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Sleep in Normal Late Pregnancy

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Summary: Twelve women in their third trimester of pregnancy and 10 age-matched nonpregnant controls underwent complete polysomnography for one night in the laboratory. Seven of the original women returned for a second study 3–5 months postpartum. During late pregnancy, women showed increased wake after sleep onset (WASO) and a lower sleep efficiency in comparison with the control group. The percentage of rapid eye movement (REM) sleep was significantly decreased and the percentage of stage 1 significantly increased compared to the nonpregnant group. At 3–5 months postpartum, a significant reduction in WASO and increased sleep efficiency were noted. However, only a slight increase was noted in REM sleep during the postpartum period compared to the prepartum period. The most frequent sleep complaints in the pregnant group were restless sleep, low back pain, leg cramps and frightening dreams. In summary, in accordance with their complaints, women in their third trimester demonstrated polysomnographic patterns of sleep maintenance insomnia. **Key Words:** Sleep—Pregnancy—Maintenance insomnia—Low back pain—Leg cramps.

Although pregnant women frequently report sleep disturbances to their physicians, not until recently have sleep disturbances in pregnancy been proposed as a separate entity. The International Classification of Sleep Disorders describes increased sleep time and increased daytime sleepiness as part of sleep features during the first trimester of pregnancy, whereas late pregnancy is associated with frequent awakenings and an overall decrease in sleep efficiency (1). The most common reasons given by pregnant women for sleep alterations were urinary frequency, heartburn, discomfort, fetal movements and leg cramps (2). Fast et al. reported a significant increase in the frequency of low back pain complaints, especially those occurring at night, in women in their late months of pregnancy (3). The results of previous polygraphic sleep studies in pregnancy have been variable. In the last trimester of pregnancy, decrease in both stage 4 sleep (4,5) and rapid eye movement (REM) sleep (5) have been reported. There have been no studies that included complete polysomnography during normal human pregnancy. In this study, we present a detailed investigation of sleep patterns, respiration and leg muscle electromyography in 12 women in their third trimester of pregnancy and in 10 age-matched nonpregnant controls. In addition, seven of the original pregnant group were studied a second time 3–5 months postpartum.

SUBJECTS AND METHODS

Twelve women in their third trimester of pregnancy (30–38 weeks gestation), ranging in age from 22 to 40 years (mean 30.5 ± 5.1), participated in the study. They were recruited from the Obstetrics Department at Winthrop University Hospital. All had been examined and those with high-risk pregnancy and medical or psychiatric complications were excluded from the study. Although most of the pregnant subjects complained of disturbed sleep, none had a history of sleep problems prior to their pregnancy. For seven women this was their first pregnancy. The others had had two to four prior pregnancies. The control group consisted of 10 nonpregnant women, age 28–41 years (mean 31.6 ± 5.4), without medical or psychiatric problems. None of these women had a history of sleep disorders. At the time of the study, six women were in the follicular phase of their menstrual cycle and one woman in her

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luteal phase. Information for the rest of the subjects was not available.

Subjects were asked to come to the laboratory at 8:00 p.m. and to refrain from drinking caffeinated or alcoholic beverages during the afternoon and evening hours prior to study. Upon arrival, an explanation of the study was given and informed consent was obtained from all subjects. Subjects were then asked to complete a presleep questionnaire and rate their sleepiness level on the Stanford sleepiness scale (SSS). As part of our sleep patterns questionnaire, the frequency of sleep restlessness, nocturnal low back pain, leg cramps, snoring, bad dreams and morning headaches were recorded by having subjects respond "never", "sometimes" or "always" for each question.

Following the questionnaires, surface electrodes were applied for a complete montage, which included monopolar central and occipital electroencephalography, electrooculogram (right and left outer canthi) and electromyograms from the chin and from the anterior tibialis location on both legs. Airflow, breathing effort and oxygen saturation were also included. All subjects were videotaped during sleep, and position changes were monitored.

Seven of the original pregnant women returned for a second sleep study 3–5 months postpartum. Except for one woman, all were still lactating at the time of the study.

