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Abstract:

Sleep problems affect 20% to 30% of toddlers and preschoolers. Few longitudinal studies focused on the impact of infant feeding practices on sleep. We aimed to study the associations between feeding practices up to 8 months and trajectories of sleep quantity or quality from 2 to 5-6 years. Analyses included 1028 children from the EDEN mother-child cohort. Data were collected by self-administered questionnaires. Associations between feeding practices (breastfeeding, complementary feeding, use of thickened infant formula, night feeding) and sleep trajectories (sleep onset difficulties, night waking, nighttime in bed) were analyzed by multiple logistic regressions. Predominant breastfeeding for more than 4 months was associated with lower risk for belonging to the persistent sleep onset difficulties trajectory. Night feeding at 4 months or at 2 years of age was associated with higher risk for belonging to the persistent sleep onset difficulties trajectory and night feeding at 8 months was associated with higher risk for night waking and with higher risk for short nighttime in bed. Early introduction (<4 months) to complementary foods (excluding baby cereals) was related to lower risk for short nighttime in bed. Use of baby cereals or thickened infant formula was related neither to sleep quality nor to sleep quantity. In conclusion, infant feeding practices are associated with sleep trajectories in preschoolers, with notably a potential protective role of breastfeeding. Further researches are needed to clarify the mechanisms of these relationships.

Introduction

Sleep is a complex biological function that plays a restorative role in physical and psychological functioning (Hoban, 2010). In children, sleep-wake regulation and sleep states evolve rapidly during the first year of life with a continuous maturation throughout childhood. Sleep troubles such as frequent sleep onset difficulties, frequent night waking and short sleep quantity affect 20% to 30% of children during the first 3 years of life (Al Mamun et al., 2012; Bruni et al., 2014; Morgenthaler et al., 2006). Moreover, longitudinal studies suggested that these troubles may persist later in childhood, and even during adolescence and adulthood (Al Mamun et al., 2012; Byars et al., 2012; Morgenthaler et al., 2006; Quach et al., 2009). Additionally, previous studies showed that insufficient quality and quantity of sleep in children and adolescents are associated with several negative mid- and long-term consequences (Chaput et al., 2016; Dewald et al., 2010; Fatima et al., 2015; O'Callaghan et al., 2010; Reynaud et al., 2018), including behavioral and cognitive performance (Dewald et al., 2010; Reynaud et al., 2018) or increased risk of overweight and obesity (Fatima et al., 2015).

Many studies reported associations between exclusive or predominant breastfeeding and infant sleep, with inconsistent results. Thus, in cross sectional studies, breastfeeding has been associated with more frequent night waking (Galbally et al., 2013; Huang et al., 2016; Hysing et al., 2014; Ramamurthy et al., 2012), but also with both longer (Cohen Engler et al., 2012) or shorter night sleep duration (Ramamurthy et al., 2012; Touchette et al., 2005) compared to formula-feeding, whereas other cross-sectional studies did not observe such associations (Brown and Harries, 2015; Demirci et al., 2012; Hysing et al., 2014; Nevarez et al., 2010). In longitudinal setting, no difference was observed between breastfed and formula-fed infants at 5 or 6 months for night waking frequency or sleep quantity assessed from 18 to 24 months (Hysing et al., 2014; Nevarez et al., 2010).

