

Adverse Childhood Communication Experiences  
Associated With an Increased Risk of Chronic  
Diseases in Adults Who Are DeafPoorna Kushalnagar, PhD,<sup>1</sup> Claire Ryan, MA,<sup>2</sup> Raylene Paludneviene, PhD,<sup>1</sup> Arielle Spellun, MD,<sup>3</sup>  
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**Introduction:** This study explores adverse childhood communication experiences and its RRs for acquiring specific chronic diseases and mental health disorders in adults who are deaf and hard of hearing.

**Methods:** A cross-sectional design with snowball sampling was used to recruit adults who were deaf and hard of hearing and were born or became deaf in both ears before age 13 years. Patient-reported outcomes surveys in American Sign Language and English were disseminated to collect data about early life communication experiences with caregivers. Modified Poisson regression with robust SEs was used to calculate RR estimates and 95% CIs for all medical conditions with early life communication experiences as main predictors.

**Results:** Data collection occurred from May 2016 to July 2016, October 2016 to April 2018, and October 2018 to May 2019. The U.S. sample consisted of 1,524 adults who were born or became deaf early. After adjusting for parental hearing status and known correlates of medical conditions, poorer direct child–caregiver communication was significantly associated with an increased risk of being diagnosed with diabetes (RRR=1.12, 95% CI=1.01, 1.24), hypertension (RRR=1.10, 95% CI=1.03, 1.17), and heart disease (RRR=1.61, 95% CI=1.39, 1.87). Poor indirect family communication/inclusion increased risks for lung diseases (RRR=1.19, 95% CI=1.07, 1.33) and depression/anxiety disorders (RRR=1.34, 95% CI=1.24, 1.44). The absolute risk increase and number needed to harm are also reported.

**Conclusions:** Outcomes data reported by patients who were deaf and hard of hearing demonstrated that poorer direct child–caregiver communication and ongoing exclusion from incidental family communication were associated with increased risks for multiple chronic health outcomes. Practices should consider developing and utilizing an adverse childhood communication screening measure to prevent or remediate language deprivation and communication neglect in pediatric patients who were deaf and hard of hearing.

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## INTRODUCTION

Until recently, medically underserved individuals who are deaf and hard of hearing (DHH) individuals and use American Sign Language (ASL) have been excluded from health surveillance data and public health research. Current ASL-accessible population health research that collected self-reported health information from

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a large sample of adults who were showed that certain social determinants of health are associated with a higher risk for medical and behavioral health conditions in this population.<sup>1–4</sup> As has been previously established in the literature, negative psychosocial experiences in early childhood can lead to poor health outcomes later in adulthood.<sup>5,6</sup> These experiences, known as adverse childhood experiences (ACEs), are a form of early life toxic stress, which can occur from prolonged activation of the body's stress response system and when the adverse experiences exceed the protective capacities of a child's environment.<sup>5,7,8</sup> Some individuals are DHH may face unique stressors in addition to early life toxic stress experienced by those in the general population. Two forms of early life toxic stress that can potentially impact the health of individuals who are DHH are language deprivation (insufficient access to direct child–caregiver communication during the critical period of language development) and communication neglect (ongoing or recurrent exclusion from indirect family communication and incidental learning).

Communication between children who are DHH and their caregivers can be disrupted in several ways. Most fundamentally, children who do not have full access to language through direct communication with caregivers during childhood and lack age-appropriate skills are at a risk for delayed language and cognitive development.<sup>9</sup> Assistive hearing devices (e.g., hearing aids or cochlear implants) do not always provide adequate access to sound to acquire language fluently or pick up on incidental information.<sup>10,11</sup> Similarly, opportunities for adequate exposure to sign language for typical language development to occur are not always present.<sup>12–14</sup> Children who are severely deprived of language access show evidence of early life toxic stress exposure such as severe behavioral difficulties and poor emotional regulation.<sup>15</sup> Though one-to-one communication with a caregiver may be successful, children who are DHH face additional challenges with indirect family conversations, which provide opportunities for inclusion and incidental learning. The long-term impact of early life communication adversity (direct and indirect) on health outcomes of an adult who is DHH is not well-understood.

