

Supplemental Digital Content

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SOCIODEMOGRAPHIC QUESTIONNAIRE

Child's Legal Name: _____

The purpose of this survey is to help identify factors that may be associated with childhood hearing loss in Alaska communities so that we can reduce the amount of hearing loss in the future. The head of your household and/or the primary caregiver should complete these questions for the child listed above.

Please return the questionnaire, along with the consent, to your child's school.

1. What is the Race of the child (select one or more)?
 - American Indian or Alaska Native White
 - Asian Other (please specify): _____
 - Black or African American Choose Not to Disclose
 - Native Hawaiian or Other Pacific Islander

2. What is the Ethnicity of the child?
 - Hispanic or Latino Non-Hispanic or Latino

3. How many people are currently live in household (including child participating in the study)? _____

4. How many of these are children age 18 or younger (including child participating)? _____

5. How many rooms are there in the house (excluding bathrooms, closets, hallways)? _____

6. Number of smokers in the house? None 1-2 smokers 3 + smokers

7. How often does someone smoke inside the house? Daily Weekly Monthly Never

8. Do you use a wood-burning stove or fireplace to cook or help heat the house? Yes No

9. Do you have running (plumbed) water in your house? Yes No

10. In what rooms do you have sinks for washing up? Bathroom Kitchen None Unknown

11. How many years did the mother or female caregiver attend school?
 - Primary Some High School Completed High school/GED Some College
 - College Degree No female caregiver for this child

12. How many years did the father or male caregiver attend school?
 - Primary Some High School Completed High school or GED Some College
 - College Degree No male caregiver for this child

13. What is the total household income per year?
 - ≤\$20,290 \$20,291-25,520 \$25,521-30,750 \$30,751-35,980 \$35,981-41,210
 - \$41,211-46,440 \$46,441-51,670 >\$51,670

Continued on the back

14. What is the mother or female caregiver's occupation?

- Government, Tribal, Native Corporation, or Municipality Leadership
- Professional (such as director, manager, administrator, accountant, pilot, pastor)
- Seasonal (such as mining, fish processing, reindeer herding, commercial fishing/hunting)
- Customer service (such as store cashier or airlines agent)
- Office or administrative assistant
- Educator
- Healthcare
- Subsistence
- Business owner
- Homemaker
- Maintenance or custodial
- Tourism
- Law enforcement
- Construction/contracting
- Other _____
- No female caregiver for this child

15. What is the father or male caregiver's occupation?

- Government, Tribal, Native Corporation, or Municipality Leadership
- Professional (such as director, manager, administrator, accountant, pilot, pastor)
- Seasonal (such as mining, fish processing, reindeer herding, commercial fishing/hunting)
- Customer service (such as store cashier or airlines agent)
- Office or administrative assistant
- Educator
- Healthcare
- Subsistence
- Business owner
- Homemaker
- Maintenance or custodial
- Tourism
- Law enforcement
- Construction/contracting
- Other _____
- No male caregiver for this child

SUPPLEMENTAL METHODS

Details of multiple imputation process

Multiple imputation by chained equations (MICE)^{1,2} was used to produce an alternative set of estimates, primarily for infection related hearing loss defined by pure tone average, but also for other outcomes as well (to compare to those generated from complete case analysis). To aid convergence of chained equations, imputations were made at the level of the ear and then combined to compute overall estimates of hearing loss and middle ear disease.

Variables that were entered into the imputation model were as follows:

Variable	Regression type
Air conduction 0.5kHz	Linear
Air conduction 1kHz	Linear
Air conduction 2kHz	Linear
Air conduction 4kHz	Linear
Audiometry normal for both years ¹	Binary logistic
Otoacoustic emission referral	Binary logistic
HearScreen 1k referral	Binary logistic
HearScreen 2k referral	Binary logistic
Otoscopic conditions needing follow-up	Binary logistic
Otoscopic conditions consistent with middle ear disease ²	Binary logistic
Tympanometric type ³ (audiologist)	Multinomial logistic
Tympanometric type ³ (layperson)	Multinomial logistic
Age (years)	Linear
Sex (male/female)	Binary logistic
Number of people living in home	Linear
Number of smokers living in home ⁴	Multinomial logistic
Frequency of smoking inside the home ⁵	Multinomial logistic
Maximum education level of any caregiver ⁶	Multinomial logistic
Plumbed water in home	Binary logistic
Grade (linear+quadratic terms)	N/A - independent only

¹Average of 0.5kHz, 1 kHz, 2 kHz, 4 kHz

²Includes retraction, effusion, acute otitis media, otorrhea, perforation, patent tube, plugged tube, or external otitis

³Type A (normal), B, or C

⁴Possible values of None, 1-2 smokers, 3+ smokers

⁵Possible values of never vs daily, weekly or monthly

⁶Possible values of <12 grade, high school diploma or GED, some college, or college degree

A child's grade (an integer representing year in school, starting with preschool children), was the only variable used in the imputation process that was universally non-missing and was used as a predictor for all imputations. A quadratic term for grade was also added to allow for non-linear associations. The imputation produced 10 imputed full datasets (with a 10 set burn-in) with all prevalence estimates combined using Rubin's rules.³ Although risk factors for hearing loss (number of people in household, indoor plumbing, woodburning stove/fireplace, and smoking) were used to aid the imputations, risk factors themselves were not imputed as missingness was not deemed as concerning for these factors.

Supplemental Methods References

1. van Buuren S. Multiple imputation of discrete and continuous data by fully conditional specification. *Stat Methods Med Res.* 2007;16(3):219-242. doi:10.1177/0962280206074463
2. Lee KJ, Carlin JB. Multiple imputation for missing data: fully conditional specification versus multivariate normal imputation. *Am J Epidemiol.* 2010;171(5):624-632. doi:10.1093/aje/kwp425
3. Rubin DB. *Multiple Imputation For Nonresponse In Surveys.* Vol 81. Subsequent. Hoboken, N.J: Wiley-interscience; 2004:258.

