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**Title:**

Sleep habits and sleep characteristics at age 1 year in the ELFE birth cohort study

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## **Abstract**

**Objective** Infant sleep plays a critical role in normal development. Sleep problems, including sleep onset difficulties (SODs) and night waking (NW), range from 20% to 30% in infants and young children and can be persistent over time up to adulthood. Young French children seem to have longer sleep durations and less sleep troubles than their counterparts worldwide. Here, we aimed at describing infant sleep characteristics (total sleep time (TST)/24 h, NW, and SODs) and associated sleep habits in infants at age 1 year from the French nationwide birth cohort ELFE.

**Methods** This study included 11,783 infants with information on both sleep characteristics and sleep habits (parental presence when falling asleep, eating to fall asleep, sucking a pacifier or finger to sleep and sleep arrangement and location). Associations were studied by multinomial logistic regression analyses adjusted for familial and infant characteristics.

**Results** Mean TST was 13h36min including 2h54min of naps; 20% of the infants had TST  $\leq$ 12h/24h. About 46% did not present SOD or NW, 16% had frequent SODs and 22% had NW >1 night in 2. Parental presence, feeding to fall asleep and infant sleep arrangements were frequent in infants with short sleep duration ( $\leq$ 12h/24h), NW and SODs. Non-nutritive sucking was associated with risk of NW, SOD and TST >14h/24h. Parental room sharing was associated with NW.

**Conclusion** This work provides new information on infant sleep arrangements and non-nutritive sucking that should be accounted for when considering sleep behaviors. In addition, most identified sleep habits associated with poor sleep characteristics may be amenable to change.

**Key words:** Infant, sleep duration, night waking, sleep onset difficulty, birth-cohort, epidemiology

## **Highlights**

- French infants have a better sleep than their counterparts in developed countries
- Self-soothing behaviors are associated with longer sleep duration
- Pacifier use is associated with frequent sleep onset difficulties and night waking
- Most sleep habits associated with poor sleep may be amenable to change

## 1. Introduction

Sleep is a vital physiological function and sleep needs vary depending on age. American recommendations for healthy sleep duration are from 14 to 17 h over a 24-h period for a newborn, 12 to 16 h including 2 to 3 naps from age 3 to 11 months, 11 to 14 h including 1 or 2 naps by age 1 to 2 years, and 10 to 13 h with or without a nap from age 3 to 5 years [1]. However, infants and toddlers ( $\leq 3$  years old) are susceptible to sleep problems including sleep onset difficulties and night waking, with an estimated prevalence from 20% to 30% [2-8]. In an English birth cohort of 11,500 children born in 1991-1992, night waking prevalence was 23% for infants at 6 months and 50% at 18 months and 49% for toddlers at 3 years [5]. In 1,346 children from the French EDEN birth cohort study, night waking prevalence was 22% for toddlers aged 2 years old [6, 7]. Ottaviano *et al.* also reported a night waking prevalence of 35% in toddlers  $< 2$  years old, and a prevalence of sleep onset difficulties of 11% and 7.5% at age 12 and 24 months, respectively [8]. These sleep problems may lead to shorter sleep durations [9]. Sleep problems in early childhood are persistent over time into later childhood, adolescence and adulthood [10-12]. There is much evidence that insufficient quantity and/or quality of sleep have a negative impact on children's physical and mental health development, cognitive function, behavior and academic success [13, 14].

Low parental education and incomes, unfavorable neighborhood [15], high maternal age, maternal depression [16, 17], prematurity [5, 18, 19], low birth weight [5, 19], breastfeeding [2, 9], and care outside the home [7, 20] have been found associated with infant and childhood sleep disturbances. Moreover, longitudinal studies within the first year of life suggest that parental sleep-related behaviors (e.g., needing the parent's presence to fall asleep, feeding before sleep and infant's sleep arrangement and location) play a critical role in the consolidation of the infant's sleep [2, 9, 21, 22].

However, few studies were performed of infants in large representative cohorts [5, 9, 23-25], and none in France. Hence, we aimed to describe infant sleep characteristics (sleep duration, night waking, and sleep onset difficulties) and to identify their relationships with sleep habits in a French representative sample of infants aged 1 year old.

