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Original Article

Infant sleep and early parental sleep-related cognitions predict sleep in pre-school children

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ABSTRACT

Objective: To investigate early predictors of sleep patterns in pre-school age children. Specifically, we were interested in exploring whether infant sleep patterns and parenting factors assessed at 12 months would predict sleep in four year-old children.
Methods: This was a follow-up study of a home-based longitudinal study, exploring the links between parental cognitions and children's sleep. The present study included 71 families (boys 58%) and focused on data collected when children were 12 months and four years old. Sleep at both time points was assessed for four weekdays by actigraphy and parental reports.
Results: Statistically significant zero-order correlations were found between early sleep patterns, maternal cognitions, and soothing behaviors at 12 months, and sleep patterns at four years. Multiple regression analysis revealed that 12 months maternal cognitions reflecting difficulties with limiting parental nighttime involvement were a statistically significant predictor of fragmented child's sleep and of parental bedtime involvement at four years. More objective infant night-wakings at 12 months predicted lower sleep efficiency at four years.
Conclusions: Both early sleep patterns and maternal sleep-related cognitions during infancy are significant predictors of sleep quality of pre-school children. These findings are clinically meaningful as they suggest that improving infant sleep and addressing early parental beliefs and perceptions regarding infant sleep may help in preventing sleep problems of pre-school children.

1. Introduction

Sleep plays an important role in child development. Research suggests that childhood sleep disturbances are associated with various negative outcomes, including disrupted cognitive functioning, poor emotional regulation, and behavioral problems [1–5]. Therefore, understanding the origins of childhood sleep problems has theoretical and clinical importance.

Sleep problems are very prevalent during the first years of life, ranging between 20% and 30% of children [6]. The most common complaints parents present to pediatric health-care professionals are related to sleep onset difficulties and frequent and prolonged night-wakings requiring parental attention [6–8]. Studies in pre-school and school age children suggest a decline in the prevalence of parental reported night-waking problems in comparison to infancy [9,10]. However, actigraphy based studies demonstrate that night-wakings continue to be very frequent [11,12]. Although non-signaled night-wakings may not be considered problematic by parents because they are not aware of them, the clinical importance of fragmented sleep (including non-signaled awakening), has been demonstrated in studies showing it to be associated with poor neurobehavioral functioning and behavior problems in school-age children [5]. In addition, other sleep problems, such as bedtime resistance and nighttime-fears, seem to become common during the pre-school years [13–15]. Overall, the prevalence of sleep problems in pre-school children is estimated to range between 14% and 37%, [13,16–19] although it is important to note that there are no widely accepted criteria for diagnosing sleep problems in this age group. Thus, these estimations are based on different diagnostic criteria and measurement tools [12].

Research on the etiology of sleep problems has focused mainly on infancy. The transactional model postulates that there are ongoing bi-directional links between intrinsic infant factors (e.g., maturation, temperament), parenting factors (e.g., parental cognitions, soothing behaviors), and infant sleep [8]. Furthermore, the model suggests that parental sleep-related cognitions may influence parent–infant interactions around bedtime, which, in turn, affect infant sleep patterns. On the other hand, infants with a tendency towards more frequent night-wakings may influence their parents beliefs about infant sleep and then their nighttime soothing

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behaviors [20,21]. The findings of two recent longitudinal studies support the premise regarding parents' influence on their infants' sleep [22,23]. Both studies showed that maternal cognitions reflecting difficulties in limiting parental nighttime involvement predicted higher active physical nighttime soothing (e.g., rocking, cuddling), and these soothing methods in turn predicted more infant night-wakings. Moreover, in one study [23], mothers were asked during pregnancy about their sleep related cognitions (using hypothetical case descriptions of infants with sleep problems). It was found that when expectant mothers tended to interpret infant night-wakings as a sign of infant distress and anxiety, they were more likely to get actively involved in settling their six month-old infants to sleep, and their infants had more night-wakings (measured by actigraphy and parental reports) than infants of mothers emphasizing the importance of limiting parental nighttime involvement. Because parents play such an important role in establishing infant sleep patterns, most clinical interventions for infant sleep problems focus on working with parents in modifying their sleep-related cognitions and behaviors [20,24]. Clinical research has repeatedly demonstrated the effectiveness of these interventions in reducing infant sleep problems [6,20,25,26].

