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Unilateral Hearing Loss Is Associated With Worse Speech-Language Scores in Children

Judith E. C. Lieu, Nancy Tye-Murray, Roanne K. Karzon and Jay F. Piccirillo

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WHAT'S KNOWN ON THIS SUBJECT: Although BHL has been known to cause speech-language and academic delays, as well as lower rates of literacy and high school graduation, the effects of UHL on a child's speech-language development and academic achievement have not been well documented.

WHAT THIS STUDY ADDS: Results of our study demonstrate that elementary school-aged children with UHL have significantly worse oral language scores than do their siblings with NH. The common practice of withholding hearing-related accommodations from children with UHL should be reconsidered and studied.

abstract

OBJECTIVE: To determine whether children with unilateral hearing loss (UHL) demonstrate worse language skills than their siblings with normal hearing, and whether children with UHL are more likely to receive extra assistance at school.

PATIENTS AND METHODS: We conducted a case-control study of 6- to 12-year-old children with UHL compared with sibling controls (74 pairs, $n = 148$). Scores on the oral portion of the Oral and Written Language Scales (OWLS) were the primary outcome measure. Multivariable analysis was used to determine whether UHL independently predicted OWLS scores after we controlled for potential confounding variables.

RESULTS: Children with UHL had worse scores than their siblings on language comprehension (91 vs 98; $P = .003$), oral expression (94 vs 101; $P = .007$), and oral composite (90 vs 99; $P < .001$). UHL independently predicted these OWLS scores when multivariable regression was used with moderate effect sizes of 0.3 to 0.7. Family income and maternal education were also independent predictors of oral expression and oral composite scores. No differences were found between children with right- or left-ear UHL or with varying severity of hearing loss. Children with UHL were more likely to have an individualized education plan (odds ratio: 4.4 [95% confidence interval: 2.0–9.5]) and to have received speech-language therapy (odds ratio: 2.6 [95% confidence interval: 1.3–5.4]).

CONCLUSIONS: School-aged children with UHL demonstrated worse oral language scores than did their siblings with normal hearing. These findings suggest that the common practice of withholding hearing-related accommodations from children with UHL should be reconsidered and studied, and that parents and educators should be informed about the deleterious effects of UHL on oral language skills. *Pediatrics* 2010;125:e1348–e1355

AUTHORS: Judith E. C. Lieu, MD,[a] Nancy Tye-Murray, PhD,[a] Roanne K. Karzon, PhD,[a,b] and Jay F. Piccirillo, MD[a]

[a]Department of Otolaryngology—Head and Neck Surgery, Washington University School of Medicine, St Louis, Missouri; and [b]Center for Communication Disorders, St Louis Children's Hospital, St Louis, Missouri

KEY WORDS

unilateral hearing loss, children, speech or language delay, health status disparities

ABBREVIATIONS

UHL—unilateral hearing loss
BHL—bilateral hearing loss
NH—normal hearing
HL—hearing level
PTA—pure tone average
FPL—federal poverty level
OWLS—Oral and Written Language Scales
LC—listening comprehension
OE—oral expression
OC—oral composite
WR—word recognition
WRS—world recognition score
IEP—individualized educational plan
OR—odds ratio
CI—confidence interval
BAHA—bone-anchored hearing system

Drs Lieu, Murray, and Piccirillo came up with the study concept and design; Drs Lieu and Karzon acquired the data; Dr Lieu analyzed and interpreted the data, drafted the manuscript, provided statistical analysis, obtained funding, and supervised the study; Drs Lieu, Karzon, Murray, and Piccirillo critically revised the manuscript; and Drs Lieu, Karzon, Murray, and Piccirillo provided administrative, technical, and material support.