TABLE 1. *Self-reported sleep complaints recorded prior to sleep study*

Complaint (%)	Pregnant (n = 12)	Nonpregnant (n = 10)	Postpartum (n = 7)
Restless sleep			
Never	17[a]	40	43[b]
Sometimes	50	60	57
Always	33	0	0
Snoring			
Never	42	50	43
Sometimes	58	40	57
Always	0	10	0
Lower back pain			
Never	25[a]	80	43[b]
Sometimes	67	20	57
Always	8	0	0
Leg cramps			
Never	25[a]	100	72[b]
Sometimes	75	0	28
Always	0	0	0
Bad dreams			
Never	25	50	43
Sometimes	75	50	57
Always	0	0	0
Morning headaches			
Never	42	90	28
Sometimes	58	10	72
Always	0	0	0

[a] Pregnant compared to nonpregnant group (chi-square test, $p < 0.05$).

[b] Prepartum compared to postpartum period (chi-square test, $p < 0.05$).

Data Analysis

Sleep was scored according to standard criteria (6). Parameters included time in bed (TIB); total sleep time (TST); sleep latency to stage 1 (SL); wake after sleep onset (WASO), expressed as percentage of TIB; sleep efficiency (SE), defined as TST/TIB and REM latency from sleep onset (REML). In addition, sleep stages 1, 2, 3/4 and REM were expressed as a percentage of TST sleep. The total number of awakenings >15 seconds was also calculated. Frequency analyses were performed by chi-square tests. Because of high individual variability, group comparisons were made by the nonparametric Mann–Whitney test and the Wilcoxon signed rank test. All data are presented as mean ± SD.

RESULTS

Reported sleep complaints

Reported sleep complaints can be seen in Table 1. Of the 12 pregnant participants, 4 (33%) described their sleep as "always" restless and disturbed and 6 (50%) felt their sleep was occasionally disturbed. None of the nonpregnant women responded "always" to that question. Other sleep complaints reported significantly more frequently by the pregnant subjects were: low back pain (75%), nocturnal leg cramps (75%) and morning headaches (58%). There were no significant differences noted in reported snoring. After parturition, a significant decrease was noted in reported leg cramps (28%), low back pain (57%) and restless sleep (57%). Reported frequency of dreams decreased in the postpartum period compared to the initial study, but this difference did not achieve significance.

Degree of sleepiness

Reported sleepiness, as measured by the Stanford sleepiness scale (SSS), did not differ significantly among the groups with mean scores of 4.1 ± 1.4, 4.3 ± 2.0 and 4.9 ± 1.6 for the pregnant, nonpregnant and postpartum groups, respectively (Mann–Whitney, Wilcoxon sign test, respectively).

Sleep data

Sleep characteristics in pregnancy

Sleep data are summarized in Table 2. The pregnant group demonstrated normal sleep onset and did not

TABLE 2. *Sleep variables of pregnant women compared to nonpregnant controls*

Parameter	Pregnant[a] (n = 12)	Nonpregnant[a] (n = 10)	Mann–Whitney Z	p
Time in bed (minutes)	462 ± 52.3	413.5 ± 45.6	−2.21	0.03
Total sleep time (minutes)	369.5 ± 59	376 ± 45	0.231	n.s.
Sleep efficiency	77.6 ± 12.3	91 ± 7.8	−2.77	0.005
Sleep latency (minutes)	13.6 ± 12	12 ± 10	−0.198	n.s.
WASO (minutes)	80.2 ± 44	27.6 ± 18	−2.83	0.005
REM latency (minutes)	124.6 ± 51	116.8 ± 34	−0.297	n.s.
Stage 1 (%)	19 ± 12.7	8.1 ± 3.4	−2.65	0.008
Stage 2 (%)	55 ± 13.7	57.4 ± 10	−0.198	n.s.
Stages 3/4 (%)	11.6 ± 3.3	14.4 ± 8.4	−0.428	n.s.
REM (%)	14 ± 4.2	20 ± 5.4	−2.57	0.01

[a] Values are means ± SD.

differ in total sleep time from the nonpregnant group. Although time in bed was higher in the pregnant group, sleep efficiency was significantly lowered as compared to controls. Decreased efficiency of sleep was mostly due to a marked increase in WASO in the pregnant group. Other sleep changes in the pregnant group included a significant increase in sleep stage 1 and a significant decrease in REM sleep as compared to the control group. There was a slight, but not significant, decrease noted in slow-wave sleep.

