JAMAOtolaryngol HeadNeck Surg. 2013;139(7):669-677.
Maternal Prenatal Smoking and Hearing Loss Among Adolescents
Weitzman, Michael MD 1, 2; Govil, Nandini MD 3, 4; Liu, Ying Hua MD, PhD 1; Lalwani, Anil K. MD 1, 5
1 Department of Pediatrics, New York University School of Medicine, New York
2 Department of Environmental Medicine, New York University School of Medicine, New York
3 New York University School of Medicine, New York
4 now with the Department of Otolaryngology, University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania
5 Department of Otolaryngology–Head and Neck Surgery, Columbia University College of Physicians and Surgeons, New York, New York

IMPORTANCE: Although smoking and secondhand smoke exposure are associated with sensorineural hearing loss (SNHL) in children and adults, the possible association between prenatal smoke exposure and hearing loss has not been investigated despite the fact that more than 12% of US children experience such prenatal exposure each year.
OBJECTIVE: To investigate whether exposure to prenatal tobacco smoke is independently associated with SNHL in adolescents.
DESIGN: Cross-sectional data were examined for 964 adolescents aged 12 to 15 years from the National Health and Nutrition Examination Survey 2005-2006.
PARTICIPANTS: Participants underwent standardized audiometric testing, and serum cotinine levels and self-reports were used to identify adolescents exposed to secondhand smoke or active smokers.
MAIN OUTCOMES AND MEASURES: Prenatal exposure was defined as an affirmative parental response to, “Did [Sample Person’s Name] biological mother smoke at any time while she was pregnant with [him/her]?” Sensorineural hearing loss was defined as an average pure-tone hearing level more than 15 dB for 0.5, 1, and 2 kHz (low frequency) and 3, 4, 6, and 8 kHz (high frequency).
RESULTS: Parental responses affirmed prenatal smoke exposure in 16.2% of 964 adolescents. Prenatal smoke exposure was associated with elevated pure-tone hearing thresholds at 2 and 6 kHz ($P < .05$), a higher rate of unilateral low-frequency SNHL (17.6% vs 7.1%; $P < .05$) in bivariate analyses, and a 2.6-fold increased odds of having unilateral low-frequency SNHL in multivariate analyses (95% CI, 1.1-6.4) after controlling for multiple hearing-related covariates.
CONCLUSIONS AND RELEVANCE: Prenatal smoke exposure is independently associated with higher pure-tone hearing thresholds and an almost 3-fold increase in the odds of unilateral low-frequency hearing loss among adolescents. These novel findings suggest that in utero exposure to tobacco smoke may be injurious to the auditory system.

青年期における妊娠中の出生前喫煙暴露と難聴について

背景：喫煙が感音難聴に関連することはわかっているが、妊娠中の暴露についてはまだわかっていない。アメリカでは12%もの子供がそのような妊娠中の喫煙の暴露を受けている。
目的：妊娠中の喫煙暴露が青年期の感音難聴に独立に関連するか調べる。
デザイン:National Health and Nutrition Examination survey 2005-2006 から 12 歳から 15 歳まで 964 人を対象とした横断的なデータ調査。
対象：標準的な聴力検査を実施。血清コチニンレベルの測定・アンケートにより喫煙者か間接喫煙かを調査。
アウトカム：出生前の喫煙暴露は、親に対して「[あなた]の生物学的親は妊娠中に喫煙をしたことがありますか？」という問いにより定義した。感音難聴は、0.5kHz, 1kHz, 2kHz, 3kHz, 4kHz, 6kHz, 8kHz において正常より 15dB 異常閾値上昇を認める場合とした。
結果：964 人中、出生前に暴露したのは 16.2%であった。2kHz と 6kHz において純音聴力の閾値上昇を認め($p < .05$)、2 変量解析では片側低音障害難聴が有意に多かった(17.6%/7.1%, $p< .05$)。その他の難聴に関連する因子を加えた多変量解析では、片側低音障害型感音難聴のオッズ比は 2.6 倍であった(95%信頼区間, 1.1-6.4)。
まとめ：妊娠中の間接喫煙は独立に高音域の純音聴力に関係があり、青年期において片側低音難聴のオッズ比は 3 倍程度であった。子宮内での間接喫煙は聴覚系に障害をもたらすといえる。

