

# Snoring, Pregnancy-Induced Hypertension, and Growth Retardation of the Fetus\*

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**Study objective:** Our purpose was to study the relationship between snoring and pregnancy-induced hypertension and growth retardation of the fetus.

**Design:** Retrospective, cross-sectional, consecutive case series.

**Setting:** The Department of Gynecology and Obstetrics, University Hospital, Umeå, Sweden.

**Participants and measurements:** On the day of delivery, 502 women with singleton pregnancies completed a questionnaire about snoring, witnessed sleep apneas, and daytime fatigue. Data concerning medical complications were taken from the women's casebooks.

**Results:** During the last week of pregnancy, 23% of the women reported snoring every night. Only 4% reported snoring before becoming pregnant. Hypertension developed in 14% of snoring women, compared with 6% of nonsnorers ( $p < 0.01$ ). Preeclampsia occurred in 10% of snorers, compared with 4% of nonsnorers ( $p < 0.05$ ). An Apgar score  $\leq 7$  was more common in infants born to habitual snorers. Growth retardation of the fetus, defined as small for gestational age at birth, had occurred in 7.1% of the infants of snoring mothers and 2.6% of the remaining infants ( $p < 0.05$ ). Habitual snoring was independently predictive of hypertension (odds ratio [OR], 2.03;  $p < 0.05$ ) and growth retardation (OR, 3.45;  $p < 0.01$ ) in a logistic regression analysis controlling for weight, age, and smoking.

**Conclusions:** Snoring is common in pregnancy and is a sign of pregnancy-induced hypertension. Snoring indicates a risk of growth retardation of the fetus. (CHEST 2000; 117:137-141)

**Key words:** hypertension; intrauterine growth retardation; preeclampsia; pregnancy; small for gestational age; snoring

**Abbreviation:** OR = odds ratio

Preeclampsia, defined as pregnancy-induced hypertension and proteinuria, frequently combined with edema, is asymptomatic in some women but may induce severe symptoms in others.<sup>1</sup> Hypertensive disorders during pregnancy are a leading cause of maternal death in the United States and Great Britain<sup>1,2</sup> and are important causes of neonatal morbidity and mortality.<sup>3,4</sup> The cause of these diseases is, however, still unknown.

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Gislason et al<sup>5</sup> found that snoring was strongly related to hypertension in middle-aged women. Snoring is a sign of increased upper airway resistance and obstructive sleep apnea,<sup>5-7</sup> which is associated with arterial hypertension and coronary artery disease.<sup>8-10</sup> Muscle sympathetic nerve activity and nocturnal norepinephrine levels are elevated in these patients and are considered to be a possible cause of sleep apnea-induced hypertension.<sup>11,12</sup>

Snoring and sleep apnea are often caused by factors that narrow the upper airway. Both nasal congestion and pharyngeal edema are such constricting factors occurring during pregnancy.<sup>13</sup> However, only a few case reports including sleep apnea and complications during pregnancy are available.<sup>14-17</sup> One of these reports relates to a case of intrauterine growth retardation,<sup>15</sup> and one describes a woman with preeclampsia.<sup>17</sup> Loube et al<sup>18</sup> reported that snoring frequency increases during pregnancy, but no one has investigated whether snoring is associated with hypertensive disorders of pregnancy.

In the present study, we investigated the association of self-reported snoring with complications of pregnancy and fetal outcome.

## MATERIALS AND METHODS

The study was performed at the Department of Obstetrics and Gynecology at Umeå University Hospital. A questionnaire was administered by four midwives to 518 consecutive women on the day of delivery. Women who underwent cesarean section and those who gave birth to a dead baby or twins were not included. All but 16 women completed the questionnaires. Complete answers were thus obtained from 502 women with singleton pregnancies. The women had a mean weight of  $74.5 \pm 12.0$  kg, and they were  $28.9 \pm 5.0$  years old at delivery. All but 10 women were white and were born either in Sweden or Finland.

### Questionnaire

When a woman answered the questionnaire she was, as a rule, accompanied by her partner. The questionnaire was administered when she entered the hospital on the day of delivery. She was asked to rate her snoring frequency before pregnancy and during the last week before delivery according to a five-point scale corresponding to never, seldom, sometimes, often, or always. She was also asked about the time during the pregnancy when the snoring began. Habitual snoring was considered if snoring frequency was rated as often or always at the day of delivery.

