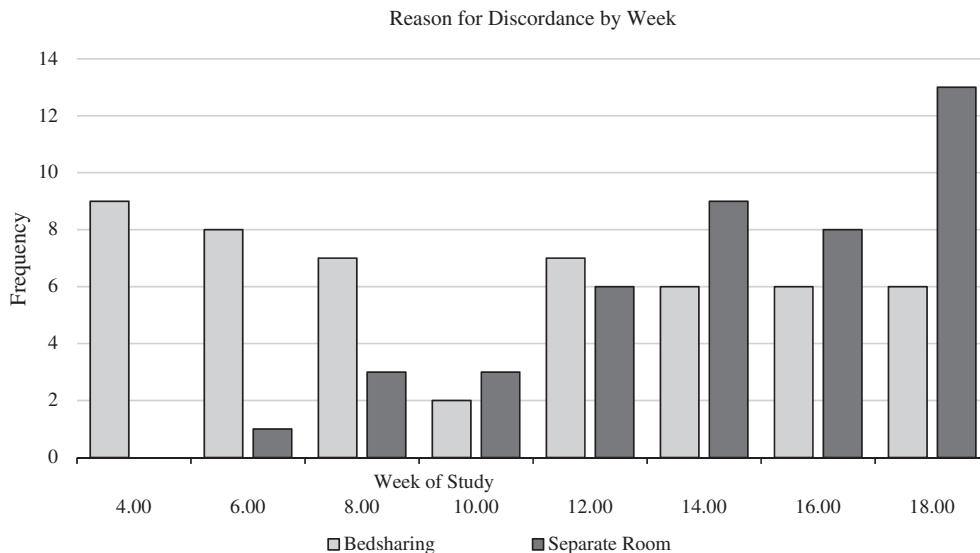


FIGURE 5 Nature of sleep location discordance with guidance over time

above analyses the relationship between feed-type and maternal discrepancy in reporting night-time infant sleep outcomes was maintained, with EFF mothers reporting significantly longer night-time LSP at 10, 12 and 18 weeks, and night-time TST at 10 weeks in comparison to actigraphy (Rudzik et al., 2018). The most likely explanation for this outcome is that mothers are told, and come to expect, that giving babies formula “improves” their sleep, and this is what they then perceive and report, despite objective evidence to the contrary.

7.2 | Maternal perceptions of night-time infant sleep by sleeping location

The data from the sub-sample of mothers who moved their infant out of their room between 8 and 18 weeks suggest that although moving the infant prior to 6 months of age does not increase objectively measured TST or LSP or decrease duration of WASO or frequency of infant night waking, it does result in a perceived increase in infant sleep.

As above with maternal perception of sleep within feeding groups, it is possible that mothers are culturally primed to expect babies to sleep better in a room on their own, and so this is what they perceive. A second potential explanation for the discrepancy between actigraphic and parental report data is that when babies are in separate rooms parents are less likely to hear them when they wake and be disturbed by them at night.

Actigraphy in this study demonstrates that some babies who sleep alone from an early age experience night-waking without receiving a response from their parents; these babies either wake and do not signal, signal but are unable to make themselves heard, or signal and are heard but are ignored by their parents. Simultaneous video-somnography of parents and infants would be needed to answer this question.

7.3 | Concordance of infant sleep ideals with public health recommendations

In response to the open-ended question “Where is the best place for your infant to sleep?” when averaged across each visit, slightly more than half our participants stated an ideal for infant sleep that aligned with two key public health recommendations for safer infant sleep—that infants should sleep in a crib or bassinet separate from the parental sleeping space and that infants should sleep in the same room as their parents. More than one-quarter of all responses omitted one of the two key elements to public health guidance on infant sleep location: most

mentioned only the former, while a small minority mentioned only the latter.

This may indicate that women more easily take up public health messages that align with their existing beliefs (Sullivan, 2009). Since bed-sharing is not culturally normative, the recommendation against the practice may therefore have made sense as an essential safety message. In contrast, the preparation of an infant nursery, intended as the infant’s sleeping location, is a normative part of pregnancy preparation for many families (Han, 2013; Tomori, 2014). Public health advice to have the infant sleep in the parental bedroom therefore may have been dismissed as merely a suggestion. There is some irony here, since the SIDS risk reduction from placing infants to sleep in the parental bedroom is uncontroversial, whereas the recommendation against bedsharing is far from being universally accepted, particularly for breastfeeding dyads (Marinelli et al., 2019).