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Address correspondence to Judith E. C. Lieu, MD, 660 S Euclid Ave, Campus Box 8115, St Louis, MO 63110. E-mail: lieuj@wustl.edu

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Unilateral hearing loss (UHL) in children affects 0.4 to 34 per 1000 newborns and 1 to 50 per 1000 school-aged children.[1–4] Although bilateral hearing loss (BHL) in children has been known to cause speech-language delays, delays in academic achievement, and lower rates of literacy and high school graduation, the effects of UHL on a child's speech-language development and academic achievement have not been well documented. In small studies from the 1980s and 1990s, it was suggested that compared with peers with normal hearing (NH), children with UHL experienced increased rates of grade failures (24%–35% vs 3% in the NH population), needed extra educational assistance (12%–41%), and had increased behavioral problems.[5–8] However, these studies were often uncontrolled or poorly controlled (there were more cases than controls) or had significant selection biases (there were unclear reasons for inclusion or a lack of data on all children). Although quality of life has not been directly assessed in children with UHL, adults with UHL have expressed negative psychosocial effects of UHL, such as decreased quality of life; feelings of frustrations, embarrassment, and annoyance; and increased hearing handicap.[9,10] Considerable biases may have affected the outcome of these studies, and little has been done to determine whether children with UHL were indeed at risk for problems in school, independent of potential confounding factors.[11] As a result, health and education professionals have often discounted the effect of UHL on a child's speech and language acquisition or academic achievement.

Limited information exists about the effect of UHL on acquisition of speech and language skills in infants and toddlers. Kiese-Himmel[12] reported that the average age of the first word spoken was 12.7 months (range: 10–33 months) and the average age of the first 2-word phrase was 23.5 months (range: 18–48 months). Although the age of the first word uttered was not delayed, the average age of the first 2-word phrase was delayed an average of 5 months on the basis of a norm of 18 months. Results were reported on 15 children with UHL in the Colorado Home Intervention Program reported who were followed since infancy.[13] Their speech and language skills were assessed when the children were at least 12 months old. None had another known disability, but 4 (27%) had significant language delays, and 1 (7%) had a borderline language delay.

Three studies have examined language skills in preschool- or school-aged children. In 1 longitudinal study, 44 children with severe UHL at 7 and 11 years of age were evaluated.[14] Although these children had a higher proportion of speech difficulties and "backwardness in oral ability and reading," only 4 children still had poor speech intelligibility at 11 years, and their reading scores were similar to their NH peers. However, at least 13 of the 44 children had temporary hearing loss. Among 25 children aged 6 to 13 with UHL, there were few differences from NH controls on a battery of standardized language tests.[15] In contrast, in a Swedish study, children aged 4 to 6 with UHL had delayed language development compared with their NH peers.[16]

Other risk factors for educational delay may be extrapolated from studies of children with BHL. For young children who are deaf or hard-of-hearing, the level of parental involvement and age at enrollment into a comprehensive intervention program were most strongly associated with speech and language outcomes at age 5.[17] In children with cochlear implants, reading competence was associated with higher nonverbal intelligence, higher socioeconomic status, female gender, and later onset of deafness (after birth).[18] In addition, speech production and language skills predicted the greatest amount of variance in the reading outcome, which suggests that avoiding speech and language delay is associated with improved prognosis for developing literacy. Thus, variables related to the child, family, and socioeconomic status may affect speech and language development, reading competence, and thereby educational achievement.

The purpose of this study was to determine whether a large sample of elementary school-aged children with UHL demonstrated significantly worse language skills than did their sibling controls with NH. Using sibling controls minimized the confounding effects of family and environment on the development of language skills.

METHODS

Institutional review board approval through the Human Research Protection Office at Washington University School of Medicine was obtained before the onset of this study. All parent and child participants signed written informed-consent and pediatric assent forms, respectively.

We conducted a case-control study of children with UHL compared with sibling controls with NH.

Participants With Hearing Loss (Cases)

Children aged 6 to 12 were recruited from the pediatric otolaryngology clinics at St Louis Children's Hospital and Washington University School of Medicine and several regional school districts: St Louis City Public Schools, Special School District of St Louis County, and the Belleville Area Special Services Cooperative (Illinois). Children from the school districts were identified through hearing screening programs or audiology testing associated with

the school districts and not as a result of receiving special services.

Inclusion Criteria

Children were eligible if they had UHL, defined as an average threshold of any 3 consecutive frequencies of ≥30-dB hearing level (HL) in the affected ear. NH in the other ear was defined as a pure tone average (PTA) threshold of 500, 1000, and 2000 Hz < 20 dB HL and a threshold of 4000 Hz < 30 dB. The hearing loss had to be sensorineural or mixed/conductive hearing loss considered "permanent."