Complementary food introduction is recommended, by the European Society for Paediatric Gastroenterology Hepatology and Nutrition (ESPGHAN), between 17 and 26 weeks according to the neuromuscular capacity of the child (Fewtrell et al., 2017; Robert, 2012). However, only few studies reported relationships between the timing of complementary feeding and sleep (Brown and Harries, 2015; Macknin et al., 1989; Morgan, 2004; Nevarez et al., 2010; Perkin et al., 2018). Macknin et al. showed that adding baby cereals in the bottle before bedtime among 5- or 16-weeks-old infants did not change the proportion of infant sleeping during the whole night (Macknin et al., 1989). Morgan et al. showed that breastfed infant were more likely to sleep during the whole night at 9 months if solid foods were introduced before 12 weeks of age (Morgan, 2004). Perkin et al showed in a randomized clinical trial, that the introduction of solids before 6 months was associated with longer sleep duration and less night waking (Perkin et al., 2018). Among infant aged 6 to 12 months, Brown et al. showed no difference in night waking frequency according to solid food consumption, but infants who received more solid foods were less likely to be fed during the night (Brown and Harries, 2015). They did not report on sleep quantity. Nevarez et al. showed that complementary food introduction before the age of 4 months (16 weeks) was associated with shorter sleep durations at 1 and 2 years (Nevarez et al., 2010). In addition, it was recently suggested that the macronutrient composition of diet at 1 year would be associated with varying sleep quantity at 2 and 3 years (Kocevska et al., 2016).

To our knowledge, no study has investigated the potential influence of feeding practices, such as breastfeeding, use of thickened infant formula, baby cereals introduction or night feeding in early childhood on preschoolers' sleep, with a prospective design. In this context, we aimed to study the relationships between feeding practices up to 8 months and child sleep trajectories from 2 to 5-6 years in the French EDEN birth cohort.

Methods

Subjects/study design

The EDEN study (study on the pre- and early postnatal determinants of child health and development) is the first mother-child cohort study conducted in France. The overall objective is to examine the relations and potential interactions between maternal exposures and health status during pregnancy, fetal development, health status of the infant at birth and the child's health and development. In this context, 2002 pregnant women were recruited between 2003 and 2006 during their prenatal visit, before the 24th week of amenorrhea (WA), in the maternities of Nancy and Poitiers. Exclusion criteria were multiple pregnancies, known diabetes before pregnancy, French illiteracy or planning to move out of the region within the next 3 years (Heude et al., 2016). Due to miscarriages, stillbirths and attrition, the number fell to 1899 children enrolled at birth. Written informed consent was obtained twice from parents: at enrolment and after the child's birth. This study was approved in 2002 by the ethics research committee of Bicêtre hospital (n° 02-70) and by the National Commission on Informatics and Liberty (n° 902277).

Measurements

Data were collected by parental self-administered questionnaires at different follow-up ages.

Sleep data

Data on sleep quantity or quality were collected during the 2, 3 and 5-6 years follow-ups, using four questions: "Usually, at what time does your child go to bed at night", "Usually, at what time does your child wake up in the morning?", "Did your child wake up at night in the last month?", and "Did your child have difficulties to fall asleep in the last month?". The sleep quantity, defined as nighttime in bed (in hours), was calculated from bedtime and get up time and was treated as a continuous variable. Frequent night-waking and frequent sleep onset

difficulties were defined, according to the literature (Shang et al., 2006; Zuckerman et al., 1987), as waking or having sleep onset difficulties every other night or more (yes/no).

The repeated measures of frequent night-waking and nighttime in bed were used to model trajectories across preschool years with the same method described below in the statistical analysis section and results were published previously (Plancoulaine et al., 2018; Reynaud et al., 2016). Briefly, night-waking pattern was a two-group model (Figure 1B) with a linear shape for the first trajectory labeled "2 to 5 persistent rare night-waking" trajectory representing 77% of the population and a quadratic inverted-U shape for the second labeled "2 to 5 persistent common night-waking" trajectory representing 23% of the population (Reynaud et al., 2016); while nighttime in bed pattern was a five-group model (Figure 1C). The first trajectory was a Short-Sleepers trajectory (SS, always <10hrs30/night) best explained by a quadratic relationship with time and representing 4.9% of the children; the second one was a Medium-Low-Sleepers trajectory (MLS, 10hrs30-11hrs00/night) best explained by a positive linear relationship with time and representing 47.8% of the children; the third one was a Medium-High-Sleepers trajectory (MHS, around 11hrs30/night) best explained by a negative linear relationship with time and representing 37.2% of the children; the fourth one was a Long-Sleepers trajectory (LS, ≥11hrs30/night) best explained by a negative linear relationship with time and representing 4.5% of the children; and the last one was a Changing-Sleepers trajectory (CS, i.e. up to age 3 similar to LS and then to MLS) estimated to be quadratic over time and representing 5.6% of the children (Plancoulaine et al., 2018). Children were assigned to the trajectory to which they had the highest probability of belonging. Thus, they were assigned to one trajectory of frequent night waking and one of nighttime in bed.