## **2. Materials and Methods**

### **2.1 Study design**

This analysis was based on data from the “Étude Longitudinale Française depuis l’Enfance” (ELFE) study, a prospective multidisciplinary nationally representative birth-cohort study. It included 18,329 newborn infants in a random sample of 349 maternity units in 2011 [26] with the aim of examining many aspects of the lives of these children from the perspectives of health, social sciences and environmental health up to adulthood. Inclusion took place during 25 selected recruitment days over four waves comprising 4 to 8 days each, from April 2011 and covering all four seasons. Inclusion criteria were infants born after 33 weeks’ gestation to mothers  $\geq 18$  years older and who were not planning to move outside of Metropolitan France in the following 3 years and were able to read French, Arabic, Turkish, or English. Participating mothers signed consent for themselves and their infant. Fathers signed consent for the infant’s participation when present on inclusion days or were informed about their rights to oppose. The participation rate was 51%.

The study received approvals from the Consultative Committee for the Treatment of Information for Health Research (Comité Consultatif sur le Traitement des Informations pour la Recherche en Santé), the national data protection authority (Commission Nationale Informatique et Libertés), and the National Statistics Council.

## 2.2 Data Collection

Data were collected by trained interviewers via standardized questionnaires, all previously tested in a pilot study [26]. Each mother was interviewed face to face at the maternity unit for medical information about their pregnancy, their newborn and their general characteristics. Information was completed with records from obstetric and pediatric medical files. Telephone interviews with mothers and fathers were conducted at 2 and 12 months post-partum. Data were taken from the maternal questionnaires; missing maternal answers were completed by the fathers when available.

### 2.2.1 Participants

Infants whose parents withdrew consent within the first year ( $n = 128$ ) or for whom it was not possible to verify the eligibility criteria due to missing data ( $n = 407$ ) were excluded from the study, thereby resulting in 17,794 eligible infants among the 18,329 infants initially included. We excluded twins ( $n = 548$ ), preterm infants ( $< 37$  weeks' amenorrhea) ( $n = 756$ ), families who did not reply at the 12-month follow-up ( $n = 3,705$ ), infants without any data on sleep characteristics at 12 months (i.e., sleep onset difficulties, night waking and sleep duration [ $n = 247$ ]) and those without any data on sleep habits (parental presence when falling asleep, feeding to fall asleep, sleeping with a blankie, use of pacifier or finger sucking before sleep, infant sleep arrangement, and sleeping in parent's room ( $n = 64$ )). The final sample was 12,474 infants. The complete-case sample, excluding individuals with missing data for co-variables ( $n = 691$ ), was 11,783 infants.

### 2.2.2 Infant sleep characteristics at age 1

Sleep onset difficulties were assessed by the question "When you put your infant to bed, does he/she have trouble falling asleep; for example, he/she calls or cries for a long time?" Possible answers were "never", "sometimes", "often". Night waking was assessed by the question "On this week, how many nights did your baby wake up (if the infant was sick

this week, answer for a week without illness)?” Possible answers were “never”, “1 or 2 nights”, “3 to 6 nights”, and “every night”). Night waking was classified into 3 groups: never, 1-2 nights/week, and > 2 nights/week, and the last category was considered frequent. Total sleep duration / 24 h was calculated based on the answers (in hours and minutes) to the following questions: “On average, what is his/her total sleep time during night?” and “On average, what is the total duration of his/her day sleep. Add up all his/her naps in one day”. Total sleep duration was then classified into 3 groups:  $\leq 12\text{h}/24\text{h}$ , 13-14h/24h, and  $>14\text{h}/24\text{h}$ . The threshold of 12h/24h was used to define short sleep duration because of sample size issues (7% of the infants slept  $<11\text{h}/24\text{h}$  at age 1 in the cohort).