Sleep in the postpartum compared to the prepartum period

The results for seven women who returned for a second study after delivery are summarized in Table 3. On the postpartum night, there was a significant decrease in WASO and a significant improvement in sleep efficiency compared to the initial prepartum study. There was also a tendency for REM sleep to be increased and stage 1 and SWS to be decreased on the postpartum night, but these differences did not achieve significance. The gradual changes in sleep efficiency and in sleep patterns from pregnancy to normal sleep are shown in Figs. 1 and 2.

Sleep postures

As expected, pregnant women spent the least amount of time in either the prone or supine sleeping positions and more time on their sides (Fig. 3). Side postures were also favored by the nonpregnant group over supine and prone postures. During the postpartum period, however, women spent significantly more time supine compared to their study while pregnant.

TABLE 3. *Comparison of pre- and postpartum sleep (means ± SD)*

Parameter	Prepartum (n = 7)	Postpartum (n = 7)	p
Sleep efficiency	75.2 ± 13.7	96 ± 11.5	0.02[a]
WASO (%)	16.9 ± 44	3.04 ± 1.2	0.02[b]
Sleep latency (minutes)	8.4 ± 5	4.2 ± 2.1	n.s.
Stage 1 (%)	15.2 ± 9.5	9.1 ± 2.9	n.s.
Stage 2 (%)	57.0 ± 13.5	65.5 ± 7	n.s.
Stages 3/4 (%)	12.3 ± 3.9	9.7 ± 3.2	n.s.
REM (%)	14.2 ± 4.5	17.2 ± 4	n.s.

[a] $Z = -2.36$.
[b] $Z = -2.33$.

Sleep fragmentation

Sleep fragmentation, as defined by the number of awakenings, was found to be significantly higher in the pregnant group (36.8 ± 10.5) as compared to controls (22.8 ± 11.1) ($Z = -2.63$; $p < 0.01$). Similarly, there was a significant decrease in the number of awakenings noted in the postpartum (13.85 ± 3.43) compared to the prepartum study (37 ± 13.2) ($Z = -2.36$; $p < 0.01$).

Breathing and periodic leg movements

None of the pregnant women or nonpregnant controls demonstrated significant periodic limb movements (PLMS). Surprisingly, however, two subjects demonstrated significant PLMS on their postpartum night (a total of 125 and 175 leg movements) but not on their first night of monitoring (6 and 11 leg move-

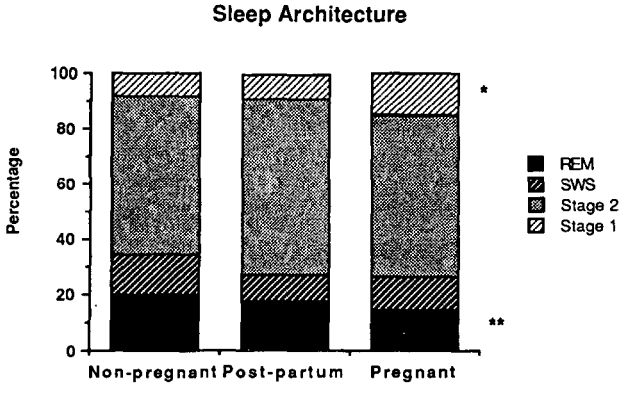

FIG. 1. Mean percentage of sleep stages in pregnant, nonpregnant and postpartum groups. The pregnant group had a significant increase in stage 1 (*$p < 0.01$) and a reduction in REM sleep (**$p < 0.05$) compared to the nonpregnant controls.