Table 1. Pure-Tone Hearing Level at Each Frequency, With or Without Prenatal Exposure in 964 Adolescents Aged 12 to 15 Years[a]

Variable	Average Level (Right and Left Ears), Mean (SD), dB			Worse Ear (Right or Left Ear), Mean (SD), dB		
	Prenatal SHS Exposure	Unexposed	*P* Value[b]	Prenatal Exposure	Unexposed	*P* Value[b]
Frequency, kHz						
0.5	11.2 (1.2)	9.3 (0.4)	.10	14.4 (1.3)	12.1 (0.5)	.08
1	5.8 (1.1)	4.2 (0.3)	.14	9.2 (1.4)	7.0 (0.4)	.10
2	6.1 (0.9)	4.2 (0.3)	.06	9.7 (1.3)	6.9 (0.3)	.05
3	6.2 (1.3)	4.9 (0.3)	.35	9.8 (1.6)	7.6 (0.4)	.20
4	7.0 (1.2)	4.7 (0.4)	.06	10.6 (1.4)	7.9 (0.4)	.06
6	13.8 (1.3)	10.7 (0.5)	.04	18.6 (1.5)	14.9 (0.5)	.03
8	10.0 (1.4)	7.7 (0.5)	.07	14.1 (1.6)	11.6 (0.6)	.10

Abbreviation: SHS, secondhand smoke.

[a] Data from National Health and Nutrition Examination Survey 2005-2006.

[b] Independent *t* test.

Table 2. Severity of Hearing Loss With or Without Prenatal Tobacco Smoke Exposure in 964 Adolescents Aged 12 to 15 Years[a]

Type of SNHL	Adolescents, %[b]					*P* Value[c]
	Total	Normal Hearing	Mild Hearing Loss	Moderate Hearing Loss	Severe Hearing Loss	
Unilateral low frequency						
Total	964	90.5	7.0	1.7	0.8	
Unexposed	809	92.8	5.6	0.9	0.7	.03
Exposed	155	82.2	11.9	4.5	1.4	
Bilateral low frequency						
Total	964	97.9	2.0	0.0	0.1	
Unexposed	809	98.5	1.5	0.0	0.0	.12
Exposed	155	95.8	4.0	0.0	0.2	
Unilateral high frequency						
Total	964	84.8	11.6	2.3	1.3	
Unexposed	809	86.0	11.1	1.9	0.9	.12
Exposed	155	80.0	13.5	3.7	3.0	
Bilateral high frequency						
Total	964	96.0	3.7	0.1	0.2	
Unexposed	809	96.5	3.3	0.1	0.2	.48
Exposed	155	94.1	5.4	0.2	0.2	

[a] Data from National Health and Nutrition Examination Survey 2005-2006.

[b] Hearing loss was categorized as follows, according to pure-tone hearing threshold: normal hearing, threshold ≤15 dB; mild hearing loss, >15 and ≤25 dB; moderate hearing loss, >25 and ≤40 dB; and severe heading loss, >40 dB.

[c] Cochran-Armitage trend test.

Table 3. Bivariate Analysis for Risk Factors for Sensorineural Hearing Loss Among Adolescents Aged 12 to 15 Years[a]

Covariate	No.	Type of SNHL[b]							
		Low Frequency				High Frequency			
		Unilateral, %	*P* Value[c]	Bilateral, %	*P* Value[c]	Unilateral SNHL, %	*P* Value[c]	Bilateral SNHL, %	*P* Value[c]
Total sample size	964	9.5		2.1		15.2		4.0	
Prenatal maternal smoking[e]									
Yes	155	17.6	.049	4.2	.18	20.0	.17	5.9	.51
No	809	7.1		1.5		13.9		3.5	
SHS exposure[d]									
Unexposed	432	7.1	.08	1.7	.43	17.6	.10	4.7	.25
Exposed	400	10.2		2.5		11.7		2.7	
Birth weight[e]									
Low (≤2.49 kg)	87	17.6	.18	4.9	.46	15.5	.99	3.3	.84
Normal (>2.49 kg)	815	9.1		1.9		15.4		3.7	
Very low (≤1.50 kg)	12	42.5	.42	42.5	.30	60.6	.33	15.5	.23
Moderately low (>1.50 to 2.48 kg)	75	14.9		0.7		10.5		1.9	
Received NICU care[e]									
Yes	120	14.9	.08	5.8	<.01	16.5	.73	2.8	.51
No	835	8.8		1.6		15.0		4.0	
Sex									
Male	482	8.1	.41	1.6	.48	15.3	.95	3.6	.63
Female	482	11.0		2.7		15.2		4.6	
Race									
Mexican	241	10.4	.66	2.2	.63	16.0	.32	4.2	.19
Other	308	8.6		3.0		17.5		5.0	
White	339	9.4		1.8		14.0		1.6	
Black	76	5.6		1.1		9.8		4.6	
Poverty									
Poor	265	14.3	.17	2.6	.69	20.0	.26	4.0	.97
Not poor	669	76.0		2.0		14.4		4.1	