Excessive daytime sleepiness was defined as an answer of "Yes, a lot" to the question, "Did you experience excessive daytime sleepiness during the pregnancy?" The other possible answers were, "No, it was as usual" or "No, I became more alert during the pregnancy."

The questions also related to smoking habits, medication, and concomitant disease. Her partner was asked if he had noted apneas during sleep. They were both asked to cooperate on questions of snoring and witnessed sleep apneas.

### BP measurements

The BP measurements were recorded in each woman's medical chart. All of the studied women had attended the prenatal clinic where investigations, including BP measurements in the supine position, were made at gestational weeks 8–10, 12, 25, 28, 31, 33, 35, 37, 39, and 41. Follow-up BP measurements were recorded more frequently when an increased BP was observed.

### Complications

The women's edema was rated from 0 to 3, and their body weight was recorded before delivery. Data concerning medical complications were taken from the women's casebooks.

Recordings were obtained from the infants' birth weight, length, sex, head size, and Apgar score at 1 and 5 min after birth. The Apgar score was based on heart rate, respiratory effort, muscle tone, reflex irritability, and skin color.<sup>19</sup> Each variable was rated from 0 to 2, where 2 was normal. The maximum Apgar score was 10.

### Definitions

Pregnancy-induced hypertension was defined as repeated BP recordings  $> 140/90$  mm Hg appearing during the pregnancy.

Four women had hypertension prior to the pregnancy and were, thus, not regarded to suffer from pregnancy-induced hypertension. Preeclampsia was defined as pregnancy-induced hypertension with proteinuria  $\geq 0.3$  g/24 h. Growth retardation of the fetus was considered when the infant was small for gestational age according to a birth weight below 2 SDs on the Swedish standard chart.<sup>20</sup>

### Statistical Analysis

The data are presented as mean  $\pm$  SD for continuous variables and as rates for nominal values. Differences between two means were assessed using Student's *t* test for independent samples. Differences between proportions were analyzed using the  $\chi^2$  test. Fisher's two-tailed Exact Test was used when appropriate. Multiple logistic regression was used to analyze the relationship between snoring and complications of pregnancy. The null hypothesis was rejected at the 5% level ( $p < 0.05$ ).

## RESULTS

Snoring frequency increased during pregnancy ( $p < 0.001$ ). Of the total sample, 7% of the pregnant women stated that they started to snore or markedly increased their snoring frequency during the first trimester, 6% during the second trimester, and 24% during the third trimester. Habitual snoring rated as every night or almost every night was reported by 23% of the pregnant women during the last week before delivery. Occasional snoring was reported by another 25%. Only 4% of the women reported that they had snored habitually, and 22% snored occasionally before becoming pregnant.

Witnessed sleep apneas were observed in 11% of habitual snorers, as compared with 2% of the non-habitual snorers ( $p < 0.001$ ). Women who snored habitually had a mean weight of  $64.1 \pm 14.3$  kg before becoming pregnant, which was more than the remainder of the women, who weighed  $59.5 \pm 10.3$  kg ( $p = 0.002$ ). The habitually snoring women also had a more pronounced weight increase during pregnancy ( $p < 0.05$ ) and were slightly older than the rest ( $p < 0.05$ ; Table 1).

### Preeclampsia and Pregnancy-Induced Hypertension

Fourteen percent of the women who snored habitually had pregnancy-induced hypertension as compared with 6% of the nonsnorers ( $p < 0.01$ ). Ten percent of the women who snored met the definition of preeclampsia with hypertension and proteinuria as compared with 4% of the nonsnorers ( $p < 0.05$ ). All the patients with preeclampsia who snored habitually during the last week of pregnancy had started to snore during the pregnancy and before any sign of preeclampsia was present.