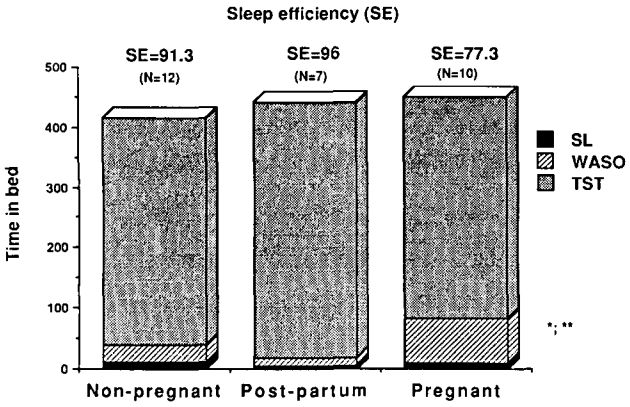

FIG. 2. Mean time (minutes) of sleep latency, WASO and total sleep time in the pregnant, nonpregnant and postpartum groups. Significant increase in WASO is shown in the pregnant group compared to the nonpregnant (*$p < 0.005$) and the postpartum (**$p < 0.01$), accounting for the decrease in sleep efficiency in that group.

ments, respectively). No significant sleep apnea was observed in any subject to account for sleep disruption. A small but significant decrease in basal SaO_2 was noted in the pregnant group (96.5 ± 1.0) compared to the nonpregnant (98.5 ± 0.8) ($p < 0.05$).

Subjective evaluation of first night effect

On the morning following the sleep study, each subject completed a questionnaire designed to assess sleep quality and the satisfaction with sleep in the laboratory compared to sleep at home. Each subject rated her sleep in the lab as "better", "same" or "worse", compared to her sleep at home. Each subject was also asked to assess her sleep based on four sleep measures: sleep latency, total sleep time, waking time and number of awakenings. Responses were rated on a five-item Likert type scale: 1 = much less than usual; 2 = slightly less than usual; 3 = same as usual; 4 = slightly more than usual; 5 = much more than usual. There were no significant differences between the pregnant and the nonpregnant groups on any of the sleep measures. Both groups felt that in the sleep laboratory they slept slightly less (2.45 ± 0.93; 2.5 ± 1.05), it took them slightly longer to fall asleep (3.7 ± 0.78; 3.6 ± 0.96) and they were awake slightly longer compared to their sleep at home (3.18 ± 1.16; 3.8 ± 0.83 for the pregnant and the nonpregnant groups, respectively) (Fig. 4). Overall, seven subjects in the pregnant group, compared to four controls, rated their sleep as "same" or "better". This difference was not statistically significant.

Reported number of awakenings

When asked how many times they woke up during the sleep study, the pregnant women reported more awakenings (3.4 ± 1.2) compared to the nonpregnant group (1.9 ± 2.1), but this difference did not achieve statistical significance. The number of awakenings reported by the postpartum group was slightly but not significantly lower compared to their reported awakenings during pregnancy.

By far the most common reason for waking in the pregnant group was bathroom trips (50%). Discomfort due to wires and equipment was reported by three (25%) subjects, followed by equally reported low back pain, dreams, or unknown (16% each). In the nonpregnant group, three (30%) subjects reported waking out of dreams. Two (20%) subjects did not know what woke them up. Finally, bathroom trip, equipment discomfort and feeling cold were each reported by one (10%) control subject. During the postpartum study, equipment discomfort, dreaming and feeling cold were equally reported (28% each).

Changes in sleep during the last trimester of pregnancy

A separate analysis was performed to examine the changes in sleep over time during late pregnancy (Table 4). For that purpose, the pregnant group was divided into two subgroups: weeks 30–33 and 35–38. Mann–Whitney comparisons between the two subgroups revealed that they did not differ on sleep latencies, WASO and stages 1, 2 and slow-wave sleep, but the late group (weeks 35–38) had a lower percentage of REM sleep than the earlier (weeks 30–33) group ($Z = -2.21$; $p < 0.02$).

