

OBSTETRICS

The effect of maternal sleep-disordered breathing on the infant's neurodevelopment

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OBJECTIVE: We sought to examine the effect of maternal sleep-disordered breathing (SDB) on infant general movements (GMs) and neurodevelopment.

STUDY DESIGN: Pregnant women with uncomplicated full-term pregnancies and their offspring were prospectively recruited from a community and hospital low-risk obstetric surveillance. All participants completed a sleep questionnaire on second trimester and underwent ambulatory sleep evaluation (WatchPAT; Itamar Medical, Caesarea, Israel). They were categorized as SDB (apnea hypopnea index >5) and controls. Infant GMs were assessed in the first 48 hours and at 8-11 and 14-16 weeks of age. At 12 months of age the Infant Developmental Inventory and the Brief Infant Sleep Questionnaire were administered.

RESULTS: In all, 74 women and their full-term infants were studied. Eighteen (24%) women had SDB. Mean birthweight was 3347.1 ±

423.9 g. Median Apgar score at 5 minutes was 10 (range, 8–10). In adjusted comparisons, no differences were found between infants born to mothers with SDB and controls in GM scores in all 3 evaluations. Low social developmental score was detected at 12 months in 64% of infants born to SDB mothers compared to 25% of infants born to controls (adjusted $P = .036$; odds ratio, 16.7). Infant snoring was reported by 41.7% of mothers with SDB compared to 7.5% of controls ($P = .004$).

CONCLUSION: Our preliminary results suggest that maternal SDB during pregnancy has no adverse effect on neonatal and infant neuromotor development but may affect social development at 1 year.

Key words: fetal outcome, neurodevelopment, pregnancy, sleep-disordered breathing

Cite this article as: Tauman R, Zuk L, Uliel-Sibony S, et al. The effect of maternal sleep-disordered breathing on the infant's neurodevelopment. *Am J Obstet Gynecol* 2015;212:656.e1-7.

Pregnancy is associated with significant changes in sleep with a large proportion of pregnant women experiencing some form of sleep disruption. Physiologic and hormonal changes that occur during pregnancy, particularly during the third trimester, place women at risk for developing sleep-disordered breathing (SDB).^{1,2} Indeed, SDB is common during pregnancy and self-reported snoring has been observed in up to 46% of pregnant women.³⁻⁶ The term “sleep-disordered breathing” refers

to a spectrum of abnormal respiration during sleep that ranges from primary (habitual) snoring to obstructive sleep apnea syndrome. It is characterized by episodic complete or partial obstruction of the airway during sleep, disruption of normal ventilation, intermittent hypoxemia, and sleep fragmentation.

It has been suggested that SDB during pregnancy may adversely influence the maternal and fetal well-being. Specifically, associations between SDB during pregnancy and gestational

diabetes, hypertension and pre-eclampsia,⁷⁻¹⁵ fetal growth restriction, prematurity, cesarean delivery, and low Apgar scores have been reported.¹⁵⁻²² However, these observations have thus far been inconclusive, one of the reasons being that most of the published literature is based on subjective assessment of sleep and lacks objective sleep measures.

Despite this inconsistency, in a recent study we found that maternal snoring was associated with enhanced fetal erythropoiesis and elevated cord interleukin 6.²³ We therefore hypothesized that maternal SDB with the resultant subtle intermittent hypoxia could influence the developing fetal brain.

To our knowledge, there are no reports on the effect of maternal SDB on infant neurodevelopmental status despite the ostensibly large body of data regarding the association of pediatric SDB with attention deficit, hyperactivity, and emotional and behavioral disturbances.²⁴⁻³¹ For all these reasons, we designed a prospective study using an

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Received Sept. 26, 2014; revised Dec. 10, 2014; accepted Jan. 5, 2015.

This research was supported by grant number 707/12, Israel Science Foundation.

The authors report no conflict of interest.

Presented at the 26th annual meeting of the Associated Professional Sleep Societies, Baltimore, MD, June 1-5, 2013.

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0002-9378/\$36.00 • © 2015 Elsevier Inc. All rights reserved. • <http://dx.doi.org/10.1016/j.ajog.2015.01.001>

objective sleep study measure to investigate the effects of maternal SDB on their infants. We hypothesized that infants born to mothers with SDB will exhibit lower developmental scores.

Our aims were to determine the effect of maternal SDB on neonatal and infant spontaneous general movements (GMs) and developmental outcome at 1 year.

MATERIALS AND METHODS

Women in the third trimester of a singleton, uncomplicated pregnancy who attended low-risk obstetric surveillance from March 2009 through March

2012 were recruited. All participants completed a sleep questionnaire during the second trimester and underwent a sleep study during the third trimester of pregnancy. Infant GMs were assessed during the first 4 months of life. Development and sleep questionnaires were administered at 12 months. The study design and recruitment flowchart are presented in the [Figure](#).

The study was approved by the institutional review board. The study was registered at [ClinicalTrials.gov](#) (NCT00931099). Informed consent was obtained from all participants.