Although there is a growing interest in the pivotal role of parental factors in the evolution and maintenance of sleep problems in the early years, little is known about parental influences on sleep patterns and sleep problems into later childhood or about the etiology of childhood sleep problems. Overall, the links between parental perception, behaviors, and discipline style and child behavior problems are well documented [27–31]. For example, over-reactive and permissive parenting has repeatedly been demonstrated to be associated with children's externalizing problems [32–34]. However, only a few studies specifically examined the links between children's sleep disorders and parental factors. These studies found that reported sleep problems were significantly associated with maternal depression and family disorganization [19,35], parental comforting and soothing behaviors [36], and parental cognitions and discipline style [18,37,38]. Parental difficulty in limit setting (e.g., inconsistency in setting limits, lax parenting, and permissiveness) seems to be an especially important contributor to pre-schoolers' sleep problems. Parents, who find it difficult to set clear and consistent limits regarding bedtime struggles, for example, may actually reinforce their child's resistance to going to sleep [20,39].

Considering the high prevalence of sleep problems in pre-school children and the clinical importance of identifying factors that could contribute to the development of these problems, the main goal of the present study was to investigate early predictors of sleep patterns in pre-school age children, by using objective measures of sleep in a sample of pre-school children that were followed-up from infancy. In the parent study, it was found that parental soothing behaviors mediated the links between maternal sleep-related cognitions and infant sleep [23]. In the present study, we also aimed at exploring whether early maternal sleep-related cognitions would be related to parental behaviors at bedtime (with their four-year old children) and whether these behaviors would be associated with children's sleep patterns.

Specifically, we hypothesized that (a) More fragmented sleep and parenting factors (e.g., parental sleep related behaviors and cognitions) reflecting difficulties with limiting parental nighttime involvement assessed at 12 months would predict more disturbed sleep in four year-old children and higher bedtime involvement of parents (lower independent falling asleep) at four years; (b) Higher bedtime involvement of parents at four years would be associated with more disturbed sleep at four years; and (c) The links between early parental factors and disturbed sleep at four years would be mediated by parental bedtime involvement at four years.

2. Methods

2.1. Participants

This was a follow-up study conducted three years after the termination of a longitudinal study on maternal cognitions and infant sleep during the first year of life [23]. The parent study included 85 families recruited during the third trimester of pregnancy, mostly through prenatal courses or announcements on Internet forums for expectant parents. The sample was comprised of middle to upper socioeconomic class Israeli families. Mean age of mothers was 29.4 ± 3.1 (range 21–37). Mean mother's education (years) was 16.1 ± 2.1 (range 12–22). (A detailed description of the recruitment procedure and demographic characteristics appear in the original paper).

The present study included 71 families out of the 85 families that participated in the original study. Thirteen families discontinued because of lack of willingness to participate or loss of contact with the families (i.e., inability to locate them). One family that agreed to participate was not included in the analysis because the parents reported that the child had been diagnosed with a PDD. There were no significant demographic or SES differences between the families participating in the follow-up study and those who were lost to follow-up.

Family characteristics: the original study included only couples expecting their first child. At the time of the present follow-up study most families had more than one child; the sample included 13 (18.3%) families with one child, 51 (71.8%) families with two children and three families (4.2%) with three children (four families did not specify the number of children). Ninety-seven percent of the fathers and 60.6% of the mothers worked full time. Mean numbers of rooms at home was 4.1 (SD = 0.98).

Children: Mean age of the children at follow-up was 4.15 years (SD = .18, range 3.75–4.58). The sample included 41 (57.7%) boys and 30 girls. All children went to pre-school. Mean duration of daytime stay at pre-school was 8.03 h (SD = 1.1).

2.2. Procedure

The study was approved by the Institutional Ethical Committee of the university. A few months before the child turned four years old we sent letters to the families who participated in the original study inviting them to participate in a follow-up study of their children's sleep. A few weeks before the child's fourth birthday the families were contacted by phone and were asked whether they would be willing to participate in the study. A research assistant scheduled a meeting with the families who agreed to participate. During the meeting, parents signed an informed consent and then received instructions regarding the assessment of their child's sleep. Sleep was assessed by actigraphy and daily parental reports for four weekdays and by the Brief Sleep Questionnaire. All children were assessed while in good health. None of the children had sleep disordered breathing (based on parental reports). If the child developed an illness (e.g., cold, flu) during the assessment week, he/she was reassessed after recovery. After completion of the study requirements families received a graphic report on their child's actigraphic sleep patterns, a gift card (15 $ value), and a written summary of the main findings of the original infant longitudinal study.