DISCUSSION

The present study evaluated sleep in 12 pregnant women during a single night only. In spite of the fact that we did not control for laboratory adaptation, a subjective evaluation of their sleep quality, obtained from the study participants, indicated that no system-

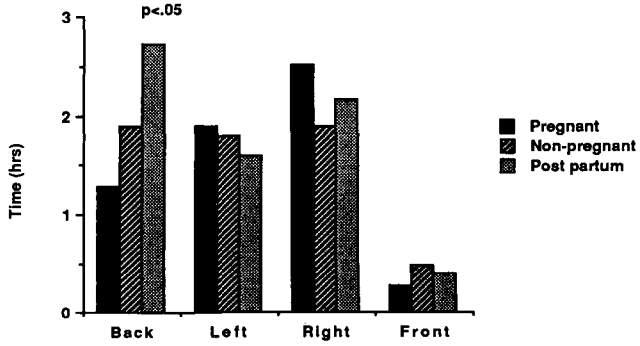

FIG. 3. Mean sleep time (hours) spent in supine, side and prone postures for the pregnant, nonpregnant and postpartum groups.

TABLE 4. *Sleep variables in women who are between 30 and 34 weeks pregnant compared to those who are between 35 and 38 weeks pregnant*

	Weeks 30–34 (n = 7)	Weeks 35–38 (n = 5)	p
Age	31.1 ± 3.8	29.8 ± 7.05	n.s.
BMI[a]	29.35 ± 3.67	29.32 ± 5.3	n.s.
Sleep latency	17 ± 15.6	7.6 ± 6.5	n.s.
WASO (%)	20 ± 10.8	15 ± 9.6	n.s.
Stage 1 (%)	17.85 ± 12.6	20.8 ± 14.23	n.s.
Stage 2 (%)	53.5 ± 15.32	57 ± 12.59	n.s.
Stages 3/4 (%)	12.28 ± 3.9	10.8 ± 2.49	n.s.
REM (%)	16 ± 2.79	11 ± 4.35[b]	0.02

[a] Body mass index.
[b] $Z = -2.21$.

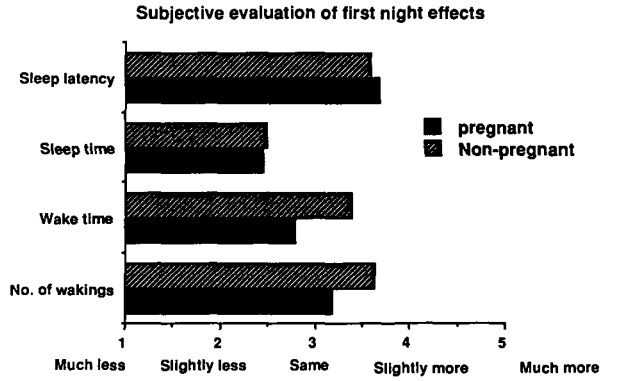

FIG. 4. Mean scores of four questions evaluating sleep quality in the laboratory compared to sleep at home. Responses are rated on a five-item scale.

atic first night effects were evident in either the pregnant or the control group. The groups did not differ significantly with respect to sleep latency, total sleep time, total waking time or number of awakenings. About half of the subjects in both groups felt they slept the same or better in the laboratory compared to their usual sleep and an equal number in each group reported discomfort due to the laboratory equipment. Furthermore, in our study, three of the seven women who came back for a postpartum study felt they slept worse in the laboratory, despite this being their second sleep study. It seems that factors other than equipment discomfort may have altered their sleep in the laboratory, e.g. one woman felt she missed her newborn son. In fact, a similar lack of systematic first night effects has been reported in insomniacs studied at home (7,8).

Polysomnographically, both pregnant subjects and nonpregnant controls were subjected to the same conditions and none exhibited sleep onset difficulties. The polygraphic features of the pregnant group, i.e. increased WASO and lowered sleep efficiency, were generally in accordance with their reported complaints. The most common complaints, restless sleep, lower back pain and leg cramps, are also consistent with surveys carried out in pregnant participants (2,9).

Our study demonstrated a significant decrease in REM sleep and an increase in stage 1 in the pregnant group. Specifically, the percentage of REM sleep was lowest in the subgroup of women who were studied between weeks 35 and 38 of pregnancy. Our data on REM sleep concur with those of Petre-Quadens who reported a similar reduction in REM sleep during the last 3–4 weeks of pregnancy (5). The significance of these REM changes toward the end of pregnancy is unclear, but it may be related to high levels of circulating progesterone during late pregnancy (10). Alternatively, such a REM decrease combined with a WASO and stage 1 increase may simply reflect a generalized increase in arousal level found in late pregnancy.