Abbreviations: NICU, neonatal intensive care unit; SHS, secondhand smoke; SNHL, sensorineural hearing loss.

[a] Data from National Health and Nutrition Examination Survey 2005-2006.

[b] SNHL was defined as a pure-tone hearing threshold >15 dB (average threshold at 0.5, 1, and 2 kHz for low-frequency SNHL and at 3, 4, 6, and 8 kHz for high-frequency SNHL).

[c] χ^2 Test.

[d] Secondhand smoke exposure was defined as serum cotinine levels <15 ng/mL with no report of smoking in the previous 5 days.

[e] Data regarding prenatal maternal smoking, low or very low birth weight, and history of NICU care were available only for adolescents younger than 15 years.

Table 4. Bivariate Analysis for Risk Factors for Sensorineural Hearing Loss Among Adolescents Aged 12 to 15 Years[a]

Variable	No.	Type of SNHL[b]							
		Low Frequency				High Frequency			
		Unilateral, %	P Value[c]	Bilateral, %	P Value[c]	Unilateral, %	P Value[c]	Bilateral, %	P Value[c]
Exposure to loud noise or listening to music with headphones in past 24 h									
No	264	5.9	.11	2.0	.84	13.1	.43	3.2	.63
Yes	670	10.8		2.3		16.2		4.3	
Time since exposure to loud noise or music, h									
0	673	10.7	.13	2.3	NA	16.0	.76	4.3	.23
≤1	49	1.7		0.0		17.7		1.1	
1 to <12	147	6.7		2.1		11.7		3.4	
12 to 24	68	6.9		3.0		13.1		4.3	
History of firearm use									
Yes	126	8.8	.87	1.6	.63	15.8	.77	4.7	.63
No	810	9.3		2.4		14.9		3.7	
History of job exposure to loud noise									
Yes	22	0.0	NA	0.0	NA	25.2	.36	6.6	.65
No	915	9.6		2.3		14.7		3.8	
Frequency of wearing hearing protection									
Most of the time	40	6.2	.45	2.5	NA	19.7	.84	9.1	.75
Sometimes	115	10.5		2.2		16.4		3.4	
Rarely or seldom	45	9.8		0.0		9.6		4.8	
Never	736	9.2		2.4		14.9		3.5	

Abbreviations: NA, not available; SNHL, sensorineural hearing loss.

[a] Data from National Health and Nutrition Examination Survey 2005-2006.

[b] Sensorineural hearing loss was defined as a pure-tone hearing threshold >15 dB (average threshold at 0.5, 1, and 2 kHz for low-frequency SNHL and at 3, 4, 6, and 8 kHz for high-frequency SNHL).

[c] χ^2 Test.

Table 5. Multivariate Analyses: Unilateral Sensorineural Hearing Loss and Prenatal Tobacco Smoke Exposure for 964 Adolescents Aged 12 to 15 Years[a]

Covariate	Odds Ratio (95% CI)
Prenatal maternal smoking	
Yes	2.6 (1.1-6.4)
No	
Neonatal intensive care unit	
Yes	2.0 (0.7-5.7)
No	
Secondhand smoke	
Unexposed	1.1 (0.6-2.3)
Exposed	
Sex	
Male	1.6 (0.7-3.8)
Female	
Race	
Mexican American	1.6 (0.8-3.3)
Other	1.4 (0.6-3.3)
Non-Hispanic white	Reference
Non-Hispanic black	0.9 (0.2-4.0)
Poverty	
Poor	0.6 (0.1-3.8)
Not poor	

[a] Data from National Health and Nutrition Examination Survey 2005-2006.