2.3. Instruments and measures

2.3.1. Background and developmental questionnaires

These questionnaires were used to receive updated information about parental current job status, number of children, number of

rooms at home (as a measure of SES), and to collect information about the children's development (i.e., weight and length), health problems (e.g., allergies, breathing problems), and information about daycare setting.

2.3.2. Sleep assessment

2.3.2.1. Actigraphy. Actigraphy has been established as a valid and reliable method for studying and assessing sleep–wake patterns in infants, children, and adults in their natural sleep environment for extended monitoring periods [40–44]. Actigraphy records continuous body motility data that are later translated into sleep–wake measures. It is based on a wristwatch-like device attached to the infant's ankle or to the child's wrist. In both the original longitudinal study and the present study we used the miniature actigraph (Ambulatory Monitoring Inc., Ardsley, NY), with amplifier setting 18 and a one-minute epoch interval according to the standard working mode for sleep–wake scoring.

The actigraphic sleep analysis (ASA) program was used to score the data based on a validated sleep–wake scoring algorithm for infants [45] and young children [11]. Derived measures included: (1) Sleep onset time – the first minute of the first consecutive 15 min of sleep after bedtime; (2) total sleep period – from sleep onset time to morning awakening time; (3) morning awakening time; (4) true sleep time – sleep time excluding wakefulness during the night; (5) sleep percent – percent of true sleep time from total sleep period; and (6) number of night-wakings – the definition of night-wakings was based on identification of activity periods of at least five minutes, scored as awake by the validated scoring algorithm. Although this specific night-waking measure has not been validated against polysomnography, its empirical validity has been demonstrated in different studies showing that it differentiates between clinical and non-clinical samples and is associated with various developmental and behavioral measures in children. See Sadeh [46] for a review.

2.3.2.2. Sleep diary. In both the original infant study and the present follow-up study, parents were asked to complete a daily report on their child's sleep patterns [23,40,41]. The derived measures included: (1) lights-off time; (2) morning rise time; (3) sleep duration (from lights-off to waking-up time); (4) number of signaled night-wakings; and (5) bedtime soothing (infancy only) – a five level scale assessing the way parents help their child to fall asleep, ranging from child falling asleep independently in his/her bed (low parental involvement) to child falling asleep outside his/her bed with active help from parent (high parental involvement).

2.3.2.3. Brief child sleep questionnaire (BCSQ). This questionnaire assesses the child's typical sleep patterns based on parental reports [47]. The questionnaire's items were derived from the brief infant sleep questionnaire (BISQ) [48] and from the sleep habits questionnaire (SHQ) [49]. The derived measures used in the present study are: (1) Sleep onset time; (2) Nocturnal sleep duration; (3) Daytime sleep duration; (4) Number of signaled night-wakings; and (5) Bedtime practice – a 3-level scale asking the parent, "How and where does your child fall asleep?" with the possible answers (a) in his/her bed independently; (b) in his/her bed with parental help; and (c) in parents bed.

2.3.3. Parental measures used only at 12 months

2.3.3.1. Infant Sleep Vignettes Interpretation Scale (ISVIS). The ISVIS was used in the original infant study to assess *maternal cognitions* about infant sleep. This questionnaire was developed, validated, and described in detail in previous studies [23,50]. It includes 14 hypothetical case descriptions of infants who display behavioral sleep problems (find it difficult to fall asleep and resume sleep). After each description the parents are asked to rate (on a 6-point Likert-type scale, from highly disagree to highly agree) their agreement with the following assertions: (1) Distress – assertions that represent parental belief that infants experience distress or anxiety upon awakening and parents should therefore directly help or soothe them at night; and (2) Limits – assertions that emphasize the importance of limiting parental involvement at night and focus on encouraging infants to learn self-soothing with or without minimal parental assistance. The third scale of the questionnaire (temperament) was not assessed in the original study.

2.3.3.2. Maternal cognitions about infant sleep questionnaire (MCISQ) – limit scale [22]. The MCISQ assesses cognitions that mothers have about their infant's sleep. The parents are asked to rate their agreement (on a one to six Likert-type scale) with different assertions reflecting difficulties or concerns with five domains. The Hebrew version was validated in a previous study [50]. The internal reliability obtained in that study ranged between .65 and .72. In the present study we used only the limit setting scale, which assesses difficulties parents report regarding setting limits or resisting the infant's calls and demands at night.