Previous sleep studies in pregnancy reported a marked decrease or even an absence of stage 4 during the third trimester of pregnancy (4,5). In our study, no significant difference was found in slow-wave sleep between the two groups, but a separate analysis for stage 3 and stage 4 was not carried out. Two recent case reports presented unusual episodes of night terror and sleep walking during pregnancy, both of which are slow-wave sleep-related phenomena (11,12). In both reports, however, the parasomnias occurred during the first few months of pregnancy. We are not aware of similar cases reported during late stages of pregnancy.

All seven women who returned for a postpartum study had a significant reduction in WASO and an overall improvement in their sleep efficiency. Coincident with their more efficient sleep was a decrease in reported leg cramps and low back pain. There were no significant differences, however, noted in REM sleep or slow-wave sleep in the postpartum study, suggesting that whereas increased WASO can be easily reversed once the discomfort of pregnancy disappears, the "normalization" of sleep architecture is a slower process that may be tied to hormonal changes.

Of interest is the significant number of periodic limb movements found in two women during their postpartum study. Both did not have significant limb movements during their first study. This is surprising as the association of restless legs with normal pregnancy has been described before (13). Night-to-night variability in periodic limb movements during sleep may account for the lack of significant leg movements in the initial study, but multiple recordings are needed to clarify this finding.

In summary, women in late pregnancy exhibit primarily sleep maintenance difficulties as a result of the discomfort, aches and pains that are associated with pregnancy. Whether the alterations in sleep architecture during pregnancy also reflect specific hormonal changes is yet to be determined.

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REFERENCES

1. American Sleep Disorders Association. *The international classification of sleep disorders.* First edition, prepared by the Sleep Disorders Classification Committee, M Thorpy, Chairman. Kailey: Kansas, 1990.
2. Schweiger MS. Sleep disturbances in pregnancy. *Am J Obstet Gynecol* 1972;114:879–82.
3. Fast A, Shapiro D, Ducommun EJ, Friedman LW, Bouklas T, Floman Y. Low back pain in pregnancy. *Spine* 1987;12(4):368–71.
4. Karacan I, Agnew HW, Williams RL, Webb WB, Ross JJ. Characteristics of sleep patterns during late pregnancy and the postpartum periods. *Am J Obstet Gynecol* 1968;101:579–86.
5. Petre-Quadens O. Sleep in pregnancy: evidence of foetal sleep characteristics. *J Neurol Sci* 1967;4:600–5.
6. Rechtschaffen A, Kales A, eds. *A manual of standardized terminology, techniques and scoring system for sleep stages of human subjects.* Los Angeles: Brain Information Service/Brain Research Institute, 1968.
7. Edinger JD, Marsh GR, McCall WV, Erwin CW, Lininger AW. Sleep variability across consecutive nights of home monitoring in older mixed DIMS patients. *Sleep* 1991;14:13–7.
8. Coates TJ, George JM, Killen JD, Marchini E, Hamilton S, Thorensen CE. First night effects in good sleepers and in sleep maintenance insomniacs when recoded at home. *Sleep* 1981;4:293–8.
9. Fast A, Weiss L, Parikh S, Hertz G. Night back-ache in pregnancy: hypothetical pathophysiological mechanism. *Am J Phys Med Rehabil* 1989;68:227–9.
10. Kawakami M, Sawyer CH. Conditioned induction of paradoxical sleep in the rabbit. *Exp Neurol* 1964;9:470–82.
11. Snyder S. Unusual case of sleep terror in a pregnant patient. *Am J Psychiatry* 1986;143:3.
12. Berlin RM. Sleep walking disorder during pregnancy: a case report. *Sleep* 1988;11(3):298–300.
13. Ekbom K. Restless legs. *Acta Med Scand* 1945;158(suppl):4–122.