Feeding practices

Detailed feeding data were collected at 4 months, 8 months and 1 year, dealing with breastfeeding, complementary food introduction, name and brand of infant formulas used during each period and were previously presented in detail (Betoko et al., 2013). Breastfeeding was considered predominant when the only milk received by the child was breast milk. Complementary food introduction has been defined as the introduction of foods other than breast milk, formula milk or water. In addition, we considered in the present analyses the age of introduction of baby cereals and the use of thickened formula as the main formula (Betoko et al., 2014). Night feeding practices was assessed at 4 and 8 months through the question "Does your baby currently take one or more meals at night (between 11 pm and 6 am)" and at 2 years through the questions "Does your child currently take a bottle or a breastfeeding before falling asleep?" and "Does your child currently take one or more bottle or breastfeeding during the night?". If the bottle contained only water, it was not considered as a night feeding practice.

Other characteristics

Data were also collected on the factors known to influence diet and sleep quantity and quality:

• data collected at the maternity: family monthly income (<1500, [1500-2300], [2301-3000] or > 3000 €), maternal education level (< high-school, high school diploma, 2-year university degree, 5-year university degree), marital status (married or not), age at delivery, parity (first or more), pregnancy smoking (yes/no), prenatal depression (Centre for Epidemiologic Studies-Depression Scale (CES-D) during pregnancy validated among French women, i.e. women with a score greater or equal than 23 presented depressive symptoms compatible with a probable diagnosis of depression (Fuhrer and Rouillon, 1989));

• data collected at birth and during the first year: child gender, gestational age and maternal return to work in the first year (before 4 months, between 4 and 8 months, after 8

months or never), occurrence of regurgitations problems from birth to 4 months and from 4 to 8 months.

Sample selection

From the 1899 infants present in the study at birth, sleep onset difficulties trajectories could be assessed for 1347 children and 1212 children were assigned to trajectory for all three sleep variables (sleep onset difficulties, night waking and nighttime in bed). Among them, data on infant diet during the first year was available in 1079 children. Finally, 51 children were excluded due to missing data on potential confounding variable leading to a final sample of 1028 children.

Statistical Analysis

All statistical analyses were performed using SAS® software (version 9.3 SAS Institute Inc, Cary, NC, USA). The comparison of included and excluded subjects was performed using Chi-squared test and Student's t-tests.

Frequent sleep onset difficulties trajectories modeling

The same approach used for frequent night waking and nighttime in bed trajectories modeling, i.e. the group-based trajectory modeling method (PROC TRAJ procedure) developed by Nagin et al. (Nagin, 2005), was applied to identify meaningful and distinct patterns of frequent sleep onset difficulties between 2 and 5-6 years old.

The group-based trajectory modeling method is based on the underlying hypothesis that within a population there are inherent groups that evolve according to different sleep patterns. The groups are not directly identifiable or pre-established by sets of characteristics but statistically determined through each series of responses using maximum likelihood. The relationship between age and frequent sleep onset difficulties was modeled by polynomial equations defining trajectories. The most adequate model, regarding the number of groups and the shape of the trajectories, was determined by iterations: different models with two to

four groups were computed and then compared using the Bayesian Information Criteria (BIC) and favoring parsimony. The chosen model quality was verified according to the recommended criteria: the average posterior probabilities for each subgroup (≥0.7), the odds of correct classification (≥5), and the similarity between the model's estimation of the trajectory prevalence and the actual prevalence (Nagin, 2005). Children were included in the trajectory's elaboration if their parents had answered the questions regarding sleep onset difficulties at least at two time points out of three. Children were then assigned to the sleep onset difficulty trajectory to which they had the highest probability of belonging. To verify the robustness of the model, sensitivity analyses were performed in children who had complete data or sleep onset difficulties at all three time points.