Exclusion Criteria

Children were excluded if they had temporary or fluctuating conductive hearing loss or had a medical diagnosis associated with cognitive impairment (eg, Down syndrome or congenital cytomegalovirus infection) or cognitive impairment per parental report.

Participants Without Hearing Loss (Controls)

Control subjects were eligible if they were siblings of participants with UHL, 6 to 12 years old, had NH in both ears, and did not meet any of the exclusion criteria listed above.

Demographic and Baseline Variables

Subjects' demographic information, parental socioeconomic data, current and past medical history, and educational history were obtained through a parental questionnaire and interview. Subjects' percentage of the federal poverty level (FPL) was calculated by using family size and income.[19] The percentage of FPL was then categorized into 3 levels: <100% of FPL; 100% to 200% FPL; and >200% FPL.

Outcome Variables

Patient scores on the oral portion of the Oral and Written Language Scales (OWLS) were the primary outcome for this analysis. The listening comprehension (LC) scale measures understanding of spoken language. The oral expression (OE) scale measures understanding and use of spoken language. The oral composite (OC) scale combines the LC and OE scores into a single overall score. The scaled scores are normed to have a mean of 100 and an SD of 15.[20] Cognitive ability was measured by using the Wechsler Abbreviated Scale of Intelligence, which provided the 3 traditional verbal, performance, and full-scale IQ scores.[21]

Hearing outcomes were measured in a sound-treated booth. PTAs were calculated as the average of 500, 1000, 2000, and 4000 Hz. Severity of hearing loss in the worse ear was categorized as mild if the PTA was <40-dB HL; moderate if the PTA was 40 to 69 dB HL; severe if the PTA was 70- to 89-dB HL; and profound if the PTA was ≥90-dB HL. Word-recognition scores (WRS) were obtained monaurally in quiet using Central Institute for the Deaf W-22 word lists through headphones at 40 dB above the speech-reception threshold or the participant's most comfortable loudness level. WRS in noise using Central Institute for the Deaf W-22 word lists were obtained through soundfield testing at 5- and 0-dB signal-to-noise ratios, with noise consisting of recorded 8-talker speech babble.

Secondary outcomes recorded included parents' report of speech-language delay or problems, receipt of speech-language therapy, and provision of individualized educational plans (IEPs) or Section 504c accommodations for hearing disability at school.

Analysis

Descriptive statistics were obtained for each group and included means and SDs, medians and interquartile ranges, and frequency counts. With bivariate analyses, we examined speech-language score outcomes associated with patient demographic, baseline clinical, and risk factor variables. A Student's t test or 1-way analysis of variance was used for continuous variables. A χ^2 or Fisher's exact test was used for categorical variables. Bivariate analysis of other outcomes involved calculating the odds ratio (OR) and 95% confidence interval (CI). A 2-tailed α level of .05 was considered statistically significant.

Multivariable linear regression was used to control for the effect of multiple independent predictors of OWLS scores. Variables with a bivariate P value of <.25 were candidates for selection into multivariable regression models to reduce type II (or β) error.[22] Final multivariable models were developed to maximize the adjusted model R^2 and include predictor variables with partial R^2 values of ≤0.01. Models were checked for interactions and influence, and plots of residuals were examined. Statistical analysis was performed by using SAS 9.1.3 (SAS Institute, Inc, Cary, NC).

RESULTS

Seventy-four pairs of case-control siblings (148 subjects) were included in the analysis. Characteristics of the children with UHL and their families are shown in Table 1. The majority had profound UHL, and the greatest proportion was identified via preschool or school screening. Other ways that UHL was identified included clinical suspicion of hearing loss, such as after head trauma or meningitis. The mean age of identification of UHL was 4.7 years (SD: 2.6). Hearing loss was deemed "congenital" if it was identified through a newborn hearing screening or attributed to temporal bone abnormalities found on computed tomography or MRI. None had syndromic hearing loss. UHL had progressed in 15% of the sub-