Maternal and infant data

All women completed a sleep questionnaire (gestational week 25-27) regarding the presence of habitual snoring before and during pregnancy. Habitual snoring was defined as snoring at least 3 nights per week.^{32,33} Pregnancy-onset snoring was considered present when habitual snoring began during pregnancy. All participants underwent an ambulatory overnight sleep study between 33-36 weeks of gestation using a validated ambulatory sleep technology (WatchPAT 200; Itamar Medical, Caesarea, Israel).³⁴⁻³⁷ Apnea hypopnea index, respiratory disturbance index, oxygen desaturation index, mean oxygen saturation (SpO₂) and SpO₂ nadirs were retrieved as previously described.³⁷ Women with an apnea hypopnea index >5 per hour of sleep were considered to have SDB.³⁸ We used the standard adult criteria for SDB, since there is no distinctive threshold for SDB in pregnancy. Medical records review was conducted by one of the researchers blinded to the sleep study results. Pertinent demographic (sex, gestational age, birthweight) and clinical (mode of delivery, Apgar scores at 1 and 5 minutes, and any perinatal complications) information were collected.

Outcome data

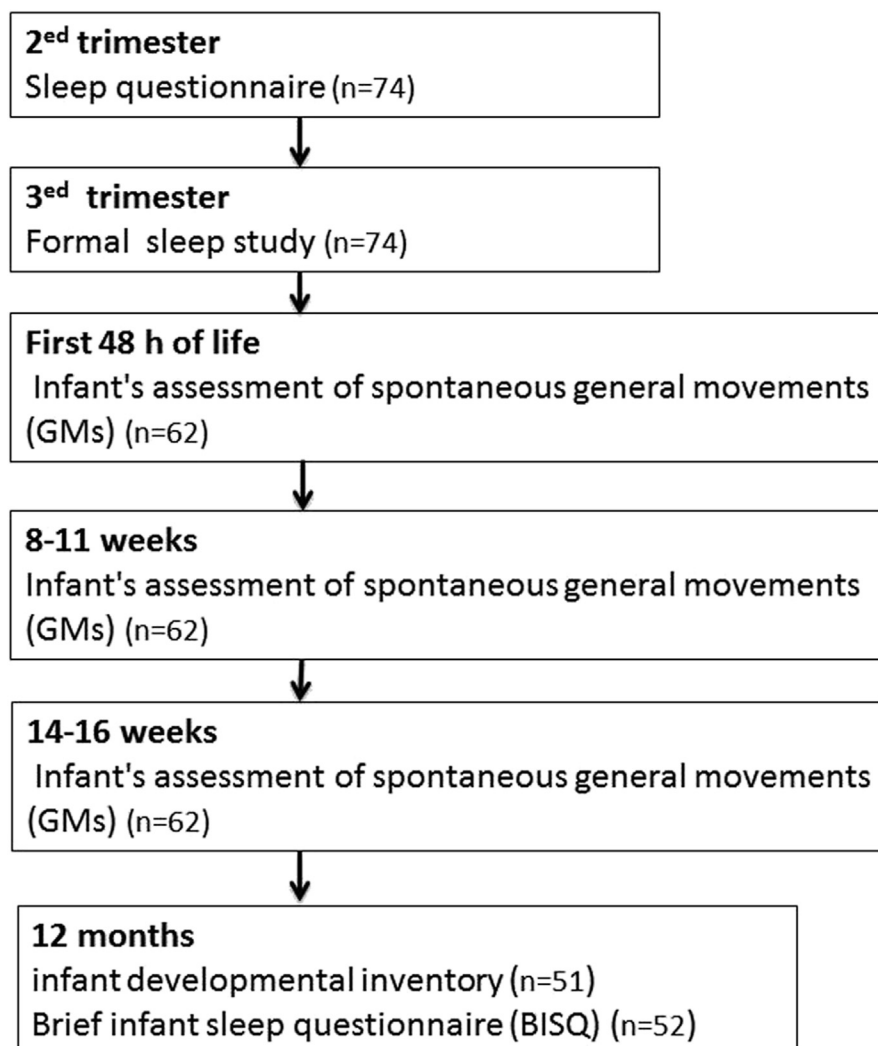
Spontaneous GMs assessment of infants

GMs were videotaped (15 minutes in length) for offline assessment in the first 48 hours of life, between 8-11 weeks of age, and between 14-16 weeks of age postterm. All infants were dressed in a diaper only, and were in the supine position. During off-time replay of the 3 periods videotaped, the GM quality was analyzed and assessed by an independent trained observer and the data scored. GMs were scored when infants were in active wakefulness. Periods of crying, fussing, and sucking were excluded from analysis.^{39,40} The observer was unaware of the infant's group assignment (maternal SDB yes/no) as well as of other test results and clinical data.

Sleep evaluation at the age of 1 year

Sleep was evaluated at 1 year of age using the Brief Infant Sleep Questionnaire

FIGURE
Recruitment flowchart



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