Associations between infant feeding practices and sleep trajectories.

The associations between infant feeding practices and child's sleep trajectories (frequent sleep onset difficulties, frequent night waking and nighttime in bed trajectories) were analyzed by multiple regression models. For sleep onset difficulties and night waking trajectories, we used multiple logistic regressions and, for nighttime in bed trajectories, we used multiple multinomial logistic regressions. Potential confounding factors included in the models were identified from literature (Bat-Pitault et al., 2017; Blair et al., 2012; Johansson et al., 2008; Karraker and Young, 2007; Machado et al., 2013; Nevarez et al., 2010; Reynaud et al., 2016; Sadeh et al., 2010) and selected using the Directed Acyclic Graphs (DAG) method (www.dagitty.net) (Textor et al., 2011). All the models were then adjusted for family income, marital status, maternal educational level, maternal age at delivery, maternal depressive symptoms during pregnancy, maternal smoking during pregnancy, preterm birth, child's gender, child's regurgitation problems from birth to 8 months of age and maternal return to work within the first year.

Results

Identification of sleep onset difficulties trajectories

Out of the 1899 children enrolled at birth, a total of 1347 presented two out of three completed time points for sleep onset difficulties and were included in the trajectory elaboration. The optimal trajectory model to describe frequent sleep onset difficulties patterns was a two-group model (Figure 1A). The first group or trajectory was labeled "2 to 5 persistent rare sleep onset difficulties", represented 75% of the population and showed a linear constant shape. The second group or trajectory was labeled "2 to 5 persistent common sleep onset difficulties", represented 25% of the population and showed a quadratic inverted-U shape. Nagin's recommended criteria for goodness of fit were met for all groups (Nagin, 2005). The same procedure performed including only children with three completed time points (N=996) showed no notable difference regarding the number of groups, the shape of the trajectories or compliance with Nagin's recommendations. Hence, we chose to include the largest sample size for further analysis.

Characteristics of the final study sample

Compared to children included in our analyses (n=1028), the excluded children (N=871) were from families with a lower maternal educational level (master degree: 24.0% vs 38.4%, $p<0.0001$), lower family income (<€1500/month: 26.3% vs 9.1%, $p<0.0001$), lower maternal age at delivery (29 years vs 30 years, $p<0.0001$), higher rate of first parity (60.1% vs 51.5%, $p=0.0002$), higher rate of maternal depressive symptoms during pregnancy (12.7% vs 5.9%, $p<0.0001$), and higher rate of maternal smoking during pregnancy (33.8% vs 20.9%, $p<0.0001$). Table 1 provides characteristics of included mothers and children. Table 2 provides the infant feeding practices and the sleep trajectories details.

Associations between feeding practices and sleep characteristics

Bivariate analyses are presented in Supplementary table 1.

No association was observed between the use of thickened infant formula or the age of introduction of baby cereals or complementary feeding and sleep trajectories (Table 3).

Infants who were predominantly breastfed for more than 4 months were less likely to belong to the persistent common sleep onset difficulties trajectory (OR [95%CI]=0.51 [0.31; 0.83]). Predominant breastfeeding duration was related neither to night waking nor to nighttime in bed trajectories.

Early introduction (<4 months) to complementary foods, excluding baby cereals, was related to lower risk of belonging to the short-sleepers trajectory (OR [95%CI]=0.35 [0.13; 0.95]) but was not related to other sleep trajectories.