TABLE 1 Characteristics of 74 Children With UHL (Cases) and Their Families

Characteristic ($N = 74$)	*n* (%)
Children with UHL	
Right-side hearing loss	44 (59)
Severity of hearing loss	
Mild	4 (5)
Moderate	15 (20)
Severe	11 (15)
Profound	44 (59)
Identification of hearing loss	
Preschool or school screening	28 (38)
Parental suspicion	12 (16)
Screening by primary care provider	8 (11)
Audiogram for ear infections	7 (9)
Newborn hearing screening	5 (7)
Other	14 (19)
Etiology of hearing loss	
Congenital	28 (38)
Trauma	5 (7)
Meningitis	2 (3)
Unknown	32 (43)
Trial of amplification	
FM system	22 (30)
Hearing aid	4 (6)
CROS aid	3 (4)
BAHA	3 (4)
Participating families	
Race/ethnicity	
White	59 (80)
Black	9 (12)
Hispanic	5 (6)
Asian	3 (4)
Estimated family income, $	
<40 000	23 (31)
40 000–100 000	27 (36)
>100 000	24 (32)
Health insurance	
Public (Medicaid)	18 (24)
Private	55 (75)
Both public and private	1 (1)
Maternal education	
Did not graduate high school	4 (6)
High school graduate or GED	9 (12)
Some college or associate's degree	28 (37)
Bachelor's degree or higher	33 (45)

CROS indicates contralateral routing of signals; GED, general equivalency diploma.

TABLE 2 Demographic, Educational, and Medical History Characteristics of 74 Children With UHL (Cases) Compared With 74 Siblings With NH (Controls)

Characteristic	Cases	Controls	*P*
Mean (SD) age, y	8.8 (1.8)	9.1 (2.4)	.33
Male gender, *n* (%)	38 (51)	40 (54)	.87
Adopted, *n* (%)	6 (8)	6 (8)	.99
Firstborn, *n* (%)	25 (34)	30 (41)	.60
Repeated grade, *n* (%)	8 (11)	4 (5)	.37
Mean (SD) age of first word, mo	10.8 (4.2)	10.0 (4.4)	.24
Mean (SD) age of first 2-word phrase, mo	17.8 (8.8)	15.3 (8.3)	.13
Received speech therapy, *n* (%)	31 (42)	16 (22)	.01
IEP/504 plans, *n* (%)	34 (46)	12 (16)	<.01
School-related behavioral problems, *n* (%)	23 (31)	19 (26)	.58
Full scale IQ, mean (SD)	101.9 (17.2)	103.8 (17.3)	.42
Verbal IQ, mean (SD)	102.6 (15.0)	104.3 (14.8)	.50
Performance IQ, mean (SD)	100.8 (13.8)	102.5 (14.9)	.46
Premature birth, *n* (%)	14 (19)	10 (14)	.97
History of head trauma, *n* (%)	14 (19)	4 (5)	.02
History of recurrent otitis media, *n* (%)	22 (30)	18 (24)	.58
Received tympanostomy tubes, *n* (%)	24 (32)	17 (23)	.27
Attention deficit hyperactivity disorder, *n* (%)	8 (11)	6 (8)	.78

jects. Fewer than half of the subjects had trialed amplification and/or assistive devices, and some had tried more than 1 option. Twelve percent of families had incomes below the 2005 FPL.

Other demographic and baseline characteristics of the subjects are shown in Table 2. No demographic or cognitive differences existed between children in the case and control cohorts. Only 1 child, a control, had a full-scale IQ of <70; none had performance IQs of <70. More children with UHL suffered head trauma (OR: 4.1 [95% CI: 1.3–13.1]), received speech therapy (OR: 2.6 [95% CI: 1.3–5.4]), and had an IEP or Section 504c accommodations (OR: 4.4 [95% CI: 2.0–9.5]). No differences in neonatal risk factors for hearing loss[23] were identified, including a history of jaundice or hyperbilirubinemia, NICU admission, ventilator or extracorporeal membrane oxygenation use, intravenous antibiotics, or persistent pulmonary hypertension of the newborn (data not shown). In addition, the proportions of children who had a history of recurrent otitis media and tympanostomy tubes, attention-deficit/hyperactivity disorder, and school-related behavioral problems (ie, inattention, disruptive behavior, social isolation, or another teacher-identified problem) were not significantly different.