SUPPLEMENTAL TABLES

Supplemental Table 1. Regression estimated prevalence ratios and prevalence differences for environmental associations with infection-related hearing loss, by measurement type (complete case analysis)

Risk factor	OAE-based ¹					PTA-based ²				
	Obs	Sample prevalence (95% CI)	Obs	Prevalence ratio (95% CI) ³	Prevalence difference (95% CI) ⁴	Obs	Sample prevalence (95% CI)	Obs	Prevalence ratio (95% CI) ³	Prevalence difference (95% CI) ⁴
Number currently living in household			1533	1.06 (0.97,1.16)	0.7 (-0.5,1.9)			1503	1.07 (0.99,1.15)	0.4 (-0.1,1.0)
Do you have running water in your house?										
Water in house	1043	9.7 (8.0,11.6)		(ref)	(ref)	1029	5.5 (4.2,7.1)		(ref)	(ref)
No water in house	495	13.5 (10.6,16.9)	1533	1.38 (0.80,2.39)	3.7 (-2.7,10.1)	479	6.9 (4.8,9.5)	1503	1.26 (0.75,2.11)	1.4 (-1.8,4.6)
Do you use a wood-burning stove or fireplace?										
No	957	11.6 (9.6,13.8)		(ref)	(ref)	939	6.4 (4.9,8.1)		(ref)	(ref)
Yes	574	9.9 (7.6,12.7)	1526	0.85 (0.55,1.32)	-1.7 (-6.5,3.0)	562	5.3 (3.6,7.5)	1496	0.85 (0.44,1.62)	-1.0 (-4.8,2.9)
Number of smokers in the house?										
None	514	11.3 (8.7,14.3)		(ref)	(ref)	506	5.7 (3.9,8.1)		(ref)	(ref)
1-2 smokers	817	10.4 (8.4,12.7)	1532	0.92 (0.53,1.58)	-0.9 (-7.0,5.2)	801	5.9 (4.3,7.7)	1502	1.01 (0.42,2.46)	0.1 (-5.1,5.3)
3 or more smokers	206	12.1 (8.0,17.4)	1532	1.07 (0.48,2.38)	0.8 (-8.5,10.1)	200	7.0 (3.9,11.5)	1502	1.26 (0.47,3.42)	1.5 (-5.1,8.1)
Count of risk factors ⁵	.		1525	1.11 (0.86,1.44)	1.2 (-1.6,3.9)			1495	1.09 (0.78,1.54)	0.5 (-1.5,2.5)
Total	1569	11.1 (9.6,12.7)				1538	6.2 (5.0,7.5)			

¹Otoacoustic emission (OAE)-based infection related hearing loss defined as having referral status for OAE screening combined with referral for tympanometry or otoscopic conditions consistent with middle ear disease (missing n=65).

²Pure tone average (PTA)-based infection related hearing loss defined as a pure tone average>25dB on 0.5, 1, 2, and 4kHz air conduction tones, combined with referral for tympanometry or otoscopic conditions consistent with middle ear disease (missing n=96).

³Estimated using modified Poisson with generalized estimating equations with clustering at the community level (n=15) and small sample correction, adjusted for age, sex, and Alaska Native race

⁴Estimated using generalized estimating equations with normal distribution and identity linking, accounting for clustering at the community level (n=15) and small sample correction, adjusted for age, sex, and Alaska Native race

⁵Count of binary indicators for lack of water, wood burning stove/fireplace, and 3+smokers in house (range 0-3)

Supplemental Table 2. Regression estimated prevalence ratios and prevalence differences for environmental associations with infection-related hearing loss, by measurement type (multiply imputed outcome)¹

Risk factor	OAE-based ²					PTA-based ³				
	Obs	Sample prevalence (95% CI)	Obs	Prevalence ratio ⁴ (95% CI)	Prevalence difference ⁵ (95% CI)	Obs	Sample prevalence (95% CI)	Obs	Prevalence ratio ⁴ (95% CI)	Prevalence difference ⁵ (95% CI)
Number currently living in household	.		1594	1.05 (0.97,1.14)	0.7 (-0.5,1.8)			1594	1.1 (1.0,1.1)	0.4 (-0.1,0.9)
Do you have running water in your house?	1601		1594			1601		1594		
Water in house		11.1 (9.2,12.9)	.	(ref)	(ref)		5.9 (4.5,7.4)	.	(ref)	(ref)
No water in house		16.9 (13.6,20.1)		1.52 (0.93,2.47)	5.7 (-1.0,12.5)	1601	8.3 (5.8,10.8)		1.4 (0.9,2.4)	2.4 (-1.1,6.0)
Do you use a wood-burning stove or fireplace?	1594		1587			1594		1587		
Do not use wood burning stove/fireplace		13.5 (11.4,15.6)	.	0.90 (0.62,1.31)	-1.3 (-5.9,3.4)		7.3 (5.6,8.9)	.	(ref)	(ref)
Use wood burning stove/fireplace		12.2 (9.5,14.8)		(ref)	(ref)		5.8 (3.9,7.8)		0.8 (0.5,1.5)	-1.2 (-5.2,2.8)
Number of smokers in the house?	1600		1593			1600		1593		
None		12.8 (9.9,15.7)		(ref)	(ref)		6.3 (4.1,8.4)	.	(ref)	(ref)
1-2 smokers		12.6 (10.3,14.8)		0.97 (0.56,1.68)	-0.3 (-7.4,6.7)		6.6 (4.9,8.3)		1.0 (0.4,2.4)	0.3 (-5.1,5.7)
3 or more smokers		14.8 (9.9,19.6)		1.19 (0.62,2.28)	2.4 (-6.6,11.3)		8.2 (4.5,12.0)		1.3 (0.5,3.4)	2.2 (-4.6,9.0)
Count of risk factors ⁶	.		1586	1.23 (0.99,1.52)	2.7 (-0.2,5.6)	.		1586	1.2 (0.8,1.6)	1.0 (-1.0,3.1)
Total	1634	13.1 (11.5,14.8)	.			1634	6.9 (5.6,8.2)			

¹ Multiple imputation by chained equations (MICE) was used to impute the outcome.

² Defined as having referral status for otoacoustic emission screening combined with referral for tympanometry or otoscopic conditions consistent with middle ear disease.

³ Defined as having a pure tone average of 0.5, 1, 2, 4kHz tones greater than 25dB combined with referral for tympanometry or otoscopic conditions consistent with middle ear disease.