Witnessed sleep apneas tended to be more frequent in women with preeclampsia ( $p = 0.069$ ) and

**Table 1—Habitual Snoring and the Mother\***

Characteristics	Habitual Snorers, n = 113	Nonfrequent Snorers, n = 389	p Value
Hypertension (n = 40), %	14	6	< 0.01†
Preeclampsia (n = 26), %	10	4	< 0.05
Weight before pregnancy, kg	64.1 ± 14.3	59.5 ± 10.3	0.002‡
Weight increase during pregnancy, kg	15.0 ± 5.8	13.6 ± 4.6	0.025
Weight before delivery, kg	79.1 ± 13.7	73.1 ± 11.2	< 0.001
Age at delivery, yr	29.8 ± 5.4	28.7 ± 4.7	< 0.05
Any edema of face, hands, legs, or feet (n = 176), %	52	30	< 0.001
Edema of face (n = 68), %	27	10	< 0.001
Excessive daytime sleepiness (n = 328), %	66	65	NS
Smoking (n = 71), %	18	13	NS
Gestation length, wk	39.5 ± 2.0	39.5 ± 1.6	NS

\*Data are presented as mean ± SD unless otherwise indicated; NS = not significant.

† $\chi^2$  test was used for differences between proportions.

‡Student's *t* test for independent samples was used for differences between the mean ± SD.

pregnancy-induced hypertension ( $p = 0.055$ ). They were reported in 12% of women with preeclampsia and 10% of women with hypertension.

Habitual snoring was a risk factor, independent of weight, age and smoking habits, for pregnancy-induced hypertension (odds ratio [OR], 2.03;  $p < 0.05$ ) and also tended, but not significantly, to be an independent risk factor for preeclampsia (OR, 2.18;  $p = 0.07$ ) according to the multiple logistic regression analysis (Table 2).

#### Excessive Daytime Sleepiness

Excessive daytime sleepiness was subjectively reported in as many as 65% of the women. It started during the first trimester in 25% of the women, during the second trimester in 18%, and during the third trimester in 22%. The prevalence of excessive daytime sleepiness was similar among women who snored habitually and among those who did not (Table 1). In general, daytime sleepiness started earlier in pregnancy than did snoring.

#### Edema

Edema was overrepresented among women who snored habitually. Edema of the face, hands, legs, or feet occurred in 52% of the habitual snorers com-

pared with 30% of the remainder ( $p < 0.001$ ). Facial edema was observed in 27% of the habitual snorers, compared with 10% of the remaining women ( $p < 0.001$ ).

#### Infant Outcome

Eight of the 113 habitual snorers (7.1%) delivered an infant with growth retardation at birth (small for gestational age), compared with 10 of 379 of the nonhabitual snorers (2.6%;  $p < 0.05$ ). Snoring remained as a significant predictor of growth retardation (OR, 3.45;  $p < 0.01$ ) in the multiple logistic regression after adjustment for weight, age, and smoking habits (Tables 3, 4). Smoking was also found to be an independent predictor of growth retardation (OR, 3.94;  $p < 0.01$ ).

An Apgar score  $\leq 7$  was more common in infants born to habitual snorers compared with infants born to occasional snorers and nonsnorers, 1 and 5 min after delivery (Table 3).

Habitual snoring did not influence the ratio of

**Table 2—Predictors of Hypertension and Relative Risk\***

Characteristics	OR	95% CI	p Value
Habitual snoring	2.03	1.01–4.10	< 0.05
Smoking	1.06	0.42–2.69	NS
Weight before delivery (kg)	1.02	1.00–1.05	0.08
Age at delivery (yr)	1.06	0.99–1.13	0.09

\*CI = confidence interval; see Table 1 for abbreviation.

**Table 3—Habitual Snoring and Infant Outcome\***

Characteristics	Habitual Snorers, n = 113	Nonfrequent Snorers, n = 389	p Value
Small for gestational age, %	7.1	2.6	< 0.05‡
Apgar score $\leq 7$ after 1 min, %	12.4	3.6	0.001
Apgar score $\leq 7$ after 5 min, %	3.5	0.3	0.01
Birth weight divided by placenta weight	5.9 ± 1.1	6.1 ± 0.9	NS†

\*Data are presented as mean ± SD unless otherwise indicated; see Table 1 for abbreviation.

† $\chi^2$  test was used for differences between proportions.

‡Student's *t* test for independent samples was used for differences between the mean ± SD.

**Table 4—Predictors of Infants Born Small for Gestational Age and Relative Risk\***

Characteristics	OR	95% CI	p Value
Habitual snoring	3.45	1.26–9.42	< 0.01
Smoking	3.94	1.45–10.72	< 0.01
Weight before delivery (kg)	0.96	0.92–1.01	0.09
Age at delivery (yr)	0.99	0.90–1.10	NS

\*See Tables 1, 2 for abbreviations.

birth weight to placenta weight. Witnessed sleep apneas of the mother did not relate to infant outcome.