### *2.2.3 Infant sleep habits at age 1*

Information on sleep environment and habits were collected at 1 year. Pacifier or finger sucking before sleep (coded as none, pacifier only, thumb/finger only, both pacifier and thumb/finger), feeding to fall asleep (yes/no), sleeping with a blankie (yes/no), parental presence when falling asleep (yes/no), sleep arrangement (i.e., where the infant falls asleep and ends sleep: falls asleep and ends sleep in own bed/crib, falls asleep in own bed/crib but ends it in parent’s bed, falls asleep and ends sleep elsewhere than in own bed/crib), and sleeping in parent’s room (yes/no).

### *2.2.4 Parental and infant general characteristics*

Data were collected at the maternity ward, at 2 months and at age 1 year. Information collected during the maternity stay was used only in case of missing values at 2 months. These data concerned maternal birth place (born in France or abroad), maternal age at delivery ( $<25$ , 25-29, 30-34 and  $>34$  years), maternal psychological difficulties during pregnancy (yes/no), first child (yes/no), birth weight and child’s sex.



At 1 year, the consumption unit (CU) was calculated as the number of family co-habitants weighted according to the age of each co-habitant (<14 or  $\geq$ 14 years old). The familial income by CU at age 1 year was then classified as  $\leq$ 850, 851-1200, 1201-1700, 1701-2200, 2201-3000, >3000 €/month/CU. Additional information was collected on maternal education attainment (lower secondary, upper secondary, intermediate, higher), infant age at the interview and infant exposure to tobacco smoke, based on the question “Currently, is your child exposed to tobacco smoke?”. Predominant breastfeeding duration (i.e., the only milk received was breast milk) was considered never, <3 months, 3 to 6 months, >6 months [27]. Main childcare arrangement at age 1 year was coded as community child-care (i.e., preschool, nursery school, or child-care center), nursery assistant (external to the infant’s home) and home child-minding (parents, family member, neighbors, or nanny).

### **2.3 Statistical methods**

To provide representative descriptive statistics for birth in 2011 in France, descriptive data (percentages for discrete variables and means for continuous variables) were weighted to take into account the inclusion procedure and biases related to non-consent. Weighting also included calibration on margins from the state register's statistical data and the 2010 French National Perinatal study [28] on the following variables: age, region, marital status, migration status, level of education, and parity. Potential confounding factors included in the models were identified from the literature and were selected with the Directed Acyclic Graphs method ([www.dagitty.net](http://www.dagitty.net)). Associations between sleep habits and each sleep characteristic (total sleep duration, night waking and sleep onset difficulties) were tested by multinomial logistic regression analyses adjusted for infant and parental characteristics and recruitment specificities (mother’s region of residence, size of maternity unit and wave of recruitment). The significance level was set at  $p \leq 0.05$ . All analyses were performed with SAS 9.3 (SAS, Cary, NC, on an AIX 7.1 platform).

### 3. Results

#### 3.1 Preliminary analyses

Among 18,329 infants enrolled at birth, 11,783 (64%) met the inclusion criteria and had complete information for covariates. As compared with non-included infants ( $n = 6,546$ ), included infants were more frequently born to a mother with a higher educational level (41% vs 26%,  $p < 10^{-4}$ ), age 30 to 34 years old (39% vs 31%,  $p < 10^{-4}$ ) and fewer psychological difficulties during pregnancy (12% vs 14%,  $p = 0.0002$ ). In addition, included infants more frequently lived in a family with higher income/CU (47% vs 35% with income/CU > 1700 €,  $p < 10^{-4}$ ).

##### 3.1.1 Population description

General characteristics of the studied population are in Table 1. Overall, 49% of infants were girls, 43% were first born. At age 1 year, about half of the infants were home-minded and 4% were exposed to tobacco smoke.

##### 3.1.2 Sleep characteristics at 1 year

The total mean sleep duration at 1 year was 13h36min, with mean nocturnal and daytime sleep duration 10h42min and 2h54min, respectively (Table 2). In total, 20% of the infants slept  $\leq 12$ h/24h, 22% presented frequent night waking ( $> 2$  nights/week) and 16% presented frequent sleep onset difficulties. Also, 29% and 10% of the infants required the parental presence and feeding to fall asleep, respectively and 82% used a blankie; 49% sucked only a pacifier, 19% sucked only their thumb/finger and 23% sucked both a pacifier and thumb/finger. About 9% of the infants did not fall asleep nor end their sleep in their bed/crib and about 15% slept in the parent's room.