⁴ Estimated using modified Poisson with generalized estimating equations with clustering at the community level (n=15) and small sample correction, adjusted for age, sex, and Alaska Native race

⁵ Estimated using generalized estimating equations with normal distribution and identity linking, accounting for clustering at the community level (n=15) and small sample correction, adjusted for age, sex, and Alaska Native race

⁶ Count of binary indicators for lack of water, wood burning stove/fireplace, and 3+smokers in house (range 0-3)

Supplemental Table 3. Heterogeneous treatment effects analysis for regression estimated prevalence ratios and prevalence differences for environmental associations with infection-related hearing loss, using complete case analysis

Risk factor	Sample prevalence		Obs	Prevalence ratio (95% CI) ³			Prevalence difference (95% CI) ⁴		
	Age 3-6	Age 7+		Age 3-6	Age 7+	Interaction	Age 3-6	Age 7+	Interaction
Infection-related hearing loss (OAE-based)¹									
Number currently living in household			1533	1.17 (1.05,1.31)	1.02 (0.90,1.16)	0.87 (0.75,1.02)	2.2 (0.7,3.8)	0.2 (-1.2,1.7)	-2.0 (-3.9,-0.1)
Do you have running water in your house?			1533						
Water in house	10.1 (6.8,14.1)	9.6 (7.6,11.9)	.	(ref)	(ref)		(ref)	(ref)	
No water in house	15.7 (10.0,23.0)	12.5 (9.3,16.4)	.	1.58 (0.66,3.78)	1.32 (0.72,2.42)	0.83 (0.34,2.03)	5.8 (-6.4,17.9)	3.0 (-3.8,9.8)	-2.8 (-15.1,9.6)
Do you use a wood-burning stove or fireplace?			1526						
No	11.5 (8.0,15.9)	11.7 (9.3,14.3)	.	(ref)	(ref)		(ref)	(ref)	
Yes	12.7 (7.7,19.3)	8.9 (6.3,12.0)	.	1.10 (0.41,2.90)	0.76 (0.52,1.13)	0.70 (0.26,1.87)	1.1 (-10.8,13.0)	-2.7 (-6.7,1.3)	-3.8 (-15.5,7.8)
Number of smokers in the house?			1532						
None	9.0 (4.9,14.8)	12.2 (9.1,16.0)	.	(ref)	(ref)		(ref)	(ref)	
1-2 smokers	12.5 (8.4,17.7)	9.7 (7.4,12.4)	.	1.36 (0.67,2.76)	0.81 (0.44,1.48)	0.59 (0.32,1.10)	3.3 (-3.4,9.9)	-2.3 (-9.2,4.6)	-5.6 (-12.9,1.8)
3 or more smokers	16.4 (8.2,28.1)	9.7 (5.4,15.8)	.	1.87 (0.71,4.95)	0.86 (0.32,2.32)	0.46 (0.18,1.16)	7.6 (-4.0,19.3)	-1.7 (-11.7,8.3)	-9.4 (-17.8,-0.9)
Count of risk factors ⁵			1525	1.45 (0.78,2.70)	1.00 (0.82,1.21)	0.69 (0.36,1.29)	4.5 (-3.6,12.7)	-0.1 (-2.1,1.9)	-4.6 (-12.9,3.7)
Total	12.2 (9.3,15.7)	10.6 (8.9,12.6)							
Infection-related hearing loss (PTA-based)²									
Number currently living in household			1521	1.13 (0.96,1.32)	0.99 (0.92,1.07)	0.88 (0.73,1.06)	1.3 (-0.2,2.8)	-0.1 (-0.7,0.6)	-1.4 (-3.0,0.3)
Do you have running water in your house?			1521						
Water in house	9.8 (6.5,13.9)	7.8 (6.0,9.9)	.	(ref)	(ref)		(ref)	(ref)	
No water in house	9.1	9.4	.	0.93 (0.57,1.52)	1.20 (0.73,1.95)	1.29 (0.78,2.13)	-0.7 (-5.5,4.1)	1.5 (-2.6,5.6)	2.2 (-2.5,7.0)

	(4.6,15.7)	(6.6,12.8)							
Do you use a wood-burning stove or fireplace?			1514						
No	10.5 (7.0,14.9)	8.8 (6.8,11.2)	.	(ref)	(ref)		(ref)	(ref)	
Yes	8.0 (4.1,13.9)	7.2 (5.0,10.1)	.	0.76 (0.31,1.85)	0.82 (0.52,1.29)	1.07 (0.48,2.41)	-2.5 (-10.7,5.7)	-1.6 (-5.4,2.1)	0.9 (-6.6,8.4)
Number of smokers in the house?			1520						
None	7.2 (3.5,12.9)	9.5 (6.8,12.9)	.	(ref)	(ref)		(ref)	(ref)	
1-2 smokers	11.4 (7.4,16.7)	7.2 (5.2,9.5)	.	1.55 (0.44,5.47)	0.77 (0.41,1.42)	0.49 (0.12,2.02)	4.0 (-5.3,13.4)	-2.2 (-7.7,3.3)	-6.2 (-16.7,4.2)
3 or more smokers	8.6 (2.9,19.0)	9.7 (5.4,15.8)	.	1.21 (0.27,5.30)	1.05 (0.50,2.18)	0.87 (0.25,3.08)	1.5 (-10.5,13.5)	0.4 (-6.7,7.6)	-1.0 (-11.5,9.4)
Count of risk factors ⁵			1513	0.83 (0.49,1.41)	1.05 (0.76,1.45)	1.26 (0.68,2.36)	-1.7 (-6.8,3.4)	0.4 (-2.3,3.0)	2.1 (-3.5,7.7)
Total	10.0 (7.2,13.4)	8.3 (6.8,10.1)							

¹Otoacoustic emission (OAE)-based infection related hearing loss defined as having referral status for OAE screening combined with referral for tympanometry or otoscopic conditions consistent with middle ear disease (missing n=65).

²Pure tone average (PTA)-based infection related hearing loss defined as a pure tone average>25dB on 0.5, 1, 2, and 4kHz air conduction tones, combined with referral for tympanometry or otoscopic conditions consistent with middle ear disease (missing n=96).

³Estimated using modified Poisson with generalized estimating equations with clustering at the community level (n=15) and small sample correction, adjusted for age, sex, and Alaska Native race

⁴Estimated using generalized estimating equations with normal distribution and identity linking, accounting for clustering at the community level (n=15) and small sample correction, adjusted for age, sex, and Alaska Native race

⁵Count of binary indicators for lack of water, wood burning stove/fireplace, and 3+smokers in house (range 0-3)

Supplemental Table 4. Heterogeneous treatment effects analysis for regression estimated prevalence ratios and prevalence differences for environmental associations with infection-related hearing loss, using multiply imputed outcome data¹