The bivariate effect of UHL and potential confounders on the OWLS scores are shown in Table 3. Children with UHL had lower scores on all 3 OWLS scores. Race/ethnicity, gender, and income level did not have a significant effect on LC; however, all 3 affected OE scores, and race/ethnicity and income level affected OC scores significantly. No differences in the OWLS scores were found between children with right- or left-ear UHL or with severity of hearing loss. No differences in risk factors for speech or language delay[24] were identified, including a child's birth order, whether he or she was born with very low birth weight, or whether the child had a history of tympanostomy tubes (data not shown).

Table 4 shows the persistent, independent negative effect of UHL on the OWLS scores after adjustment for confounding variables by using multivariable linear regression. UHL was associated with a 10.8-point decrement in LC, a 4.1-point decrement in OE, and a 5.7-point decrement in OC scores. The difference in scores translated to effect sizes of 0.3 to 0.7, or small-to-moderate effects. Severity of UHL accounted for >1% of the total variance for only LC scores. The multivariable models accounted for 34% to 61% of the total variance in scores.

In addition to UHL, the socioeconomic variables of income level and maternal education were significantly associated with OE and OC scores. Because

TABLE 3 Bivariate Analysis of the Effect of Case (Child With UHL) or Control (Sibling With NH) Status and Other Potential Confounders on OWLS Scores in 148 Children Aged 6 to 12 Years

	LC, Mean (SD)	OE, Mean (SD)	OC, Mean (SD)
UHL	[a]	[b]	[a]
No (control)	97.2 (14.1)	99.8 (19.4)	98.2 (16.2)
Yes (case)	91.3 (10.8)	93.6 (16.0)	90.7 (13.2)
Race/ethnicity		[c]	[a]
White	95.3 (13.0)	99.8 (16.5)	96.6 (14.7)
Black	91.1 (10.5)	81.2 (17.8)	84.8 (13.1)
Other	88.8 (13.2)	89.8 (19.5)	88.3 (16.4)
Gender		[d]	
Male	94.1 (13.4)	93.8 (19.0)	92.6 (16.1)
Female	94.4 (12.3)	99.9 (16.3)	96.5 (14.0)
Percent of FPL		[a]	[a]
<100	93.3 (7.6)	88.6 (12.1)	87.0 (12.6)
100–200	91.2 (13.7)	84.5 (20.0)	86.9 (16.2)
>200	94.8 (13.4)	99.5 (17.6)	96.5 (14.9)
Hearing loss severity (worse ear)			
None	97.1 (14.2)	99.5 (19.4)	98.0 (16.2)
Mild	89.4 (6.1)	94.8 (12.3)	91.2 (8.2)
Moderate	89.9 (11.3)	100.0 (21.3)	90.9 (20.1)
Severe	93.3 (8.4)	92.8 (11.1)	91.5 (8.1)
Profound	91.8 (11.7)	92.2 (15.7)	90.9 (12.5)
Side of hearing loss			
Right	91.6 (11.4)	93.8 (14.3)	90.4 (13.0)
Left	90.9 (10.0)	93.4 (18.4)	91.1 (13.8)
History of recurrent otitis media			
No	93.7 (12.5)	95.7 (17.8)	93.4 (14.7)
Yes	95.9 (13.7)	99.5 (18.4)	97.2 (16.2)
History of head trauma			
No	94.0 (12.9)	96.5 (18.1)	94.6 (14.8)
Yes	95.8 (12.6)	98.0 (17.6)	93.3 (18.4)
Premature birth			
No	94.3 (13.4)	96.0 (18.5)	94.4 (15.2)
Yes	94.3 (8.8)	101.6 (13.8)	94.6 (15.8)

[a] $P < .01$.
[b] $P < .05$.
[c] $P < .001$.
[d] $P < .10$.

FPL was a 3-level variable, being below the FPL was associated with a 7-point decrease in OE and an 8-point decrease in OC scores. Because maternal education was coded by yearly increments, children with mothers who are college graduates would be predicted to have OE scores of 3.2 points higher than those of children whose mothers graduated from high school only.