## **3.2 Associations between sleep characteristics and sleep habits at age 1 year**

Table 3 presents the adjusted results.

### *3.2.1 Factors associated with infant total sleep duration per 24h at age 1 year*

Both parental presence when falling asleep and ending the night elsewhere than in their own bed/crib were more likely with short sleep duration ( $\leq 12\text{h}/24\text{h}$ ) and less likely with long sleep duration ( $>14\text{h}/24\text{h}$ ) as compared with 13-14h/24h sleep. With reference to the same group, feeding to fall asleep was more likely with short sleep duration; non-nutritive sucking (pacifier, thumb/finger or both) was more likely with long sleep duration, and sleeping with a blankie was less likely with short sleep duration. In addition, probabilities of night waking and sleep onset difficulties were increased with short sleep duration, with a dose effect. Sleeping in the parents' room was not associated with infant sleep duration.

### *3.2.2 Factors associated with infant night waking at age 1 year*

Parental presence, being fed to fall asleep and sucking a pacifier with or without the thumb/finger were more likely with night waking as compared with never night waking, whereas the need for a blankie was more likely with only a few nights waking (1-2 nights/week). Sleeping elsewhere than in the infant's bed/crib was associated with risk of night waking; falling asleep in the bed/crib and ending it elsewhere was more frequent with both few (1-2 nights/week) and frequent ( $>2$  nights/week) night waking; and falling asleep and ending it elsewhere was associated with only frequent night waking as compared with not waking. Sleeping in parents' room was more likely with frequent night waking. Short sleep duration and sleep onset difficulties were both positively associated with night waking frequencies, and long sleep duration ( $>14\text{h}/24\text{h}$ ) decreased the risk of night waking.

### *3.2.3 Factors associated with infant sleep onset difficulties at age 1 year*

Parental presence was associated with sleep onset difficulties. Feeding to fall asleep was also associated with frequent sleep onset difficulties as compared with never having sleep onset difficulties. In reference to the same group, sucking both the thumb/finger and the pacifier was associated with risk of few sleep onset difficulties, whereas sucking the thumb/finger only was associated with lower risk of sleep onset difficulties but not significantly. Falling asleep in the infant's own bed/crib but ending it in the parents' bed was associated with increased risk of sleep onset difficulties whatever the frequency, and falling asleep and ending sleep elsewhere than in the infant's own bed/crib was associated with reduced risk of few sleep onset difficulties but increased risk of frequent sleep onset difficulties. Sleeping in the parents' room was not associated with infant sleep onset difficulties.

## **4. Discussion**

### **4.1 Total sleep duration**

The analysis of the ELFE cohort data showed mean sleep durations of 13h36min/24h and 10h42min/night in 1-year-old French infants. This latter result is similar to the mean night-sleep duration observed in 1,255 children 2 to 5 years old in the French EDEN mother-child cohort recruited in 2003-2006 [29]. Although these results agree with the American Academy of Sleep Medicine recommendations for the pediatric population to promote optimal health [1], the mean sleep durations in the current study were in the higher limits of their recommendations and were higher than those in other studies [5, 30-32]. These latter studies from England [5], European countries (excluding France) [31] and the United States [32] as well as a systematic review [30] reported total sleep durations between 12h40min and 13h/24h at about age 1 year, so French parents report that their infants sleep 30-60min/24h

more than their counterparts in developed countries. In a recent literature review of sleep in the first 12 months of life, sleep duration per 24 h tended to be longer in European countries than in the United States, New Zealand, Israel and China [33]. In the current study, this difference seems to be mainly due to longer nap duration in French children but similar night-sleep duration as their peers.