Risk factor	Sample prevalence		Obs	Prevalence ratio (95% CI) ⁴			Prevalence difference (95% CI) ⁵		
	Age 3-6	Age 7+		Age 3-6	Age 7+	Interaction	Age 3-6	Age 7+	Interaction
Infection-related hearing loss (OAE-based)²									
Number currently living in household			1594	1.11 (1.02,1.21)	1.03 (0.93,1.14)	0.93 (0.83,1.04)	1.8 (0.2,3.4)	0.4 (-1.0,1.8)	-1.5 (-3.2,0.3)
Do you have running water in your house?			1594						
Water in house	13.1 (9.2,16.9)	10.3 (8.2,12.5)	.	(ref)	(ref)		(ref)	(ref)	
No water in house	21.1 (14.4,27.8)	15.2 (11.5,18.9)	.	1.61 (0.82,3.15)	1.47 (0.90,2.40)	0.91 (0.56,1.48)	8.0 (-4.1,20.0)	4.8 (-1.3,10.9)	-3.2 (-12.1,5.8)
Do you use a wood-burning stove or fireplace?			1587						
No	14.5 (10.4,18.5)	13.1 (10.6,15.6)	.	(ref)	(ref)		(ref)	(ref)	
Yes	18.3 (12.0,24.5)	10.1 (7.3,12.9)	.	1.23 (0.57,2.64)	0.77 (0.54,1.10)	0.63 (0.29,1.37)	3.5 (-9.4,16.3)	-3.0 (-6.7,0.8)	-6.4 (-19.1,6.3)
Number of smokers in the house?			1593						
None	11.6 (6.3,16.8)	13.3 (9.9,16.8)	.	(ref)	(ref)		(ref)	(ref)	
1-2 smokers	17.8 (12.7,22.8)	10.7 (8.2,13.1)	.	1.44 (0.62,3.36)	0.81 (0.42,1.57)	0.56 (0.27,1.15)	5.4 (-5.7,16.5)	-2.5 (-10.9,5.9)	-7.9 (-18.8,3.0)
3 or more smokers	18.0 (8.5,27.5)	13.4 (7.9,18.9)	.	1.55 (0.52,4.66)	1.05 (0.50,2.19)	0.68 (0.27,1.72)	6.4 (-8.8,21.6)	0.6 (-9.2,10.4)	-5.8 (-18.1,6.6)
Count of risk factors ⁵			1586	1.45 (0.92,2.26)	1.11 (0.96,1.29)	0.77 (0.50,1.18)	6.0 (-1.5,13.5)	1.3 (-0.6,3.1)	-4.7 (-11.7,2.3)
Total	16.0 (12.6,19.4)	12.1 (10.2,13.9)	1625						
Infection-related hearing loss (PTA-based)³									
Number currently living in household			1594	1.10 (0.94,1.28)	1.04 (0.90,1.20)	0.94 (0.73,1.22)	1.0 (-0.6,2.6)	0.2 (-0.7,1.1)	-0.8 (-3.0,1.4)
Do you have running water in your house?			1594						
Water in house	9.6 (6.1,13.1)	4.5 (3.0,6.0)	.	(ref)	(ref)		(ref)	(ref)	
No water in house	12.6	6.7 (4.1,9.2)	.	1.33 (0.69,2.57)	1.49 (0.75,2.94)	1.12 (0.50,2.47)	3.0 (-4.6,10.7)	2.1 (-1.6,5.9)	-0.9 (-

Do you use a wood-burning stove or fireplace to cook or help heat the house?	(7.0,18.2)		1587							8.6,6.8)
No	11.1 (7.3,14.9)	5.7 (3.9,7.4)	.	(ref)	(ref)		(ref)	(ref)		
Yes	9.7 (4.6,14.8)	4.6 (2.6,6.5)	.	0.85 (0.37,1.94)	0.82 (0.40,1.65)	0.96 (0.42,2.21)	-1.6 (-10.1,6.8)	-1.0 (-4.7,2.7)		0.6 (-7.1,8.3)
Number of smokers in the house?			1593							
None	8.1 (3.4,12.8)	5.6 (3.3,7.9)	.	(ref)	(ref)		(ref)	(ref)		
1-2 smokers	12.4 (7.9,16.9)	4.4 (2.8,6.1)	.	1.45 (0.51,4.18)	0.80 (0.24,2.63)	0.55 (0.15,1.97)	3.9 (-5.8,13.6)	-1.1 (-7.4,5.2)		-5.0 (-14.5,4.6)
3 or more smokers	10.0 (2.5,17.5)	7.5 (3.2,11.7)	.	1.25 (0.34,4.60)	1.43 (0.47,4.34)	1.15 (0.34,3.89)	1.9 (-10.1,13.8)	2.3 (-5.1,9.7)		0.4 (-9.9,10.7)
Count of risk factors ⁶			1586	1.06 (0.65,1.74)	1.26 (0.83,1.92)	1.19 (0.65,2.17)	0.5 (-4.8,5.9)	1.2 (-0.8,3.3)		0.7 (-4.8,6.2)
Total	10.9 (7.9,14.0)	5.4 (4.1,6.6)	1625							

¹ Multiple imputation by chained equations (MICE) was used to impute the outcome.

² Defined as having referral status for otoacoustic emission (OAE) screening combined with referral for tympanometry or otoscopic conditions consistent with middle ear disease.

³ Defined as having a pure tone average (PTA) of 0.5, 1, 2, 4kHz tones greater than 25dB combined with referral for tympanometry or otoscopic conditions consistent with middle ear disease.

⁴ Estimated using modified Poisson with generalized estimating equations with clustering at the community level (n=15) and small sample correction, adjusted for age, sex, and Alaska Native race

⁵ Estimated using generalized estimating equations with normal distribution and identity linking, accounting for clustering at the community level (n=15) and small sample correction, adjusted for age, sex, and Alaska Native race

⁶ Count of binary indicators for lack of water, wood burning stove/fireplace, and 3+smokers in house (range 0-3)

Supplemental Table 5. Heterogeneous treatment effects analysis for regression estimated prevalence ratios and prevalence differences for environmental associations with middle ear disease¹, using complete case analysis