7.4 | Concordance of maternal practices with public health recommendations

The early and persistent discordance of exclusively breastfeeding mothers’ sleep practices with public health guidelines (i.e., their propensity to bedshare) may indicate that this group of mothers decided in advance to bedshare with their baby, contrary to public health recommendations. Focus-group data we collected in the same region support the idea that exclusively breastfeeding mothers bedshare to facilitate night-time breastfeeding and to maximize sleep (Rudzik & Ball, 2016). In contrast, exclusively formula feeding mothers began the study period with their infant in the parental room, but then moved the infant to a separate room earlier than the public health recommended age of 6 months. This early move may have been planned or may have occurred in response to infant night-time behavior (Rudzik & Ball, 2016).

8 | CONCLUSION: ESTABLISHING “NORMALCY” FOR INFANT SLEEP

Parents’ perceptions/expectations regarding infant sleep are undoubtedly influenced by the cultural/historical norms that are absorbed from family and friends, media and advertising, popular literature and so forth. Clinical and scientific infant sleep discourse reinforces the norms of the dominant society and perpetuates these views and expectations. Data from the Sleeping Like a Baby study in northeast England reveals that parental beliefs about the sleep impact of infant-care practices influence their



perceptions of infant sleep. Formula feeding mothers reported longer, less broken infant sleep than exclusively breastfeeding mothers. Mothers who moved the infant out of the parental room ahead of the 6-month recommendation likewise reported that their infant slept for longer periods and for longer in total when sleeping in a separate room. In each case, objective measures of infant sleep did not support their perceptions.

Furthermore, the use of “statistical normality” for benchmarking infant sleep practices and outcomes privileges data from particular cultures, and sub-groups within those cultures who are most likely to engage with research requests; recommendations based upon these data result in a narrow or skewed view of what is “normal” in terms of infant sleep. A reinforcing feed-back loop has therefore established itself over time where historical and cultural expectations for infant sleep have influenced the production of data and recommendations that characterize what is “normal” infant sleep should look like, and subsequently shaping public health discourse around infant sleep—defined by Wiley and Cullin (2020) as ethno-biocentrism. What is subsequently considered “normal” by epidemiologists conducting studies of sleep-related infant deaths, and hence what is highlighted as a “risk-factor,” is influenced by the dominant cultural context of infant sleep in the geo-cultural location that each study is conducted—that is, biological normalcy as conceptualized by Wiley (2021). Furthermore, based on our findings from northeast England, we note that women may be more likely to accept and incorporate into their ideals those public health recommendations which align with preconceived ideas about infant sleep safety drawn from cultural norms.

In WEIRD societies models of infant care became biomedicalized as a consequence of the reliance on statistical normalcy, that is, conceptualized as within the purview of medical experts who set the standards for what is considered “normal” and “healthy” sleep (Ball, 2008; Ball et al., 2019; McKenna et al., 2007; Tomori, 2014). Biological and evolutionary views on infant sleep norms entered the discourse only over the past 20 years, but are now beginning to gain traction with both parents and health practitioners, and with a small but growing group of pediatricians and infant sleep researchers (e.g., Barry, 2020; Mileva-Seitz et al., 2017). This approach seeks to root guidance for parents in data related to human infant physiology and evolutionary expectations, rather than cultural norms that have shifted enormously in the last two centuries. Our data on the concordance of maternal practices with public health recommendations suggests that breastfeeding women may be drawing on biologically rooted recommendations regarding close mother-infant night-time contact as

essential for breastfeeding. These recommendations then conflict with public health guidelines for infant sleep safety norms and guidelines developed by accepting as “normal” the prevalent practices of an unrepresentative sub-sample.

ACKNOWLEDGMENTS

We offer our thanks to Dr Lyn Robinson-Smith who contributed to data collection, the mothers and babies who took part in the study, and James Cook University Hospital midwifery staff who facilitated recruitment. Financial support was received from the Durham University International Junior Research Fellowship (COFUND) program, and a Wenner-Gren Post-PhD grant to Alanna E. F. Rudzik. Some of the ideas in this article benefited from discussion with participants at the School for Advanced Research Seminar on Biological Normalcy at which Helen L. Ball was an invited participant with the help of funding from the National Science Foundation.

AUTHOR CONTRIBUTIONS

Alanna Rudzik: Data curation; formal analysis; funding acquisition; investigation; methodology; project administration; writing-original draft; writing-review & editing.

Helen Ball: Conceptualization; data curation; funding acquisition; investigation; methodology; project administration; resources; supervision; writing-original draft; writing-review & editing.

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ENDNOTES

¹ We understand “Western” as an ideological construct, not a geographic one.

² No participant reported the infant sleeping in bed with anyone other than a parent.

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How to cite this article: Rudzik AEF, Ball HL. Biologically normal sleep in the mother-infant dyad. *Am J Hum Biol*. 2021;e23589. <https://doi.org/10.1002/ajhb.23589>