2.3.3.3. Nighttime feeding. To assess the degree of infant nighttime feeding, parents were asked to rate (on a five-point Likert type scale from "not at all" to "very frequently") their use of breastfeeding or bottle feeding as a nighttime soothing method. These two items were averaged to yield a nighttime feeding score.

3. Results

3.1. Descriptive statistics and preliminary analysis

Descriptive statistics for the sleep variables at four years according to actigraphy, sleep diaries, and the BCSQ are described in Table 1.

Because of technical problems with the actigraphs of three children, actigraphy data were analyzed for 68 out of the 71 children that participated in the study.

No significant gender differences were found for any of the sleep variables at four years. Therefore, the results are presented for the total sample.

To assess the congruence between the two reported measures and the actigraphic measures, Pearson correlations were calculated between corresponding measures. The correlations between the three measures revealed very high agreement for sleep duration ($r = .90$, $p < .0005$ for actigraphy and sleep diary; $r = .63$, $p < .0005$ for actigraphy and the BCSQ; $r = .66$, $p < .0005$ for the sleep diary and the BCSQ). The correlations for the number of night-wakings were in the moderate range ($r = .32$ for actigraphy and sleep diary; $r = .31$, $p < .05$ for actigraphy and the BCSQ; $r = .44$, $p < .0005$ for the sleep diary and the BCSQ). However, paired-sample t-test showed that there was a significant difference in sleep duration between the two subjective measures and the actigraphic measure ($t[67] = 9.9$, $p < .0005$ for actigraphy and sleep diary; $t[67] = 6.2$, $p < .0005$ for actigraphy and the BCSQ) and there was a significant difference in the number of identified night-wakings between the two subjective measures and the actigraphic measure as well ($t[67] = 10.7$ $p < .0005$ for actigraphy and sleep diary; $t[67] = 11.6$, $p < .0005$ for actigraphy and the BCSQ). Parents significantly underestimated the number of their children's night-wakings (see Table 1).

3.1.1. Sleep ecology

According to the BCSQ, 35.7% of the children slept in their own room without siblings and 64.3% shared a room with a sibling. There were no parent–child co-sleeping arrangements. Regarding

Table 1
Means, standard deviations, and range of the pre-school sleep measures ($N = 71$).

Sleep measures	Actigraphy		Daily logs		Sleep questionnaire (BCSQ)	
	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range
Sleep onset (time)	21.21 ± .76	19.63–23.12	21.08 ± .73	19.55–22.85	20.63 ± .66	19.3–22.5
Sleep dur (h ± min)	9.44 ± 50.4	7.42–11.10	9.86 ± 43.2	8.35–11.83	9.96 ± 46.2	6.50–11.50
N. of night-wakings	2.71 ± 1.54	0.00–6.63	0.77 ± .60	0.00–3.00	0.62 ± .67	0.00–2.50
True sleep T (h ± min)	8.50 ± 59.4	5.66–10.23	N/A		N/A	
Sleep efficiency (%)	90.10 ± 5.6	65.54–98.93	N/A		N/A	
Napping (min)	N/A		N/A		30.66 ± 44.39	0.00–150.00

Sleep duration – sleep duration from sleep onset time to morning awakening, including wakefulness during the night; *N*. of night-wakings = number of night-wakings; True sleep *T* = True sleep time – nocturnal sleep duration excluding wakefulness during the night; sleep efficiency – percent of true sleep time from sleep duration.

bedtime process: 59.4% of the parents reported their child fell asleep independently in his/her own bed. 21.7% of the children fell asleep in their own bed with parental help, 7.2% alternated between falling asleep independently and receiving parental help, and 11.6% fell asleep in their parents' bed.

3.1.2. Reported bedtime and nighttime sleep problems

Approximately 68.5% of the parents reported that falling asleep was not a problem for their child, 21% reported falling asleep as a small problem, 7% as a moderate problem, and 3% defined it as a difficult problem. Regarding sleep during the night, 83% defined their child's sleep as non problematic, 11.5% defined it as a small problem, 4% reported it was a moderate problem, and 1.5% defined it as a very difficult problem. The Spearman correlation between reported falling asleep problem and nighttime sleep problem was .55 ($p < .0005$).