Variable	Sample prevalence		Obs	Prevalence ratio (95% CI) ²			Prevalence difference (95% CI) ³		
	Age 3-6	Age 7+		Age 3-6	Age 7+	Interaction	Age 3-6	Age 7+	Interaction
How many people currently live in the household?			1564	1.11 (1.03,1.21)	1.02 (0.94,1.11)	0.92 (0.81,1.04)	2.6 (0.7,4.5)	0.3 (-1.0,1.6)	-2.3 (-4.7,0.1)
Do you have running water in your house?			1564						
Water in house	18.7 (14.4,23.6)	13.0 (10.7,15.6)		(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
No water in house	30.3 (22.9,38.5)	19.1 (15.2,23.5)		1.65 (1.03,2.64)	1.48 (0.97,2.27)	0.90 (0.67,1.22)	11.8 (0.0,23.6)	6.2 (-1.0,13.3)	-5.6 (-13.4,2.1)
Do you use a wood-burning stove or fireplace?			1557						
No	22.6 (17.9,27.8)	16.2 (13.5,19.1)		(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
Yes	21.9 (15.5,29.5)	13.2 (10.2,16.8)		0.97 (0.51,1.84)	0.82 (0.64,1.07)	0.85 (0.44,1.63)	-0.6 (-14.8,13.5)	-2.8 (-6.5,0.8)	-2.2 (-16.2,11.8)
Number of smokers in the house?			1563						
None	16.1 (10.6,23.0)	17.8 (14.1,22.1)		(ref)	(ref)	(ref)	(ref)	(ref)	(ref)
1-2 Smokers	26.3 (20.7,32.6)	13.4 (10.8,16.4)		1.59 (0.84,3.03)	0.77 (0.42,1.40)	0.48 (0.27,0.85)	9.8 (-2.1,21.6)	-4.0 (-14.4,6.3)	-13.8 (-25.6,-1.9)
3 or more smokers	23.8 (14.0,36.2)	14.3 (9.1,21.0)		1.52 (0.71,3.25)	0.86 (0.44,1.69)	0.57 (0.32,1.02)	8.1 (-6.7,22.8)	-2.3 (-13.2,8.5)	-10.4 (-21.1,0.3)
Count of risk factors ⁴			1556	1.27 (0.87,1.86)	1.11 (0.88,1.38)	0.87 (0.67,1.13)	5.3 (-3.3,14.0)	1.5 (-1.9,4.9)	-3.8 (-10.3,2.6)
Overall prevalence of middle ear disease	22.7 (18.9,26.9)	15.3 (13.3,17.5)							

¹ Presence of middle ear disease was determined by Type B (flat) or Type C tympanogram (<200 daPa) or positive findings on otoscopy.

² Estimated using modified Poisson with generalized estimating equations with clustering at the community level (n=15) and small sample correction, adjusted for age, sex, and Alaska Native race

³ Estimated using generalized estimating equations with normal distribution and identity linking, accounting for clustering at the community level (n=15) and small sample correction, adjusted for age, sex, and Alaska Native race

⁴ Count of binary indicators for lack of water, wood burning stove/fireplace, and 3+smokers in house (range 0-3)

Supplemental Table 6. Heterogeneous treatment effects analysis for regression estimated prevalence ratios and prevalence differences for environmental associations with middle ear disease¹, using multiply imputed outcome data²

Risk factor	Sample prevalence (n=1625)		Obs	Prevalence ratio (95% CI) ³			Prevalence difference (95% CI) ⁴		
	Age 3-6	Age 7+		Age 3-6	Age 7+	Interaction	Age 3-6	Age 7+	Interaction
Number currently living in household			1594	1.10 (1.01,1.19)	1.02 (0.94,1.11)	0.93 (0.83,1.04)	2.3 (0.4,4.3)	0.3 (-0.9,1.6)	-2.0 (-4.4,0.4)
Do you have running water in your house?			1594						
Water in house	19.4 (14.9,23.8)	12.7 (10.4,15.1)	.	(ref)	(ref)		(ref)	(ref)	
No water in house	31.7 (24.0,39.3)	19.7 (15.6,23.7)	.	1.64 (1.03,2.61)	1.55 (1.02,2.36)	0.95 (0.67,1.33)	12.3 (-0.0,24.6)	6.9 (-0.3,14.2)	-5.4 (-14.0,3.3)
Do you use a wood-burning stove or fireplace?			1587						
No	23.7 (18.8,28.6)	16.3 (13.6,19.1)	.	(ref)	(ref)		(ref)	(ref)	
Yes	22.3 (15.6,29.0)	13.0 (9.8,16.1)	.	0.92 (0.48,1.74)	0.80 (0.59,1.09)	0.88 (0.44,1.75)	-2.0 (-16.7,12.8)	-3.2 (-7.6,1.2)	-1.2 (-16.3,13.9)
Number of smokers in the house?			1593						
None	16.3 (10.4,22.3)	17.4 (13.6,21.2)	.	(ref)	(ref)		(ref)	(ref)	
1-2 smokers	27.4 (21.6,33.3)	13.4 (10.7,16.1)	.	1.58 (0.84,2.96)	0.77 (0.40,1.51)	0.49 (0.27,0.89)	9.9 (-2.2,22.1)	-3.8 (-15.2,7.5)	-13.8 (-26.4,-1.1)
3 or more smokers	25.7 (15.0,36.4)	15.1 (9.4,20.9)	.	1.57 (0.75,3.29)	0.92 (0.43,1.95)	0.58 (0.30,1.13)	9.2 (-5.6,24.1)	-1.4 (-13.7,11.0)	-10.6 (-22.9,1.7)
Count of risk factors ⁵			1586	1.25 (0.84,1.86)	1.13 (0.92,1.40)	0.90 (0.68,1.20)	5.3 (-4.4,14.9)	1.9 (-1.4,5.1)	-3.4 (-11.0,4.2)
Total	23.6 (19.7,27.5)	15.3 (13.2,17.4)	1625						

¹ Presence of middle ear disease was determined by Type B (flat) or Type C tympanogram (<-200 daPa) or positive findings on otoscopy.

² Multiple imputation by chained equations (MICE) was used to impute the outcome.

³ Estimated using modified Poisson with generalized estimating equations with clustering at the community level (n=15) and small sample correction, adjusted for age, sex, and Alaska Native race

⁴ Estimated using generalized estimating equations with normal distribution and identity linking, accounting for clustering at the community level (n=15) and small sample correction, adjusted for age, sex, and Alaska Native race

⁵ Count of binary indicators for lack of water, wood burning stove/fireplace, and 3+smokers in house (range 0-3)

Supplemental Table 7. Sociodemographic characteristics of children with at least one ear with valid OAE- and PTA-based infection-related hearing loss outcome data vs. those with no valid data for each outcome

