



## Original Article

# Night-waking trajectories and associated factors in French preschoolers from the EDEN birth-cohort



Eve Reynaud<sup>a, b, c</sup>, Anne Forhan<sup>a, b</sup>, Barbara Heude<sup>a, b</sup>, Blandine de Lauzon-Guillain<sup>a, b</sup>, Marie-Aline Charles<sup>a, b</sup>, Sabine Plancoulaine<sup>a, b, \*</sup>

<sup>a</sup> INSERM, UMR1153, Epidemiology and Statistics Sorbonne Paris Cité Research Center (CRESS), Early Origins of Child Health And Development Team (ORCHAD), Villejuif, F-94807, France

<sup>b</sup> Paris-Descartes University, Paris, F-75006, France

<sup>c</sup> Ecole des Hautes Etudes en Santé Publique (EHESP), Rennes, F-35043, France

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## ABSTRACT

Night waking in preschoolers has been associated with adverse health outcomes in cross-sectional studies, but has rarely been analyzed in a longitudinal setting. Therefore, little is known about the evolution of night waking in early childhood. The objectives of the present study were: to identify night-waking trajectories in preschoolers, and to examine the risk factors associated with those trajectories. Analyses were based on the French birth-cohort study EDEN, which recruited 2002 pregnant women between 2003 and 2006. Data on a child's night waking at the ages of two, three, and five, six years, and potential confounders, were collected through parental self-reported questionnaires. Night-waking trajectories were computerized using group-based trajectory modeling on 1346 children. Two distinct developmental patterns were identified: the "2–5 rare night-waking" (77% of the children) and the "2–5 common night-waking" pattern. Logistic regressions were performed to identify the factors associated with the trajectories. Risk factors for belonging to the "2–5 common night-waking" trajectory were: exposure to passive smoking at home, daycare in a collective setting, watching television for extended periods, bottle feeding at night, high emotionality, and low shyness. This approach allowed identification of risk factors associated with night waking during a critical age window, and laid the groundwork for identifying children at higher risk of deleterious sleep patterns. Those risk factors were mainly living habits, which indicated that prevention and intervention programs could be highly beneficial in this population.

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## 1. Introduction

Sleep quantity and patterns greatly change during childhood. Occasional night waking in preschoolers is part of a normal process of the development and maturation of sleep. At this age, the frequency of night waking is considered abnormally high when it exceeds three times a week [1,2]. As occasional night waking is common at such a young age, the effects of sleep disruption may go undetected. During routine consultations, about 20% of pediatricians do not ask any questions about sleep [3]. However, night waking is one of the primary complaints of parents to pediatricians

[4] and recent findings have suggested that they are associated with aggressive behavior [2], hyperactivity [5], attention problems, and impaired reasoning [6].

Most of the studies have used a cross-sectional design, and considered sleep disorders in a non-specific manner among school-aged children. Risk factors that have been associated specifically with night waking in preschoolers are: maternal depression [7], the child's sleep habits [8], and atopic dermatitis [9]. Only Weinraub et al. [10] have analyzed night waking with a developmental pattern approach. They studied 1200 toddlers (3–36 months old) and identified two trajectories with the growth mixture modeling method. The first represented children who rarely woke up during the night across the study period, and the second represented children with high night waking occurrences between 6 and 18 months, but were similar to the other children thereafter. The analyses of associated factors mainly focused on socioeconomic and

\* Corresponding author. INSERM, UMR1153, Team 6 ORCHAD, 16 Avenue Paul Vaillant Couturier, 94807, Villejuif Cedex, France.

E-mail address: [sabine.plancoulaine@inserm.fr](mailto:sabine.plancoulaine@inserm.fr) (S. Plancoulaine).

demographic variables, along with mother and child psychological and behavioral states. Less attention was given to postnatal exposures such as sleep habits, passive smoking or television viewing, also reported to be associated with sleep quality in children [11,12].

The first objective of the present study was to identify night-waking trajectories in children from the age of two to five to six years in the French EDEN mother-child cohort, using the group-based trajectory modeling method [13], in order to best characterize evolving sleep modalities before children start school. The second objective was to identify risk factors from birth to three years associated with the identified trajectories.