Success in direct child–caregiver communication requires commitment and understanding from both child and caregivers. In some cases, a caregiver may have difficulties understanding the child who is DHH regardless of the signed or spoken modality that the child uses. Poor direct child–caregiver communication risks language delays that impact psychosocial and cognitive health outcomes,<sup>9</sup> a growing public health concern for children who are DHH.

The extent to which the direct form of language-related stressor impacts health outcomes, concurrently

or later in life, has been demonstrated empirically in several studies. Adjusting for age, parental hearing status, and language/communication modality used with parents, a youth cohort study found that perceived inability of youths who are DHH to understand what their caregivers said was significantly associated with lower quality of life and increased depressive symptomatology.<sup>16</sup> Adjusting for language preference and hearing level in a college sample of 143 adults who were DHH, poorer direct child–caregiver communication was also strongly associated with greater symptoms of depression.<sup>17</sup> Finally, in a retrospective study of 475 adults who were DHH, those who reported being unable to understand what their primary caregiver said during their formative years had significantly higher odds of experiencing food insecurity than adults who were deaf and understood some to all of what their caregivers said.<sup>2</sup> For all the 3 studies, parental hearing status did not contribute significantly to health outcomes. As with other established forms of early childhood adversity, impaired direct child–caregiver communication may reflect a unique form of early life toxic stress for individuals who are DHH.

Even when caregivers are successful in isolated one-on-one conversations with their children, they may lack the communication abilities to fully include the child in all family and group interactions. This can be referred to as communication isolation, exclusion, or neglect and forms another potential source of early life toxic stress for children who are DHH. The child who is DHH may attempt to remind family members to include him/her in conversations but may be told to wait or simply be ignored. Many people who are DHH recall family members' saying, "It wasn't important" or "I'll tell you later," where "later" is often forgotten. These concerns for children who are DHH remain regardless of parents' intention, awareness, or conscious efforts to ensure that their child who is DHH has full communication access in their immediate environment.

One 2013 survey included a question concerning retrospective perception of adults who were DHH of how well they understood family conversations.<sup>18</sup> In a sample of 211 adults who answered this question, 81% (141 of 175) of respondents who had hearing parents and 18% (4 of 22) of respondents who had parents who were DHH reported lower levels of understanding indirect family conversations. Even when direct communication access is not obstructed (e.g., if parents sign adequately to a signing child who is DHH), missing out on incidental family conversations can occur when a child who is DHH has trouble understanding conversations that caregivers have with other family members. A sense of belonging is essential for healthy child development; thus, feeling excluded or left out within the family may

have an adverse impact on development. For children who are DHH, ongoing difficulty with participation in family conversations and missing out on incidental information is likely to result in psychological distress.<sup>16,19</sup> Again, this experience can happen regardless of parental hearing status.

The term communication neglect is used to indicate that a child who is DHH always or often feels ignored or excluded from family conversations. Even with the best caregiver intentions, communication neglect happens just like language deprivation happens. These phenomena must be named and studied to be prevented and remediated. Given that a large majority of children who are DHH and are born to parents with no experience using visual languages or assistive technologies to communicate,<sup>20</sup> the threat of adverse early life communication experiences and its impact on health outcomes are of great concern.

A better understanding of adverse childhood communication experiences as unique contributors to specific health outcomes is needed so that interventions and policy can be targeted to better support accessible, language-rich, and inclusive environments for developing children who are DHH and their families. This study explores adverse childhood communication experiences and their RRs for acquiring specific chronic diseases and mental health disorders later in life.

## METHODS

### Study Sample

After approval by Gallaudet University IRB, research staff recruited adults who were DHH and were born or became deaf in both ears before age 13 years (prepuberty stage). Recruitment methods included snowball sampling through personal networks, distribution of flyers, and advertisements on deaf-centered organizations' websites and e-newsletters. Data collection occurred from May 2016 to July 2016, October 2016 to April 2018, and October 2018 to May 2019. Those who provided consent completed the online survey in approximately 1 hour.