	OAE-based infection-related hearing loss ¹		PTA-based infection-related hearing loss ²		Middle ear disease ³	
	Missing (N = 65)	Complete (N = 1569)	Missing (N = 96)	Complete (N = 1538)	Missing (N = 34)	Complete (N = 1600)
How many people currently live in household						
Mean (SD)	6.43 (2.64)	6.34 (2.48)	6.49 (2.74)	6.34 (2.46)	6.66 (3.27)	6.34 (2.46)
Median (Q1, Q3)	6.0 (5.0, 7.0)	6.0 (5.0, 7.0)	6.0 (5.0, 7.0)	6.0 (5.0, 7.0)	6.0 (5.0, 8.0)	6.0 (5.0, 7.0)
N (% Missing)	63 (3.1%)	1538 (2.0%)	93 (3.1%)	1508 (2.0%)	32 (5.9%)	1569 (1.9%)
Child Age Range						
3-6	23 (42.6%)	426 (27.2%)	55 (64.7%)	394 (25.7%)	9 (39.1%)	440 (27.6%)
7-9	10 (18.5%)	394 (25.2%)	13 (15.3%)	391 (25.5%)	5 (21.7%)	399 (25.0%)
10-12	6 (11.1%)	325 (20.8%)	8 (9.4%)	323 (21.1%)	3 (13.0%)	328 (20.6%)
13-15	10 (18.5%)	231 (14.8%)	8 (9.4%)	233 (15.2%)	5 (21.7%)	236 (14.8%)
16+	5 (9.3%)	188 (12.0%)	1 (1.2%)	192 (12.5%)	1 (4.3%)	192 (12.0%)
Missing	11	5	11	5	11	5
Child's age						
Mean (SD)	8.93 (4.38)	9.73 (4.13)	6.48 (3.64)	9.88 (4.09)	8.74 (4.16)	9.72 (4.14)
Median (Q1, Q3)	7.5 (5.0, 13.0)	9.0 (6.0, 13.0)	5.0 (4.0, 8.0)	9.0 (6.0, 13.0)	8.0 (5.0, 13.0)	9.0 (6.0, 13.0)
Child's sex						
Male	34 (52.3%)	824 (52.5%)	50 (52.1%)	808 (52.5%)	18 (52.9%)	840 (52.5%)
Female	31 (47.7%)	745 (47.5%)	46 (47.9%)	730 (47.5%)	16 (47.1%)	760 (47.5%)
Race						
Non-Native	2 (3.1%)	69 (4.4%)	7 (7.3%)	64 (4.2%)	2 (5.9%)	69 (4.3%)
Alaska Native/American Indian	63 (96.9%)	1500 (95.6%)	89 (92.7%)	1474 (95.8%)	32 (94.1%)	1531 (95.7%)
Grade Level						
ECE	8 (12.3%)	145 (9.2%)	40 (41.7%)	113 (7.3%)	4 (11.8%)	149 (9.3%)
K-5	35 (53.8%)	830 (52.9%)	40 (41.7%)	825 (53.6%)	20 (58.8%)	845 (52.8%)
6-8	12 (18.5%)	306 (19.5%)	12 (12.5%)	306 (19.9%)	6 (17.6%)	312 (19.5%)
9-12	10 (15.4%)	288 (18.4%)	4 (4.2%)	294 (19.1%)	4 (11.8%)	294 (18.4%)

Highest education level of any caregiver						
<12 grade	3 (4.8%)	90 (5.9%)	4 (4.3%)	89 (5.9%)	1 (3.2%)	92 (5.9%)
HS Diploma or GED	45 (72.6%)	982 (64.1%)	66 (71.7%)	961 (63.9%)	21 (67.7%)	1006 (64.3%)
Some College	9 (14.5%)	311 (20.3%)	14 (15.2%)	306 (20.4%)	6 (19.4%)	314 (20.1%)
College Degree	5 (8.1%)	150 (9.8%)	8 (8.7%)	147 (9.8%)	3 (9.7%)	152 (9.7%)
Missing	3	36	4	35	3	36
Do you have running water in your house?						
Water in house	38 (60.3%)	1043 (67.8%)	52 (55.9%)	1029 (68.2%)	22 (68.8%)	1059 (67.5%)
No water in house	25 (39.7%)	495 (32.2%)	41 (44.1%)	479 (31.8%)	10 (31.3%)	510 (32.5%)
Missing	2	31	3	30	2	31
Do you use a wood-burning stove or fireplace?						
No	44 (69.8%)	957 (62.5%)	62 (66.7%)	939 (62.6%)	19 (59.4%)	982 (62.9%)
Yes	19 (30.2%)	574 (37.5%)	31 (33.3%)	562 (37.4%)	13 (40.6%)	580 (37.1%)
Missing	2	38	3	37	2	38
Number of smokers in the house?						
None	27 (42.9%)	514 (33.4%)	35 (37.6%)	506 (33.6%)	15 (46.9%)	526 (33.5%)
1-2 Smokers	27 (42.9%)	817 (53.2%)	43 (46.2%)	801 (53.2%)	13 (40.6%)	831 (53.0%)
3 or more smokers	9 (14.3%)	206 (13.4%)	15 (16.1%)	200 (13.3%)	4 (12.5%)	211 (13.5%)
Missing	2	32	3	31	2	32
Count of risk factors ⁴						
0	20 (31.7%)	502 (32.8%)	24 (25.8%)	498 (33.2%)	11 (34.4%)	511 (32.7%)
1	34 (54.0%)	796 (52.0%)	53 (57.0%)	777 (51.8%)	15 (46.9%)	815 (52.2%)
2	8 (12.7%)	220 (14.4%)	14 (15.1%)	214 (14.3%)	6 (18.8%)	222 (14.2%)
3	1 (1.6%)	12 (0.8%)	2 (2.2%)	11 (0.7%)	0 (0.0%)	13 (0.8%)
Missing		39	3	38	2	39

ECE: Early Childhood Education; GED: General Education Development

¹Otoacoustic emission (OAE)-based infection related hearing loss defined as having referral status for OAE screening combined with referral for tympanometry or otoscopic conditions consistent with middle ear disease.

²Pure tone average (PTA)-based infection related hearing loss defined as a pure tone average >25dB on 0.5, 1, 2, and 4kHz air conduction tones, combined with referral for tympanometry or otoscopic conditions consistent with middle ear disease.

³Presence of middle ear disease was determined by Type B (flat) or Type C tympanogram (<-200 daPa) or positive findings on otoscopy.