Multivariable models for predicting OWLS scores in children with UHL only are shown in Table 5. Although the variables in the models are largely the same, additional variables added small increments to the overall adjusted R^2 values. For LC, the current use of any amplification (eg, FM system, hearing aid, or bone-anchored hearing aid [BAHA]) was associated with a small increase. For both OE and OC scores, the age at which the UHL was identified added to the overall variance explained. In addition, WRS in noise added to the overall variance explained for the OC scores. For children who had received services through an IEP, the age at which services began and duration of these services were not associated with the OWLS scores (data not shown).

DISCUSSION

In contrast with previous studies of children with UHL, we enrolled a large number of elementary school–aged children, carefully described their hearing, cognitive, and socioeconomic status, and included sibling controls. The results showed that UHL is associated with a significant negative effect on scores on standardized speech-language tests. Obtaining cases and controls within families controlled for a host of family, genetic, socioeconomic, and environmental factors that could affect language development. Although speech-language scores do not translate directly into school performance, the secondary outcomes of speech therapy and IEPs suggest that the children with UHL had significant problems in school. The multivariable-analysis results suggested that use of amplification might be associated with a small increase in LC scores. We do not think selection bias influenced these results, because the participants with UHL were identified through hearing-screening programs or diagnostic audiograms, not through special-services programs at schools.

The etiology of UHL in children may encompass a different spectrum than BHL. Genetic mutations, such as connexin 26 mutations, rarely cause UHL, and syndromic hearing loss usually involves both ears.[25] The most commonly known etiologies in UHL are temporal bone anomalies, such as enlarged vestibular aqueduct, cochlear dysplasias, and cochlear nerve aplasia.[26–28] Familial or hereditary UHL is rare and not well characterized.[29–31] Head trauma is a relatively common etiology of acquired UHL, but the frequencies of intrauterine infections, meningitis, otologic surgery, and ototoxic medications in UHL have not been well tallied.[32] Children with microtia or auricular atresia may have syndromic hearing loss (eg, Goldenhar syndrome) but usually have conductive or mixed hearing loss that is well treated with BAHA.[33–35] Because neonatal risk factors for hearing loss have been identified in children with congenital

TABLE 4 Multivariable Linear Regression Models on Speech-Language OWLS Scores in a Sample of 148 Children Aged 6 to 12 Years

Outcome	Parameter Estimate	SE	*T*	*P*	Adjusted R^2
LC					0.34
Intercept	38.6	7.3	5.3	<.001	
UHL	−10.8	4.3	−2.5	.01	
Full-sum IQ	0.47	0.06	7.9	<.001	
Age	1.0	0.4	2.7	.009	
Severity of hearing loss	1.9	1.2	1.6	.12	
OE					0.61
Intercept	−20.0	9.3	−2.1	.04	
UHL	−4.1	1.9	−2.2	.03	
Full-sum IQ	0.79	0.07	11.7	<.001	
Age	2.0	0.4	4.6	<.001	
Female gender	5.3	1.9	2.8	.005	
Poverty level	−3.7	1.5	−2.4	.02	
Maternal education	0.8	0.4	2.2	.03	
OC					0.53
Intercept	13.7	7.7	1.8	.08	
UHL	−5.7	1.7	−3.3	.001	
Full-sum IQ	0.6	0.06	10.3	<.001	
Age	1.7	0.4	4.3	<.001	
Female gender	3.8	1.7	2.2	.03	
Poverty level	−4.3	1.3	−3.4	.001	

TABLE 5 Multivariable Linear Regression Models on Speech-Language OWLS Scores in a Sample of 74 Children Aged 6 to 12 Years With UHL