Night feeding, in infancy or at 2 years, was associated with higher risk of belonging to the persistent common sleep onset difficulties trajectory between 2 and 5-6 years old (OR=2.18 [1.46; 3.24] and OR=1.58 [1.16; 2.16], respectively). Night feeding at 2 years was also associated with the changing-sleepers trajectory between 2 and 5-6 years old (OR=2.19 [1.22; 3.95]). Night feeding reported at 8 months was also related to higher risk of belonging to the persistent common night waking trajectory and to the short-sleepers trajectory (OR=3.65 [1.12; 11.93]).

Discussion

With a prospective design, we highlight that long breastfeeding duration was related to lower risk of persistent common sleep onset difficulties reported by parents but not with other sleep trajectories. Moreover, in our cohort, the use of thickened infant formula and the age at baby cereals introduction were not related to any sleep trajectories from 2 to 5-6 years. The most

significant practice related to sleep in preschoolers was night feeding, both in infancy and in toddlerhood.

Long predominant breastfeeding (more than 4 months) was not associated with subsequent persistent night waking or any specific nighttime in bed trajectories but showed a negative association with the persistent common sleep onset difficulties trajectory. As already suggested, mothers who breastfeed their infant, and those who breastfeed for a long time may be less likely to perceive their child's sleep as being problematic and may have an overall better acceptation of sleep onset difficulties or night waking, considering them more as natural and expected (Ramamurthy et al., 2012; Rudzik and Ball, 2016). Another possibility is that mothers who breastfeed for a long duration may be more likely to follow child's health recommendations including sleep ones hence resulting in overall better child's sleep. However, in this case, we would have expected a negative association between breastfeeding duration and short sleepers trajectory, that is not observed. Considering the overall high health benefit of breastfeeding (Victora et al., 2016), these results showing no deleterious association with sleep development in early childhood and preschool years, after taking into account other feeding practices, provide additional support to promote long predominant breastfeeding (Ball, 2013; Rudzik and Ball, 2016). Of note, predominant breastfeeding rates and duration were very low in the EDEN mother-child cohort but similar to those observed in mainland France (Wagner et al., 2015).

We showed, here and in previous papers (Plancoulaine et al., 2018; Reynaud et al., 2016), that sleep trajectories between 2 and 5-6 years were well separated and quite stable with time reflecting mainly persistence of the sleep characteristics over time. As sleep patterns and troubles persist from infancy to childhood, these trajectories may reflect consequences of early infancy sleep characteristics (Byars et al., 2012), and we made the hypothesis that thickened infant formulas and complementary foods would be introduced earlier than

recommended to help in sleep consolidation and maintenance (Brown and Rowan, 2016; Clayton et al., 2013; Crocetti et al., 2004). As a matter of fact, we showed that complementary feeding introduction except baby cereals before 4 months of age was associated only with lower risk to belong to the short-sleepers trajectory between 2 and 5-6 years old. This is in line with Brown et al. who showed no correlation between period of solid introduction and night waking in children aged 6 to 12 months (Brown and Harries, 2015) and Perkin et al who showed that early introduction of solids (before 6 months) is associated with significantly longer duration and less night waking (Perkin et al., 2018) but contradictory to Nevarez et al. who showed that solid food introduction before 4 months was associated with shorter sleep durations at both 1 and 2 years (Nevarez et al., 2010). More important than the use of thickened infant formula and the timing of complementary feeding, might be the daytime repartition of feeding. Indeed, we showed that night feeding in infancy and at age 2 were independently and positively associated with the persistent sleep onset difficulties trajectory between 2 and 5-6 years. Several studies indicate that night feeding limits the development of self-soothing capacities of the child, prompting the child to rely on overnight parental interventions to go back to sleep (Mindell et al., 2010; Schwichtenberg and Poehlmann, 2009; Touchette et al., 2005). This may favor the requirement of parental presence to fall asleep in later childhood.