⁴Count of binary indicators for lack of water, wood burning stove/fireplace, and 3+smokers in house (range 0-3)

Supplemental Table 8. Bivariate associations between missingness in environmental correlates and ear/hearing status

	OAE-based infection related hearing loss ¹			PTA-based infection-related hearing loss ²			Middle ear disease ³		
	No (N = 1395)	Yes (N = 174)	p-value ⁴	No (N = 1443)	Yes (N = 95)	p-value ⁴	No (N = 1322)	Yes (N = 278)	p-value ⁴
Covariate									
Child's age			0.445			1			1
Missing	4 (0.3%)	1 (0.6%)		5 (0.3%)	0 (0.0%)		4 (0.3%)	1 (0.4%)	
Complete	1391 (99.7%)	173 (99.4%)		1438 (99.7%)	95 (100.0%)		1318 (99.7%)	277 (99.6%)	
Highest education level of any caregiver			0.109			0.06			0.023
Missing	29 (2.1%)	7 (4.0%)		30 (2.1%)	5 (5.3%)		24 (1.8%)	12 (4.3%)	
Complete	1366 (97.9%)	167 (96.0%)		1413 (97.9%)	90 (94.7%)		1298 (98.2%)	266 (95.7%)	
How many people currently live in household			0.145			0.034			0.05
Missing	25 (1.8%)	6 (3.4%)		25 (1.7%)	5 (5.3%)		21 (1.6%)	10 (3.6%)	
Complete	1370 (98.2%)	168 (96.6%)		1418 (98.3%)	90 (94.7%)		1301 (98.4%)	268 (96.4%)	
Do you have running water in your house?			0.145			0.034			0.05
Missing	25 (1.8%)	6 (3.4%)		25 (1.7%)	5 (5.3%)		21 (1.6%)	10 (3.6%)	
Complete	1370 (98.2%)	168 (96.6%)		1418 (98.3%)	90 (94.7%)		1301 (98.4%)	268 (96.4%)	
Do you use a wood-burning stove or fireplace?			0.303			0.073			0.079
Missing	32 (2.3%)	6 (3.4%)		32 (2.2%)	5 (5.3%)		27 (2.0%)	11 (4.0%)	
Complete	1363 (97.7%)	168 (96.6%)		1411 (97.8%)	90 (94.7%)		1295 (98.0%)	267 (96.0%)	
Number of smokers in the house?			0.157			0.038			0.055
Missing	26 (1.9%)	6 (3.4%)		26 (1.8%)	5 (5.3%)		22 (1.7%)	10 (3.6%)	
Complete	1369 (98.1%)	168 (96.6%)		1417 (98.2%)	90 (94.7%)		1300 (98.3%)	268 (96.4%)	
Count of risk factors ⁵			0.433			0.08			0.085
Missing	33 (2.4%)	6 (3.4%)		33 (2.3%)	5 (5.3%)		28 (2.1%)	11 (4.0%)	
Complete	1362 (97.6%)	168 (96.6%)		1410 (97.7%)	90 (94.7%)		1294 (97.9%)	267 (96.0%)	

¹Otoacoustic emission (OAE)-based infection related hearing loss defined as having referral status for OAE screening combined with referral for tympanometry or otoscopic conditions consistent with middle ear disease (missing n=65).

² Pure tone average (PTA)-based infection related hearing loss defined as a pure tone average >25dB on 0.5, 1, 2, and 4kHz air conduction tones, combined with referral for tympanometry or otoscopic conditions consistent with middle ear disease (missing n=96).

³ Presence of middle ear disease was determined by Type B (flat) or Type C tympanogram (<-200 daPa) or positive findings on otoscopy (missing n=34).

⁴ P-values computed using a Fisher's exact test due to expected cell sizes <5

⁵ Count of binary indicators for lack of water, wood burning stove/fireplace, and 3+smokers in house (range 0-3)

Supplemental Table 9. Distribution of missing covariate data by age¹

	Age 3-6 (N = 449)	Age 7+ (N = 1169)	p-value ²
Highest education level of any caregiver			0.138
Missing	6 (1.3%)	31 (2.7%)	
Complete	443 (98.7%)	1138 (97.3%)	
How many people currently live in household?			0.069
Missing	4 (0.9%)	27 (2.3%)	
Complete	445 (99.1%)	1142 (97.7%)	
Do you have running water in your house?			0.069
Missing	4 (0.9%)	27 (2.3%)	
Complete	445 (99.1%)	1142 (97.7%)	
Do you use a wood-burning stove or fireplace?			0.102
Missing	6 (1.3%)	32 (2.7%)	
Complete	443 (98.7%)	1137 (97.3%)	
Number of smokers in the house?			0.070
Missing	4 (0.9%)	28 (2.4%)	
Complete	445 (99.1%)	1141 (97.6%)	
Count of risk factors ³			0.102
Missing	6 (1.3%)	33 (2.8%)	
Complete	443 (98.7%)	1136 (97.2%)	

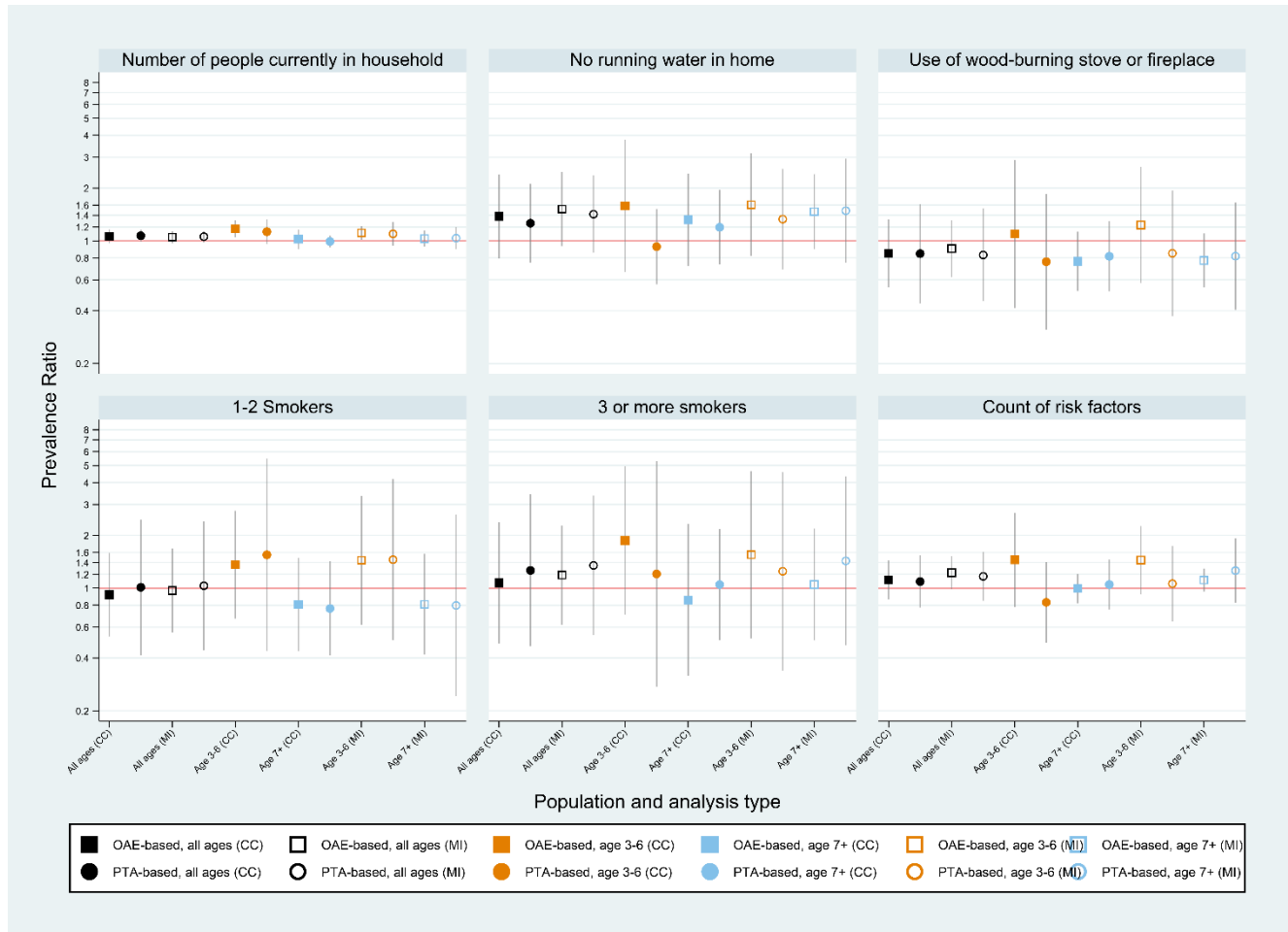
¹ n=16 children had missing values for age