Sleep duration is the most-studied sleep characteristic. A couple of sleep habits observed associated with infant's shorter sleep duration in the current study have been reported in infants and toddlers, namely, parental presence when falling asleep [8, 29, 34], infant sleep arrangements outside his/her own bed during the night [21, 35], feeding to fall asleep [29, 34], and frequent night waking and sleep onset difficulties [29]. Sleeping in the parents' room was not associated with sleep duration, which suggests that even if parents who share the room with their infant might be more aware of disrupted sleep, they do not report different sleep durations as compared with parents whose infant sleeps in another room, as was observed at this age by others [21, 34]. In this cross-sectional analysis, the observed relations between child's sleep and parental sleep strategies may be bi-directional [36]. However, interventions modifying the previously cited sleep habits have been found to improve sleep duration in young children [24, 37]. Nevertheless, to our best knowledge, we report for the first time the association of several self-soothing and comforting behaviors with longer sleep duration such as non-nutritive sucking (thumb/pacifier) or the use of a blankie [38].

#### **4.2 Night waking**

The prevalence of frequent night waking (>2 nights/week) as declared by parents concerned 22% of 1-year old French infants. This finding is globally similar to previous findings, especially those obtained in the EDEN French cohort for 2-year-old children (22%)

[7], the Richman *et al.* study (20% for toddlers between age 1 and 2 years) [39], and the Bruni *et al.* study (17.5% for Italian infants aged 12 months with >2 wakings/night) [40]. However, our results were lower than those reported in the United States for about 1,200 children from 0 to 36 months old (31% at 15 months and 28% at 24 months) [41] and those reported in Italy for 563 infants (34% for infants aged 13 to 24 months) [8].

As for shorter sleep duration, parental presence [7, 8, 34], feeding to fall asleep [7, 34], and ending the night elsewhere than in the infant's own bed/crib [9] were associated with frequent night waking. Results on parents' room sharing suggest that room-sharing parents reported more night waking because they were more aware of them. Also, parents of infants with sleep troubles may prefer to have infants closer to them at night. However, then we would expect that room sharing would also be associated with other sleep troubles such as shorter sleep duration or sleep onset difficulties, which were not observed. Infants sucking a pacifier (with or without finger/thumb) were at increased risk of night waking per week whatever the frequency as compared with non-suckers or finger/thumb only suckers at age 1 year. Only a few studies focused on pacifier use or finger/thumb sucking and sleep at around age 1 year old [38, 42]. They all focused on number of wakings per night. Butler *et al.* observed an increased number of wakings per night for infants using pacifiers as compared with finger/thumb suckers or non-suckers in a sample of 104 infants aged 0 to 11 months in the United States [38]. When focusing on older infants ( $\geq 7$  months,  $n = 57$ ), the authors observed an increased number of wakings per night in pacifier users as compared with thumb/finger users but not as compared with non-suckers. They explained the difference by the ability for pacifier users to find it by themselves in the bed [38]. Along the same lines, Balaban *et al.* did not observe any difference in number of wakings per night in pacifier users versus non-suckers in 100 infants aged 5 to 13 months (mean 10.58 months). Discrepancies between our results and these latter studies may result from the night waking scale used (per

night vs per week), the statistical analyses performed (distribution comparisons, covariance analyses vs multinomial logistic regressions), the sample size and the confounders taken into account.

### **4.3 Sleep onset difficulties**

The prevalence of sleep onset difficulties at age 1 year was 53%, with 16% of infants presenting frequent difficulties. Few studies reported the prevalence of sleep onset difficulties in infants. Jiang *et al.* reported a prevalence of sleep latency >30 min (30.6%) in 1,129 Chinese infants aged 1 to 23 months [43] and Ottaviano *et al.* reported a prevalence of 11% and 7.6% for sleep latency >30 min in Italian children aged 6-12 months and 12-23 months [8]. More recently, Bruni *et al.* reported bedtime difficulties in 13.8% of Italian infants aged 12 months [40]. Most of the studies used a clinical definition of problematic sleep latency, but our results are based on a qualitative question, less precise and more susceptible to subjective answers. However, mean sleep latency reported at age 1 year is quite short (14.7 min by Bruni *et al.* [40] and 9.3 min by Dias *et al.* [33]), and reporting troubles falling asleep with cries and calls for a long time, as we did, might correspond to infants with increased sleep latency that meet the clinical definition.