## 2. Materials and methods

### 2.1. Study sample

The EDEN study aimed to investigate the pre-natal and post-natal determinants of child health and development. Details of the EDEN study protocol have been previously published [14]. In short: pregnant women at <24 weeks of amenorrhea were recruited between 2003 and 2006 at the university hospitals of Poitiers and Nancy. Exclusion criteria were: being aged <18 years, unable to give informed consent, functionally illiterate in French, a history of diabetes, planning on changing address, or without social security cover. Among the 3758 women invited to participate, 2002 (53%) agreed to enroll in the study. Women with multiple pregnancies were further excluded. Due to miscarriages, stillbirths and attrition, the number fell to 1899 children enrolled at birth. Written informed consent was obtained twice from parents: at enrollment and after the child's birth. The ethics research committee of Bicêtre Hospital (Comité Consultatif de Protection des Personnes dans la Recherche Biomédicale) and the Data Protection Authority (Commission Nationale de l'Informatique et des Libertés) approved the study.

### 2.2. Data collection

All variables included in the analysis were collected through paper-based self-questionnaires, with the exception of the anthropometric measures, which were assessed by clinical examination, and the birth term, which was drawn from medical records.

#### 2.2.1. Outcome variable

Parents reported the number of times per week that their child woke during the night at ages two, three and five to six years. At each time point, and in accordance with the literature, "frequent night waking" was defined as the child waking every other night or more [1,2], as opposed to "no or occasional night waking." This binary night waking repeated measure was used to compute the outcome variable: the "2–5 night-waking" trajectories. These trajectories were modeled using the "group-based trajectory" method described in the statistical analysis section. The reported night wakings were those noticed by parents, meaning that the child signaled being awake. As noted by other authors [15,16], parental questionnaires, unlike actigraphy, measure the difficulty a child has in falling back to sleep by him/herself; in other words: it accounts for the child's self-soothing capacities and not night waking per se.

#### 2.2.2. Socio-economic, socio-demographic and maternal variables

The household socio-economic and demographic factors, as well as maternal characteristics, were collected at inclusion. Household income was divided into three categories: <€1500 per month, €1500–3000 per month, and >€3000 per month. Education level was also defined in three categories, using the highest level reached by one of the parents: below high-school diploma, high-school

diploma, and above. The mother's age at delivery was analyzed as a continuous variable. Single parenting was defined as a mother living without the child's father, another companion, or another adult family member. The mother's depression status during pregnancy was assessed by the French version of the Center of Epidemiologic Studies Depression scale (CES-D), using the cut-off point that has been validated in French Women [17]. Mothers with a CES-D score of  $\geq 23$  were considered to present depressive symptoms. The present study used the mother's nationality (European/non-European) to take into account potential cultural differences. Ethnicity was not assessed in the EDEN cohort, in accordance with French law and ethics.

#### 2.2.3. Child's variables

The child's characteristics, anthropometrics and perinatal exposures were collected at birth from self-reported questionnaires and medical records, these included: gender, birth order (first/other), ponderal index (defined by birth weight in kg divided by the cube of birth height in meters), breastfeeding (yes/no) and preterm birth (<37 weeks of amenorrhea). Temperamental traits, namely emotionality, activity and shyness, were assessed at one year of age using the Emotionality Activity and Sociability scale (EAS) [18].

The child's postnatal environment and health was investigated at three years of age. The present study also examined the time spent in front of the television as a continuous variable (h/day), passive smoking at home ("Does anyone smoke inside the child's home several times a month or more?" yes/no), care arrangement (in large collective settings like preschool or daycare centers vs home care) and two sleep habits: falling asleep with a parent (yes/no) and bottle feeding at night (yes/no). It also looked at health characteristics when diagnosed by a physician (yes/no): occurrence of ear nose or throat infections, and atopic profile (defined as skin atopy, respiratory or food allergy).

### 2.3. Statistical analysis

All analyses were performed using SAS<sup>®</sup> (SAS 9.4 SAS institute INC, Cary, NC, USA).

#### 2.3.1. Group-based trajectory modeling

To describe the night-waking patterns of children from the age of two to five to six years, the group-based trajectory modeling method (PROC TRAJ procedure) was used [13]. The method is based on the underlying hypothesis that within a population there are inherent groups that evolve according to different 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 night waking was modeled by polynomial equations defining the trajectories. The model selection process is described in the supplementary data. The most adequate model, regarding the number of groups and the shape of the trajectories, was determined by iterations: different models were computed and then compared using the Bayesian Information Criteria (BIC) and favoring parsimony. The chosen model's quality was verified according to recommended criteria: the average posterior probability ( $\geq 0.7$ ), the odds of correct classification ( $\geq 5$ ), and the similarity between the model's estimation of prevalence and the actual prevalence.

Children were included in the trajectory's elaboration if their parents had answered the question regarding night waking for at least two time points out of three. To verify the robustness of the model, sensitivity analyses were performed: the full procedure was also carried out among children who had complete night-waking data at all three time points as well as separately by gender.

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