Short sleep duration and sleep troubles appear to be more prevalent among women with lower socioeconomic status (Gellis, 2011). This also true for early introduction of baby cereals (de Lauzon-Guillain et al., 2017; Lucas et al., 2017). We do not observe this in the present study, however, as mothers from the EDEN mother-child cohort had higher education level and higher socioeconomic position than the general population (Heude et al., 2016), we cannot exclude that the association between complementary feeding and sleep would be different in a more representative sample. More specifically, further studies are needed in disadvantaged

families to confirm our results in this specific population. The present study had some additional limitations. Firstly, sleep information was reported by parental self-administered questionnaires. Objective sleep measurements by actigraphy would have been more accurate, but this strategy was not considered when the EDEN cohort was designed. The use of reported information leads to a possible information bias. Indeed, parents' perception and level of tolerance around their child's sleep disorders could be different. However, studies comparing measurements of sleep characteristics obtained by parental self-administered questionnaires, as in the present study, and by actigraphy showed that these two methods provided measurements with similar trends (Sadeh, 2008). We approximated sleep quantity by nighttime in bed (i.e. difference between bedtime and wake-up time) and thus overestimated sleep duration (i.e. the difference between sleep onset and morning wakening minus time spent awake during the night when occurring). However, this approximation is usually done in epidemiological studies using parental self-questionnaires (Blair et al., 2012; Bruni et al., 2014; Kocevska et al., 2016). We analyzed several trajectories and a large number of variables. This may have lead to lack of power to detect differences especially when considering trajectories with small sample size (e.g. short- and long- night sleep duration trajectories). Finally, sleep quantity and quality during the first year of life of children were not collected in the EDEN cohort. Then, we were not able to assess the reverse causation of the influence of infant sleep characteristics on parental feeding practices.

Conclusion

This study provides new information on the associations between feeding practices in early childhood and the trajectories of sleep in children from 2 to 5 years. Some of these factors associated with sleep are modifiable factors, namely, breastfeeding and night feeding. Further researches with a detailed follow-up from birth and objective measurements of sleep characteristics are needed to clarify whether the association is causal. Knowledge about these

factors would be useful in identifying groups at risk for sleep disorders for which interventions such as nutritional actions could be beneficial in the short and long term.

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Conflict of interest

None

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Legend for figure

Figure 1. Sleep trajectories between 2 and 5-6 years in the EDEN birth-cohort (n=1347). A) Frequent sleep onset difficulties. Black squares = Persistent common sleep onset difficulties (25% of the children); Grey triangles = Persistent rare sleep onset difficulties (75% of the children); B) Frequent night waking. Black squares = Persistent common night waking (23% of the children); Grey triangles = Persistent rare night waking (77% of the children); C) Sleep quantity approximated by nighttime in bed. Black triangles = Short sleepers (SS, 4.9% of the children); Black squares = Medium Low sleepers (MLS, 47.8% of the children); Black circles = Medium High sleepers (MHS, 37.2% of the children); Grey squares = Changing sleepers (CS, 5.6% of the children) and Black diamonds = Long sleepers (LS, 4.5% of the children).

Table 1. Maternal and child characteristics (n=1028)

	% (n) or mean (sd)
Maternal characteristics	
Age at delivery (y)	30.1 (4.6)
Primiparous	48.4% (498)
Married	58.6% (602)
Education level	
<High school	19.9% (205)
High school	17.3% (178)
2-year university degree	24.3% (250)
5-year university degree	38.4% (395)
Household income	
<1500 €/month	9.1% (94)
[1500-2300] €/month	29.6% (304)
[2301-3000] €/month	29.6% (304)
>3000 €/month	31.7% (326)
Smoking during pregnancy	20.9% (215)
Depressive symptoms during pregnancy (CESD ≥ 23)	5.9% (61)
Return to work	
Before 4 months	41.9% (431)
Between 4 and 8 months	26.6% (273)
After 8 months or no return in the first year	31.5% (324)
Child characteristics	
Boys	52.8% (543)
Birth weight (g)	3307 (484)
Pre-term birth	4.8% (49)
Regurgitations problems	
Reported at 4 months only	28.2% (290)
Reported at 8 months	39.8% (409)
None	32.0% (329)