Several sleep habits were associated with sleep onset difficulties, such as parental presence, and feeding to fall asleep. These elements are known to be associated with sleep problems in young children [2, 13] and infants [22, 40]. Sucking both a pacifier and thumb/finger was associated with more troubles falling asleep as compared with not sucking, whereas sucking a thumb/finger only tended to be associated with fewer sleep onset difficulties, which suggests that finger/thumb sucking may facilitate more sleep than a pacifier. Bulter *et al.* [38] also suggested this hypothesis, whereas in the Mauch *et al.* study in Australia, focusing on the reason and the predictors of pacifier introduction, pacifiers were mainly introduced by first-time mothers to soothe their infant (78.3%) and to help them fall

asleep (57.4%) [44]. Confirmation of the relation between non-nutritive sucking, especially pacifier use, and sleep onset difficulties is needed.

#### **4.4 Strengths and limitations**

This study was performed in a large nationwide sample of infants from metropolitan France, and allowed for analysis of current sleep habits within the French general population with good statistical power. However, some limitations need to be recognized. Most of the data and especially sleep data were collected by questionnaires that may possibly lead to misestimations of sleep characteristics. Sleep duration, calculated by using bedtime and wake-up time reflects infant's time in bed; night wakings were those noticed by parents (i.e., signaled by the infants) and reflected infants with difficulties falling back asleep by themselves. These situations may lead to overestimation of sleep duration and underestimation of night waking. Objective sleep measured by actigraphy would have provided better estimations of sleep characteristics but had not been considered in this nationwide study including 13,000 infants because of cost and logistic issues. However, the use of questionnaires for sleep characteristic estimation is a classical approach used in large epidemiological studies [5, 30, 32, 33]. Information on co-sleeping (bed-sharing) was not directly available but was approximated by the sleep arrangement. Finally, this was a cross-sectional analysis and causality cannot be inferred.

#### **5. Conclusion**

We report data on the infant sleep quality and quantity as well as associated sleep habits from a large national cohort study that can serve as a reference for infants living in France. The study confirmed known sleep habit factors such as parental presence, feeding to fall asleep and infant sleep arrangement (particularly, ending sleep elsewhere than in their own bed/crib), associated with shorter sleep duration and frequent night waking. It also



specifically highlighted sleep habits associated with sleep onset difficulties but also with longer sleep durations (non-nutritive sucking and using a blankie). Notably, most of the sleep habits associated with poor sleep characteristics may be open to change with intervention programs [45, 46]. Longitudinal studies will be needed, when data on follow-ups will be available, to analyze the persistence of the observed relations between early sleep habits, especially self-soothing, and later sleep characteristics or patterns of sleep over time. However, this work provides additional information to consider when making recommendations related to sleep behaviors.

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### **Conflict of interest**

The authors declare that they have no conflicts of interest.

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Table 1. Weighted\*general characteristics of the studied ELFE population (N=11,783)

	% or mean §
<b>Maternal and familial characteristics</b>	
Maternal birthplace (France)	84.6
Psychological difficulties during pregnancy (yes)	13.1
Maternal age at delivery, years	
< 25	15.2
25-29	25.6
30-34	35.1
>34	24.1
Maternal educational level at 1 year	
Below secondary	10.6
Upper secondary	36.6
Intermediate	19.9
Higher	32.9
Familial income/consumption unit (CU) when the infant was age 1 year, €/month/CU	
≤ 850	17.2
851-1200	17.7
1201-1700	27.1
1701-2200	21.1
2201 -3000	11.7
>3000	5.2
<b>Infant characteristics</b>	
Infant' s age during the interview (in month)	13.0 §
Sex (girl)	49.0
Birthweight (kg)	3.4 §
First child (yes)	43.4
Predominant breastfeeding duration	
Never	35.8
<3 months	37.1
3-6 months	19.6
>6 months	7.5
Infant exposed to tobacco smoke at age 1 year (yes)	4.1
Main childcare arrangement during daytime at age 1 year	
Home child-minding	50.2
Collective care	35.1
Nursery assistant	14.7