## DISCUSSION

In the present study, habitual snoring during pregnancy was related to hypertension, preeclampsia, edema, and increased body weight. Habitual snoring in the mother was also associated with growth retardation of the fetus and a low Apgar score for the infant. Habitual snoring was independently predictive of hypertension and growth retardation, even when weight, age, and smoking were controlled for.

Snoring may be regarded as a common feature of pregnancy, as 23% of the women in this study snored habitually and 25% snored occasionally, whereas only 4% had snored habitually prior to pregnancy. Loube et al<sup>18</sup> found that habitual snoring occurred in 14% of pregnant women (n = 350). The women answered the questionnaire on the day of delivery in the present study, and not during the second or third trimester as was the case in the study by Loube et al.<sup>18</sup> They did not find any effect on the infants, while we found an increased frequency of infants born small for gestational age.

The increased frequency of infants born small for gestational age and low Apgar scores in the infants of snoring mothers is a novel finding. It indicates that the consequences of increased upper airway resistance during sleep may affect the fetus and supports the previously suggested relationship between sleep apnea and intrauterine growth retardation.<sup>15</sup>

The association between snoring and pregnancy-induced hypertension and preeclampsia is also a novel finding that has not previously been studied. It is not possible to draw any firm conclusions about the cause and effect because of the present study design. However, all of the subjects who snored habitually and had preeclampsia started to snore before any sign of hypertension or proteinuria was present, and habitual snoring was related to witnessed sleep apneas. This indicates that nocturnal

upper airway obstruction may contribute to the development of pregnancy-induced hypertension and preeclampsia. It is possible that pregnant women are especially vulnerable to increases in upper airway resistance, as breathing may also be restricted by an increase in the abdominal pressure affecting the diaphragm. Respiratory sleep studies, including the treatment of sleep apnea in women with preeclampsia, are desirable and may answer the question of whether there is an etiologic link between increased upper airway resistance and preeclampsia.

Apart from snoring, excessive daytime sleepiness is the most common symptom of obstructive sleep apnea.<sup>21</sup> A majority of the present women reported that they had experienced excessive daytime sleepiness during the pregnancy. It was not, however, overrepresented among those who snored habitually, and sleepiness often began earlier in pregnancy than snoring. Similar to our findings, Loube et al<sup>18</sup> could not find any relationship between daytime sleepiness and snoring in pregnant women using the Epworth sleepiness scale. On the contrary, they reported that the Epworth sleepiness score was the same for pregnant and nonpregnant women. Whether or not excessive daytime sleepiness is induced by pregnancy is still unclear. However, it is likely that complaints of daytime fatigue and sleepiness during pregnancy are due to factors other than disturbed sleep due to snoring.

Snoring is the audible sign of an increase in upper airway resistance. In this study, the snoring frequency depended on the extent to which the bedroom partner perceived it. There is no international consensus on the objective definition of snoring, although objective recordings using microphones correlate well with subjective snoring in young adults.<sup>22</sup> Subjective reports are, however, the most commonly used instrument for measuring snoring, partly because of the technical problems involved with microphone recordings and partly because the subjective reports give an average of the subject's degree of snoring, whereas the result of the recording of a single night may be misleading.

A limitation with cross-sectional surveys is that it is not possible to draw any conclusions regarding the cause and the effect. A confounding effect of an uncontrolled factor could have been responsible for the present results even though snoring appears to be a risk factor. Possible confounding factors not controlled for in the present study were, for example, the body mass index, the parity, and the social status. Another limitation is that snoring was based on subjective reports. However, this is a problem also in other epidemiologic studies of snoring.

Women who reported habitual snoring were

heavier before pregnancy and gained more weight during pregnancy. Edema was more common in habitual snorers. It may be speculated that pharyngeal swelling could narrow the upper airway to a critical point at which snoring would occur. Weight gain and pharyngeal edema are therefore possible causes of pregnancy-induced snoring. Nasal congestion due to hormonal changes may, however, also have contributed to snoring, since 7% reported that they started to snore during the first trimester.

Snoring is common in pregnancy and is a sign of pregnancy-induced hypertension. Snoring indicates a risk of growth retardation of the fetus.

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