² All p-values computed using Fisher's exact test due to low expected cell sizes

³ Count of binary indicators for lack of water, wood burning stove/fireplace, and 3+smokers in house (range 0-3)

SUPPLEMENTAL FIGURES

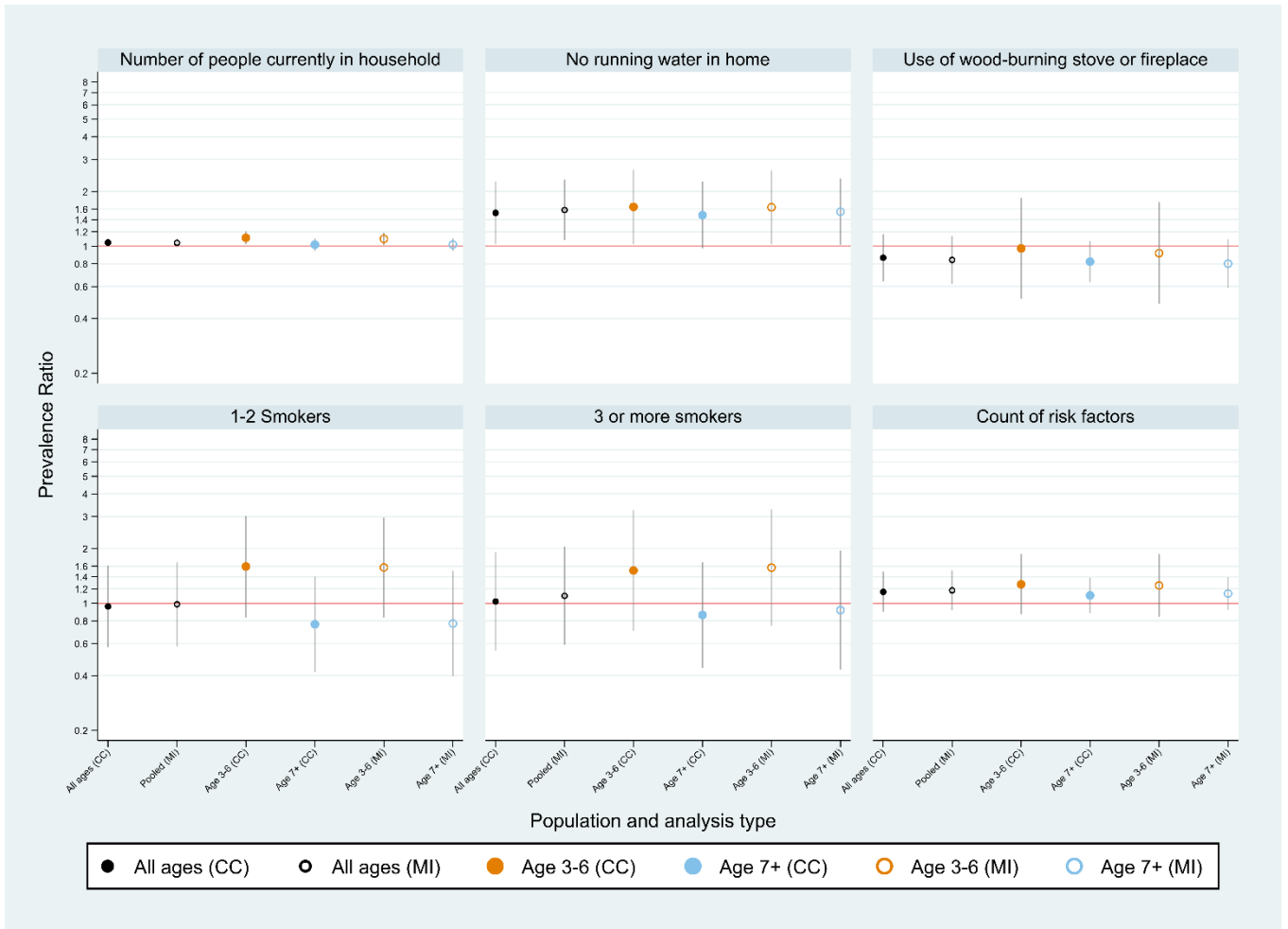
Supplemental Figure 1. Estimated prevalence ratios¹ for risk factors associated with OAE- and PTA-based infection-related hearing loss for all ages and by age group (3-6 vs. 7+), using complete case and outcome imputed regression estimates².



¹ Axes scaled on linearized log estimates with axes labeled with corresponding prevalence ratio

² Multiple imputation by chained equations (MICE) was used to impute the outcome.

Supplemental Figure 2. Estimated prevalence ratios¹ for risk factors associated with middle ear disease for all ages and by age group (3-6 vs. 7+), using complete case and outcome imputed regression estimates²



¹ Axes scaled on linearized log estimates with axes labeled with corresponding prevalence ratio

² Multiple imputation by chained equations (MICE) was used to impute the outcome.