Table 2. Feeding practices and child sleep characteristics (n=1028)

	% (n)
Feeding practices	
Predominant breastfeeding	
Never	40.6% (417)
<2 months	19.2% (197)
2 to <4 months	25.0% (257)
≥ 4 months	15.3% (157)
Thickened formula as the main infant formula	
Never	54.0% (555)
Between 0 and 4 months only	13.8% (142)
Between 4 and 8 months	32.2% (331)
Complementary foods introduction, excluding baby cereals	
<4 months	17.6% (181)
4 to <6 months	43.3% (445)
≥ 6 months	39.1% (402)
Baby cereals introduction	
<4 months	13.6% (140)
4 to <6 months	16.1% (165)
≥ 6 months	20.9% (215)
Never	49.4% (508)
Night feeding in infancy between 11pm and 6 am	
Never	79.9% (821)
Reported at 4 months only	14.2% (146)
Reported at 8 months	5.9% (61)
Feeding to fall asleep or during the night at 2 years	28.3% (291)
Sleep characteristics at 2 years	
Frequent sleep onset difficulties	13.3% (137)
Frequent night waking	21.2% (217)
Nighttime-in-bed duration in hours, mean (sd)	11.1 (0.8)
Sleep characteristics between 2 and 5-6 years	
Frequent sleep onset difficulties trajectories	
Persistent rare	71.7% (737)
Persistent common	28.3% (291)
Frequent night waking trajectories	
Persistent rare	77.9% (801)
Persistent common	22.1% (227)
Nighttime-in-bed trajectories	
Short sleepers (SS)	4.7% (48)
Medium-Low sleepers (MLS)	48.0% (493)
Medium-High sleepers (MHS)	37.1% (381)
Changing sleepers (CS)	5.9% (61)
Long sleepers (LS)	4.4% (45)

Table 3. Associations between feeding practices and sleep developmental trajectories between 2 and 5-6 years (N=1028).