3.2. Early predictors of sleep patterns in pre-school children

Our main hypothesis was that more disturbed sleep and parenting factors reflecting difficulties with limiting parental nighttime involvement assessed at 12 months would predict more disturbed sleep and more parental bedtime involvement in four year-old children. To test these links, zero-order correlations were calculated between the 12 months sleep quality, parental cognitions, and soothing measures (number of night waking, sleep percent, ISVIS scales, the MCISQ limits scale, the bedtime soothing scale, and the nighttime feeding scale) and between the pre-school sleep patterns measures (actigraphic sleep quality and duration measures, number of reported night-waking according to sleep diaries, the BCSQ, reported sleep problems, and bedtime practice/parental bedtime involvement). The correlations between these measures are presented in Table 2. The findings demonstrated significant predictive correlations between these measures. In particular: (a) higher scores on the MCISQ limits scale (reflecting more perceived difficulties with nighttime limit-setting) at 12 months predicted poorer sleep at four years as reflected by a higher number of actigraphic night-wakings, lower sleep efficiency, and shorter true sleep time. In addition, a higher score on this scale predicted more reported bedtime and nighttime problems and a higher involvement of parents at bedtime (lower child independent falling asleep); (b) higher scores on the ISVIS limits scale (reflecting a parental belief in the importance of encouraging infant self-soothing at night) predicted fewer actigraphic night-wakings, lower reported sleep problems, and lower parental involvement at bedtime; (c) a higher involvement of parents in bedtime soothing at 12 months predicted more reported bedtime and sleep problems, and more parental bedtime involvement at four years; and (d) increased nighttime feeding to soothe the infant at 12 months predicted poorer sleep at four years as reflected by a higher number of actigraphic night-wakings, lower sleep efficiency, and shorter true sleep time. In addition, infant nighttime feeding was associated with more parental bedtime involvement at four years.

3.3. Multiple regression analysis

To examine the relative contribution of infant sleep and early parental factors to sleep outcomes at the age of four, we conducted a series of multiple regression analyses. The four-year outcome measures predicted by the regression analyses were only those that were significantly correlated with at least one 12 month sleep variable and with the 12 months maternal cognitions scales (i.e., four-year actigraphic sleep efficiency, the number of four-year actigraphic night-wakings, and four-year parental bedtime involvement). Predictors in each of the regression analyses were only those variables correlating significantly with the three putative outcome measures: number of actigraphic night-wakings at 12 months, the 12-months combined-limits score (see below), and the 12-months nighttime feeding score (see Table 2).

Importantly, because the correlation between the two main cognition variables (ISVIS limit scale and the MCISQ limit scale) was very high ($r = -.70$, $p < .001$), suggesting that the two variables capture the same psychological construct, we were concerned that including both within the same regression equation might lead to prohibitive multicolinearity. To address this, we (1) transformed the MCISQ limit variable so that elevated levels reflect lower difficulties with nighttime limit-setting, (2) standardized this variable, as well as the ISVIS limits variable, and (3) averaged the standard scores of both variables in order to create a composite cognition score. This composite score, labeled Combined-limits score, served as a predictor in all subsequent analyses.

The regression models accounted for 20% of the variance in the number of four-year (actigraphic) night-wakings ($F_{[3,62]} = 5.29$, $p < .005$), 21% of the variance in four-year (actigraphic) sleep efficiency ($F_{[3,62]} = 5.46$, $p < .005$), and 30% of the variance ($F_{[3,61]} = 8.59$, $p < .001$) in the level of parental involvement at bedtime. The only statistically significant predictor of the number of four-year actigraphic night-wakings was the combined-limits score. Higher levels of maternal cognitions reflecting difficulties with limiting parental nighttime involvement at 12 months predicted more night-wakings at four years. The only statistically significant predictor of four-year sleep efficiency was the number of (actigraphic) night-wakings. A higher number of 12 months night–wakings predicted lower sleep efficiency at 4 years. The level of parental bedtime involvement at 4 years was significantly predicted by the combined-limits score and the number of (actigraphic) night-wakings. Both higher levels of maternal cognitions reflecting difficulties with limiting parental nighttime involvement at 12 months and a higher number of 12 months night-wakings predicted more parental bedtime involvement at four years (lower independent falling asleep) (see Table 3 for beta and percent of variance explained by the different predictors).