\* Weighting took into account factors related to inclusion procedure, non-consent and included calibration on margins from national statistics data

§ Weighted means



Table 2. Weighted\* sleep characteristics and sleep habits for studied ELFE children at age 1 year (N=11,783)

	<b>% or mean</b> §
Daytime sleep duration	2h54min §
Nocturnal sleep duration	10h42min §
Total sleep duration in 24 h	13h36min §
Total sleep duration in 24 h	
≤12 h	20.3
13-14 h	48.1
>14 h	31.6
Night waking	
Never	45.2
1-2 nights/week	32.6
>2 nights/week	22.2
Sleep onset difficulties	
Never	46.5
Sometimes	37.4
Often	16.1
Parental presence when falling asleep (yes)	28.6
Feeding to fall asleep (yes)	10.3
Sleeping with a blankie (yes)	81.9
Use of pacifier or finger sucking before sleep	
None	9.8
Thumb/finger only	18.6
Pacifier only	48.9
Pacifier and thumb/finger	22.7
Infant sleep arrangement	
Falls asleep and ends sleep in own bed/crib	75.2
Falls asleep in own bed/crib but ends sleep in parent's bed	15.6
Falls asleep and end sleep elsewhere than in their own bed/crib	9.3
Sleeping in parents' room (yes)	15.5

\* Weighting took into account factors related to inclusion procedure, non-consent and included calibration on margins from national statistics data

§ Weighted mean

Table 3. Multinomial logistic regression analysis of sleep habits and sleep characteristics at age 1 year in the studied ELFE population (N=11,783)