	Sleep onset difficulties		Night waking		Nighttime in bed (reference: MHS trajectory, n=381)				
	Common (n=291) vs rare (n=737)		Common (n=227) vs rare (n=801)		SS (N=48)	MLS (N=493)	CS (N=61)	LS (N=45)	
Predominant breastfeeding		0.03		0.9					0.5
Never	1 [Ref]		1 [Ref]		1 [Ref]	1 [Ref]	1 [Ref]	1 [Ref]	
<2 months	0.94 [0.64 ; 1.39]		1.14 [0.76 ; 1.72]		0.81 [0.35 ; 1.84]	1.02 [0.70 ; 1.50]	0.90 [0.43 ; 1.88]	0.82 [0.32 ; 2.10]	
2 to <4 months	0.70 [0.48 ; 1.02]		0.98 [0.66 ; 1.46]		0.78 [0.33 ; 1.81]	1.27 [0.88 ; 1.82]	0.50 [0.22 ; 1.15]	0.75 [0.30 ; 1.88]	
≥ 4 months	**0.51 [0.31 ; 0.83]**		1.03 [0.62 ; 1.71]		0.34 [0.08 ; 1.34]	0.95 [0.60 ; 1.52]	0.96 [0.38 ; 2.40]	1.33 [0.51 ; 3.44]	
Thickened formula as the main infant formula		0.3		0.9					0.3
Never	1 [Ref]		1 [Ref]		1 [Ref]	1 [Ref]	1 [Ref]	1 [Ref]	
Between 0 and 4 months only	0.77 [0.49 ; 1.21]		0.93 [0.57 ; 1.49]		1.72 [0.75 ; 3.90]	0.76 [0.49 ; 1.18]	0.95 [0.41 ; 2.21]	0.75 [0.25 ; 2.22]	
Between 4 and 8 months	0.78 [0.56 ; 1.09]		0.93 [0.66 ; 1.32]		0.55 [0.24 ; 1.22]	0.85 [0.62 ; 1.17]	0.85 [0.44 ; 1.64]	0.70 [0.32 ; 1.51]	
Complementary foods introduction, excluding baby cereals		0.5		1.0					0.1
<4 months	0.77 [0.50 ; 1.19]		1.04 [0.66 ; 1.62]		**0.35 [0.13 ; 0.95]**	0.7 [0.47 ; 1.06]	1.73 [0.77 ; 3.91]	0.82 [0.28 ; 2.37]	
4 to <6 months	1 [Ref]		1 [Ref]		1 [Ref]	1 [Ref]	1 [Ref]	1 [Ref]	
≥ 6 months	0.90 [0.65 ; 1.25]		1.05 [0.74 ; 1.49]		0.84 [0.41 ; 1.75]	0.9 [0.65 ; 1.24]	1.86 [0.93 ; 3.72]	1.51 [0.72 ; 3.15]	
Baby cereals introduction		0.3		0.5					0.7
<4 months	0.78 [0.48 ; 1.28]		1.12 [0.67 ; 1.85]		1.33 [0.48 ; 3.68]	1.48 [0.94 ; 2.35]	1.34 [0.54 ; 3.36]	0.58 [0.15 ; 2.27]	
4 to <6 months	1.15 [0.76 ; 1.74]		1.28 [0.82 ; 1.98]		1.62 [0.68 ; 3.85]	1.26 [0.84 ; 1.90]	0.88 [0.33 ; 2.37]	1.18 [0.45 ; 3.08]	
≥ 6 months	1.27 [0.88 ; 1.83]		1.29 [0.88 ; 1.91]		1.36 [0.59 ; 3.14]	0.97 [0.68 ; 1.39]	1.53 [0.78 ; 3.01]	0.83 [0.36 ; 1.90]	
Never	1 [Ref]		1 [Ref]		1 [Ref]	1 [Ref]	1 [Ref]	1 [Ref]	
Night feeding in infancy between 11pm and 6 am		0.0006		0.07					0.3
Never	1 [Ref]		1 [Ref]		1 [Ref]	1 [Ref]	1 [Ref]	1 [Ref]	
Reported at 4 months only	**2.18 [1.46 ; 3.24]**		1.26 [0.82 ; 1.94]		0.79 [0.25 ; 2.48]	1.23 [0.82 ; 1.85]	0.71 [0.29 ; 1.77]	0.62 [0.22 ; 1.81]	
Reported at 8 months	1.39 [0.76 ; 2.55]		**1.97 [1.08 ; 3.62]**		**3.65 [1.12 ; 11.93]**	0.92 [0.49 ; 1.72]	0.90 [0.26 ; 3.04]	1.12 [0.28 ; 4.45]	
Feeding to fall asleep or during the night at 2 years	**1.58 [1.16 ; 2.16]**	0.004	1.04 [0.74 ; 1.46]	0.8	0.69 [0.32 ; 1.49]	1.05 [0.77 ; 1.44]	**2.19 [1.22 ; 3.95]**	0.40 [0.16 ; 1.01]	0.01

The multiple logistic (for sleep onset difficulties and night waking) or multiple multinomial logistic (for nighttime in bed) regressions were also adjusted for family income, maternal educational level, marital status, maternal age at delivery, maternal depression during pregnancy, pregnancy smoking, return to work, child's gender, gestational age and regurgitation problems. SS= Short Sleepers, MLS=Medium-Low Sleepers, MHS=Medium-High Sleepers, CS= Changing Sleepers and LS=Long Sleepers.