Table 2
Pearson correlations between 12 months sleep, 12 months parental measures and sleep at 4 years.

12 Months measures	Pre-school sleep measure							
	N. night-waking (actigraph)	Sleep efficiency (actigraph)	True sleep (actigraph)	*N.* night waking (diary)	*N.* night waking-(BCSQ)	Bedtime problems (BCSQ)	Sleep problems (BCSQ)	Bedtime practice (BCSQ)
N. night-waking (actigraph)	.32**	−.39***	−.32**	.23	.33***	.09	.09	.32**
Sleep efficiency (actigraph)	−.20	.19	.13	−.20	−.33***	−.07	−.11	−.19
ISVIS-distress scale	.22	−.15	−.18	.04	.16	.20	.29*	.19
ISVIS-limit scale	−.28*	.22	.11	−.07	−.14	−.14	−.30*	−.28*
MCISQ-limits scale	.36***	−.27*	−.30*	.20	.16	.31**	.41***	.47***
[a]Combined limits score	−.35***	.27*	.23	−.15	−.19	−.25*	−.39***	−.42***
Bedtime soothing scale	.02	.08	−.02	.18	.15	.25*	.26*	.30*
Night feeding score	.29*	−.32**	−.36*	.10	.−04	.05	.11	.27*

N. night-waking (actigraph) = number of night waking based on actigraphy; Sleep efficiency (actigraph) = Sleep efficiency based on actigraphy; True sleep (actigraph) = True sleep time-actigraphy; *N.* night waking (diary) = number of night-wakings based on sleep diaries; *N.* night waking-(BCSQ) = number of night-wakings based on the BCSQ; Bedtime problems (BCSQ) = reported bedtime problems-BCSQ; Sleep problems (BCSQ) = reported sleep problems-BCSQ; Bedtime practice (BCSQ) = parental bedtime involvement-BCSQ; ISVIS-distress scale = Infant sleep vignettes interpretation scale-distress scale; ISVIS-limit scale = Infant sleep vignettes interpretation scale –limit Scale; MCISQ-limits scale = Maternal cognitions about infant sleep questionnaire –limits scale.

[a] Combined limits score – This variable was created for the purpose of regression analyses (based on the ISVIS-limit scale and the MCISQ-limits scale).

* $p < .05$.

** $p < .01$.

*** $p < .005$.

3.4. Bedtime practices/parental bedtime involvement at four years and children's sleep patterns at four years

To examine our second hypothesis, that higher bedtime involvement of parents at four years would be associated with more disturbed sleep at four years, zero-order correlations were calculated between the parental bedtime involvement scale and sleep measures at four years. Increased level of parental involvement at bedtime at four years (lower likelihood that the child will fall asleep independently) was found to be significantly associated with a higher number of four year actigraphic night-wakings ($r = .37$, $p < .005$) with lower actigaphic true sleep time ($r = -.27$, $p < .05$), with a higher number of reported night-wakings according to the sleep diaries ($r = .29$, $p < .05$) and the BCSQ ($r = .28$, $p < .05$), with a higher level of reported bedtime problems ($r = .33$, $p < .01$) and nighttime problems ($r = .34$, $p < .005$).

3.5. Parental bedtime involvement as a possible mediator of the link between early maternal cognitions and children's night-wakings

To explore the third hypothesis regarding the role of parental bedtime involvement as a possible mediator of the link between maternal sleep-related cognitions at 12 months and children's sleep at four years, we conducted a series of regression analyses. The only outcome measure we tested was the number of actigraphic night-wakings, as only this measure was significantly correlated with both the predictor (combined-limits score) and the potential mediator (parental bedtime involvement).

We first regressed the mediator onto the predictor. The regression model was statistically significant and accounted for 17.2% of the variance in the level of parental bedtime involvement ($F_{[1,64]} = 13.31$, $p < .001$). We then regressed the outcome measure (four-year number of night-wakings) onto the mediator and the predictor. The regression model was statistically significant and accounted for 18.5% of the variance in the number of actigraphic night-wakings ($F_{[2,62]} = 7.01$, $p < .005$). Only the level of parental bedtime involvement was significantly associated with the outcome ($\beta = .27$, $t = 2.11$, $p < .05$), thus supporting the hypothesis regarding the mediating role of parental bedtime involvement. The mediator explained 5.8% of the variance in night-wakings at four years in the expected direction: higher levels of parental bedtime involvement were associated with more night-wakings at four years. Whereas the zero-order correlation between the predictor and the outcome measure was significant ($r = -.35$, $p < .005$), the partial correlation while controlling for the level of parental bedtime involvement was not significant ($r = -.24$, $p = .06$).