	Total sleep duration (Reference=13-14h/24h)			Night waking (Reference= Never)			Sleep onset difficulties (Reference= Never)		
	≤ 12 h N=1,977	> 14 h N=3,910	P value	1-2 nights/week N=3,724	>2 nights/week N=2,445	P value	Sometimes N=4,377	Often N=1,627	P value
	aOR [95% CI]	aOR [95% CI]		aOR [95% CI]	aOR [95% CI]		aOR [95% CI]	aOR [95% CI]	
<b><i>Sleep habits</i></b>									
Parental presence when falling asleep (yes)	<b>1.55 [1.35–1.79]</b>	<b>0.63 [0.55–0.72]</b>	<10 <sup>-3</sup>	<b>1.36 [1.19–1.56]</b>	<b>1.73 [1.49–2.01]</b>	<10 <sup>-3</sup>	<b>2.10 [1.84–2.39]</b>	<b>12.02 [10.17–14.21]</b>	<10 <sup>-3</sup>
Feeding to fall asleep (yes)	<b>1.52 [1.27–1.81]</b>	0.94 [0.77–1.14]	<10 <sup>-3</sup>	<b>1.50 [1.24–1.81]</b>	<b>2.04 [1.67–2.49]</b>	<10 <sup>-3</sup>	1.12 [0.93–1.34]	<b>1.27 [1.01–1.59]</b>	0.16
Sleeping with a blankie (yes)	<b>0.73 [0.62–0.86]</b>	1.08 [0.94–1.24]	<10 <sup>-3</sup>	<b>1.20 [1.04–1.38]</b>	1.09 [0.92–1.29]	0.05	1.14 [0.99–1.30]	0.90 [0.73–1.10]	<b>0.03</b>
Use of pacifier or finger sucking before sleep			10 <sup>-3</sup>			<10 <sup>-3</sup>			<10 <sup>-3</sup>
None	Reference	Reference		Reference	Reference		Reference	Reference	
Thumb/finger only	0.97 [0.78–1.19]	<b>1.51 [1.25–1.81]</b>		0.94 [0.78–1.13]	0.86 [0.69–1.07]		0.94 [0.79–1.12]	0.79 [0.61–1.02]	
Pacifier only	1.00 [0.82–1.23]	<b>1.31 [1.09–1.58]</b>		<b>1.32 [1.10–1.59]</b>	<b>1.39 [1.12–1.71]</b>		0.92 [0.77–1.10]	0.84 [0.65–1.08]	
Pacifier and thumb/finger	1.04 [0.83–1.30]	<b>1.38 [1.13–1.68]</b>		<b>1.48 [1.22–1.80]</b>	<b>1.46 [1.16–1.83]</b>		<b>1.22 [1.01–1.47]</b>	1.08 [0.82–1.42]	
Infant sleep arrangement			<10 <sup>-3</sup>			<10 <sup>-3</sup>			<10 <sup>-3</sup>
Falls asleep and ends sleep in own bed/crib	Reference	Reference		Reference	Reference		Reference	Reference	
Falls asleep in own bed/crib but ends sleep in parents' bed	<b>1.33 [1.14–1.54]</b>	<b>0.78 [0.68–0.91]</b>		<b>2.02 [1.74–2.35]</b>	<b>3.41 [2.92–3.99]</b>		<b>1.66 [1.44–1.91]</b>	<b>2.16 [1.79–2.60]</b>	
Falls asleep and ends sleep elsewhere than in own bed/crib	<b>1.64 [1.35–1.99]</b>	<b>0.68 [0.52–0.88]</b>		1.14 [0.90–1.43]	<b>2.22 [1.78–2.77]</b>		<b>0.50 [0.39–0.64]</b>	<b>1.56 [1.24–1.97]</b>	
Sleeping in parents' room (yes)	1.11 [0.95–1.31]	0.88 [0.75–1.03]	0.06	1.04 [0.89–1.22]	<b>1.33 [1.13–1.58]</b>	<b>0.01</b>	0.90 [0.78–1.05]	0.82 [0.67–1.00]	0.10
<b><i>Sleep characteristics</i></b>									
Total sleep duration in 24h						<10 <sup>-3</sup>			<10 <sup>-3</sup>
≤12 h				<b>1.20 [1.05–1.37]</b>	<b>1.71 [1.48–1.97]</b>		<b>1.35 [1.18–1.53]</b>	<b>1.91 [1.62–2.25]</b>	
13-14 h				Reference	Reference		Reference	Reference	
> 14 h				<b>0.85 [0.77–0.93]</b>	<b>0.74 [0.65–0.84]</b>		<b>0.76 [0.7–0.83]</b>	<b>0.52 [0.44–0.62]</b>	
Night waking			<10 <sup>-3</sup>						<10 <sup>-3</sup>
Never	Reference	Reference					Reference	Reference	
1-2 nights/week	<b>1.22 [1.07–1.39]</b>	<b>0.85 [0.77–0.93]</b>					<b>1.62 [1.48–1.78]</b>	<b>1.72 [1.46–2.03]</b>	
> 2 nights/week	<b>1.73 [1.50 – 2.00]</b>	<b>0.74 [0.65–0.84]</b>					<b>2.05 [1.82–2.31]</b>	<b>3.52 [2.95–4.19]</b>	
Sleep onset difficulties			<10 <sup>-3</sup>			<10 <sup>-3</sup>			
Never	Reference	Reference		Reference	Reference				
Sometimes	<b>1.38 [1.21–1.57]</b>	<b>0.76 [0.70–0.84]</b>		<b>1.63 [1.48–1.78]</b>	<b>2.06 [1.82–2.32]</b>				
Often	<b>1.96 [1.66–2.31]</b>	<b>0.53 [0.44–0.64]</b>		<b>1.70 [1.44–2.01]</b>	<b>3.44 [2.88–4.11]</b>				

aOR, adjusted odds ratio; 95% CI, confidence interval. Significant association (p <.05) were highlighted in bold

The multiple multinomial logistic regressions (for total sleep duration, night waking and sleep onset difficulties) were adjusted on the recruitment factors (mother's region of residence, wave of recruitment, size of maternity unit), familial characteristics (maternal birth place, maternal age at delivery, maternal psychological difficulties during pregnancy, maternal education attainment, predominant breastfeeding duration, and familial income/consumption unit), and infant characteristics (infant's age during the interview, sex, birth weight, first child, child exposed to tobacco smoke at 1 year, and main childcare arrangement during daytime at age 1 year).