Outcome	Parameter Estimate	SE	*T*	*P*	Adjusted R^2
LC					0.25
Intercept	41.3	11.4	3.6	<.001	
Full sum IQ	0.4	0.08	5.0	<.001	
Age	0.2	0.6	0.3	.7	
Severity of hearing loss	2.2	1.1	1.9	.06	
Current use of amplification	2.6	2.3	1.1	.3	
OE					0.61
Intercept	−10.4	12.8	−0.8	.4	
Full sum IQ	0.7	0.09	7.3	<.001	
Age	2.2	0.7	3.3	.002	
Female gender	7.9	2.3	3.4	.001	
Poverty level	−4.2	1.9	−2.2	.04	
Age of hearing-loss identification	−1.0	0.5	−2.1	.04	
Maternal education	0.8	0.5	1.6	.12	
OC					0.40
Intercept	23.1	13.2	1.8	.08	
Full sum IQ	0.4	0.09	4.5	<.001	
Age	1.4	0.7	2.1	.06	
Female gender	6.3	2.4	2.6	.01	
Poverty level	−5.9	1.9	−3.2	.002	
WRS, 0-dB signal-to-noise ratio	0.2	0.1	1.6	.12	
Age of hearing-loss identification	−0.7	0.5	−1.4	.17	

BHL, it is not known whether the same risk factors are important for children with UHL. Research is necessary to discover which risk factors and etiologies are associated with UHL.

No study of UHL has investigated whether severity of hearing loss affects speech or language outcomes. However, studies of children and adults with asymmetric BHL have revealed that sound localization and speech discrimination are more difficult and outcomes are poorer than in children and adults with symmetric BHL.[36–39] We speculate that when the difference in hearing between ears exceeds a threshold level, a person with UHL may experience difficulty with sound localization or speech discrimination in noise similar to that experienced by a person with asymmetric BHL. However, additional research is necessary to determine whether a threshold effect might exist.

Unlike for children with BHL, who are routinely fitted with hearing aids and receive accommodations for disability, children with UHL may not be considered to have a "significant hearing loss" because their hearing loss is not bilateral (eg, in Delaware) or not sufficient to interfere with speech or language development (eg, in Arkansas, Kentucky, or Utah).[40] Each state has the right to define who is eligible for Part B and Part C of the Individuals With Disabilities Education Improvement Act (IDEA) of 2004, and UHL is often not included.[41] Therefore, children with UHL are not automatically eligible for services in the First Steps or Birth to Three programs (Part C of the IDEA), preschool or school IEPs (Part B of the IDEA), or Section 504c of the Rehabilitation Act of 1973 accommodations for disability.[42] Recommended interventions for children with UHL usually include preferential seating in class and an FM system that amplifies the teacher's voice relative to the background noise. Unless the child has another school-related issue (such as speech or behavior) or demonstrates significant developmental or educational delay, parents must often strongly advocate for their children with UHL to obtain FM systems in the classroom. In addition, parents may be actively discouraged by school teachers and administrators from seeking Section 504c accommodations. Only 3 children with UHL in this study had Section 504c accommodations. Independent private or parochial schools may not have the resources or the mandate to provide these accommodations. Our results

suggest that children with UHL should be eligible for the same accommodations as children with BHL.

Health disparities affected this study cohort significantly. Poverty was associated with decreases in speech-language scores similar in magnitude to UHL. Compared with those in the >200% FPL bracket, the OE and OC scores for children from families at 100% to 200% of FPL were lower by 4 points, and lower by 7 to 8 points in children from families at <100% of FPL. Thus, a child with UHL who comes from a family with an income of <100% FPL would be expected to have an OE score of 11 points and an OC score 14 points below a child with NH and whose family income is at >200% FPL. These large differences in oral language skills on the basis of socioeconomic status are consistent with education and health disparities noted by others[43] and have policy implications for health care and education. Although gaps in standardized achievement scores have not been measured directly in this cohort, speech and language development contribute to reading and literacy.[44–46] Interventions that reduce the negative impact of UHL on children should address both the functional problem of hearing with only 1 ear and the problems that poverty encompasses in affecting childhood language development.

Future research to determine when the onset of speech-language delays occurs, the mechanisms whereby UHL affects speech-language development, whether any interventions can mitigate the effects of UHL, and whether speech-language delays affect future educational performance and job acquisition are all necessary to allow children the opportunity to attain their potential.

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Unilateral Hearing Loss Is Associated With Worse Speech-Language Scores in Children

Judith E. C. Lieu, Nancy Tye-Murray, Roanne K. Karzon and Jay F. Piccirillo

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