4. Discussion

This study assessed objective and reported sleep patterns in four year-old children and investigated early predictors of sleep patterns in this age group. The results demonstrated significant prospective links between parenting factors and sleep quality measures assessed at 12 months and sleep patterns in four year old children. Important strengths of this study include the use of a longitudinal design enabling the investigation of the predictive links between the domains and the use of both objective and reported methods of sleep evaluation.

4.1. Sleep patterns in preschool children

Our findings regarding the characteristics of sleep in pre-school children are consistent with previous studies in the field [11,12,51,52]. In accordance with a previous study on kindergarten children [12], we found that parents were accurate reporters of sleep schedule measures (e.g., sleep duration) but were poor reporters of sleep quality measures (e.g., underestimating the number of night-wakings). The difference between the average number of actigraphic night-wakings (2.71) and reported night-wakings (0.77) suggests that parents are unaware of many of their children's night-wakings, probably because most children at this age do not signal to their parents when waking up during the night [12,52]. Thus, it is not surprising that even though as many as 50% of the children had on average more than three actigraphic awak-

Table 3
Multiple regression analysis.

Predictors (12 months)	4 Year number of night-wakings (actigraph)		4 Year sleep efficiency (actigraph)		4 Year parental bedtime involvement (BCSQ)	
	β	Explained variance	β	Explained variance	β	Explained variance
Number of night-wakings (actigraph)	.18	2.7%	−.29*	6.5%	.34**	9.1%
Combined-limits score	−.28*	7%	.17	2.5%	−.33**	10%
Nighttime feeding	.14	2%	−.16	2%	.06	0%

* $p < .05$.
** $p < .01$.

enings per night, only 17% of the parents defined their child's sleep at night to be a problem. Moreover, although 53% of the parents reported (according to the sleep diaries) that their child had at least one awakening per night, most parents seemed to tolerate these night-wakings and did not consider them to be a major problem. Nonetheless, bedtime seemed to represent a more noteworthy problem, with parents reporting that as many as 40% of the children required parental help to fall asleep, while 27% of the parents reported bedtime to be a problem. In sum, the findings demonstrate that night-wakings continue to be very prevalent in pre-school children, though most parents are not aware of their child's fragmented sleep. Bedtime problems are a source of more worry probably because of the intensive involvement they require from the parent and the expectation of the child to be able to fall asleep independently at this age. The fact that the present sample was recruited during pregnancy precludes the possibility that the high rates of night-wakings were related to pre-existing sleep problems affecting the willingness of parents to participate in the study. Therefore, the findings regarding children's night-wakings support and validate previous similar studies that could not control for this possible recruitment bias.

4.2. Early predictors of pre-school sleep patterns

One of the main aims of the present study was to investigate the links between sleep, parental cognitions, and soothing behaviors during infancy and sleep patterns of pre-school children. The longitudinal design of this study enabled us to investigate the associations between sleep patterns at 12 months and four years and to explore the contribution of early maternal sleep-related cognitions and parental nighttime soothing behaviors to the bedtime routines and sleep patterns of pre-school children.

4.2.1. Sleep at 12 months and sleep at four years

The simple correlation analysis showed significant prospective associations between the number of infant night-wakings at 12 months and preschoolers' actigraphic sleep measures (i.e., number of night-wakings, sleep percent, and true sleep time). These correlations were in the moderate range (.32–.39), thus suggesting some stability in sleep quality over the first years. Regression analysis partially supported the simple correlations by showing that the number of infant night-wakings was a significant predictor of sleep efficiency at the age of four years.

4.2.2. Maternal cognitions at 12 months and sleep at four years

The different analyses supported the hypothesis regarding the links between maternal cognitions and children's sleep. We found that early maternal cognitions, reflecting difficulties in limiting parental nighttime involvement and encouraging infant self-soothing, were significantly associated with more fragmented sleep, assessed objectively, and higher parental ratings of bedtime and nighttime problems at the age of four years. These findings are in line with previous studies demonstrating significant prospective and concomitant links between parenting factors (e.g., lax, conflicting parenting, problematic cognitions, and soothing behaviors) and pre-school sleep problems [18,36,37], though previous studies relied exclusively on parental reports whereas the present study adds to these findings by demonstrating these links with objective measures of sleep. Interestingly, the regression analyses revealed that early maternal cognitions were actually the only significant predictor of the number of preschoolers' night-wakings, measured objectively. In sum, according to the regression analysis, early maternal sleep-related cognitions and 12 month night-wakings seem to account for significant variance of the quality of sleep in pre-school children.

4.3. Parental bedtime involvement as a possible mediator of the links between maternal cognitions and child sleep

A possible explanation for the findings is that parental nighttime involvement patterns mediate the links between maternal early cognitions and later child sleep patterns [8,23]. Our findings demonstrated that parental bedtime involvement at four years was significantly predicted by sleep patterns during infancy as well as by early maternal cognitions reflecting difficulties in limiting parental nighttime involvement. In addition, higher parental bedtime involvement at four years was associated with poorer sleep and with more parental reported bedtime and nighttime sleep problems at four years. These findings are in line with previous studies focusing on infants demonstrating that infant night waking problems are related to higher involvement of parents at bedtime and at night [6,20]. In addition, the regression analysis supported the hypothesis that parental bedtime involvement mediates the link between early maternal sleep-related cognitions and fragmented sleep at four years. Thus, one possible explanation is that early parental sleep related cognitions regarding difficulties with limiting parental nighttime involvement remain relatively stable and might contribute to parental sleep related behaviors around bedtime, while these behaviors are related to variations in the child's sleep patterns during the pre-school years. Put differently, mothers who believe they should actively soothe their infant to sleep, later on remain active in helping their pre-school child to fall asleep at bedtime, and this pattern of involvement is associated with more disturbed sleep of the child. Although it is possible that children with more sleep problems ask for more parental help and involvement, the predictive links found in this study and in previous studies [8,23] support the hypothesis that parental factors such as sleep-related cognitions and soothing behaviors may contribute to the development of the child's sleep patterns. However, it is important to emphasize that the nature of our study does not allow for inferring about causal links between the variables. Therefore, the suggested explanation regarding the causal pathways between parental cognitions, soothing behaviors, and children's sleep should be further explored in controlled studies.

Another limitation that should be taken into account is that one of our main measures, the number of actigraphic night-wakings, has not been validated against polysomnography. Therefore, the findings using this measure should be interpreted with caution. Nevertheless, the meaningfulness of this measure has been demonstrated in different studies in the pediatric sleep field [46]. Lastly, the

parents in this study represented a highly educated middle-upper socio-economic status and the children were all first-born. These characteristics may limit the generalization of the findings. Nonetheless, the findings of this study are innovative as they highlight for the first time that parental cognitions present during infancy account for significant variance of preschoolers' sleep patterns.

4.4. Clinical implications and future directions

The findings of the present study demonstrated that maternal cognitions reflecting difficulties with limiting parental nighttime involvement during infancy predict more disturbed sleep in preschool children. In addition, the findings highlight the possibility that these links are at least partially mediated by the level of parental bedtime involvement.

Since sleep disturbances (bedtime problems, night-wakings) continue to be very common in pre-school children, the findings underscore the importance of preventive interventions in the pediatric sleep domain. Early parent education programs and infant sleep interventions have been found to be highly efficient in preventing infant sleep problems and treating infant sleep problems [20,26,53]. The findings of this study suggest that these early interventions may be helpful in preventing the development of later sleep problems, and underscore the importance of addressing parental cognitions in clinical sleep interventions [20,23].

This study focused on a normative non-clinical sample of parents and children. Although a prior study suggested that parenting may play a larger role in the development of sleep patterns in children with non-clinically significant sleep disorders [38], it seems important to investigate the contribution of parental factors to sleep problems in clinical samples as well. Moreover, more studies based on objective assessment of sleep are needed to examine the relative role of early sleep patterns versus environmental factors in the development of future sleep problems. This study was conducted in a sample representing a western culture. Because parental sleep-related cognitions and practices might vary vastly as a function of cultural norms and socio-economical backgrounds, [54,55] these studies should be conducted in samples representing different cultures.

Conflicts of interest

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: doi:10.1016/j.sleep.2011.07.013.

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