### Measures

Demographic information was collected on all participants. Self-reported health information was obtained by asking subjects whether health providers had ever informed them of a diagnosis of any of the following: diabetes, heart disease, hypertension, lung disease, arthritis, depression/anxiety, or cancer. Given the national scope of this survey, chart review data from the survey participants to confirm self-reported diagnoses were not available. All survey items were fully accessible in ASL and English. Details of this translation procedure and administration of bilingual health survey online in ASL and English are discussed elsewhere.<sup>21</sup>

Adverse childhood communication experiences were assessed using the Patient-Reported Outcomes Measurement Information System (PROMIS)-Deaf Profile\_Early Life Communication Experiences (ELCEs) measure, which has been validated in ASL.<sup>22,23</sup>

Psychometric results revealed 2 separate but related constructs as follows<sup>23</sup>:

1. PROMIS-Deaf Profile\_ELCEs: direct child–caregiver communication. *Thinking about the person/caregiver/parent who took care of you the most when you were growing up, how much did this person understand you? (completely, mostly, moderately, a little, not at all).*

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2. PROMIS-Deaf Profile\_ELCEs: indirect family communication and inclusion. *When you were growing up, how often did you feel included in family conversations or discussions? (always, often, sometimes, rarely, never; reverse scored).*

*When you were growing up, how often did you feel ignored or left out by your family? (always, often, sometimes, rarely, never; reverse scored)*

### Statistical Analysis

This study used SPSS, version 26.0, to examine the associations between adverse childhood communication experiences and the prevalence of each medical condition. The main predictors were converted from *t*-scores to categorical predictors before analysis. The *t*-scores that fell 1 SD below the mean were assigned to inadequate access group, with others assigned to adequate access group. The level of significance was set at  $p < 0.05$ .

Modified Poisson regression with robust SEs was used to calculate RR estimates and 95% CIs for all medical conditions with adverse childhood communication experiences as main predictors, adjusting for age, sex, race/ethnicity, education, parental hearing status, and health status. The modified Poisson approach was recommended for models with binomial outcomes, and the application of robust SEs helped rectify the overestimation for the RR of having a medical condition.<sup>24</sup> The RRRs were used to estimate the RRs of having a medical condition among people who experienced adverse childhood communication compared with people who did not experience this (reference category). The absolute risk increase (ARI) and number needed to harm (NNH) were also calculated for the negative impact of adverse childhood communication experiences on each medical condition. ARI was determined on the basis of the severity of adverse childhood communication experiences (i.e., *t*-score  $< 1$  SD from the mean), and NNH was calculated for, on average, the number of patients who needed to be exposed to a risk factor (e.g., language deprivation or communication neglect) for 1 patient to receive harm (e.g., a medical condition) relative to placebo. Therefore, an NNH close to 1 indicates a risk factor that frequently results in harm of having a medical condition, whereas larger NNH values indicate risk factors that rarely result in harm of having a medical condition.

## RESULTS

This U.S. study sample consisted of 1,524 adults who were born deaf or became deaf before age 13 years (prepuberty), with 27% having parents who were DHH and 73% having hearing parents. Among the hearing parent

group, 49% used spoken language, 31% used sign language, and the remaining 20% used other modalities (e.g., gestures, writing, cued speech) to communicate with the respondent who was DHH. In the parent who were DHH group, 82% used sign language, 12% used spoken language, and the remaining 6% used other modalities (e.g., gestures, writing, cued speech) to communicate with the respondent who was DHH. The mean age for the sample of adults who were DHH was 46 (SD=18) years, with 58% identifying as female and 66% identifying as white. The lifetime prevalence for medical conditions was 32% for diabetes, 8% for heart conditions, 32% for hypertension, 16% for lung condition, 27% for depression/anxiety disorders, and 10% for cancer. A majority of the sample (89%) perceived their health to be good (Table 1). A total of 11% of the sample of adults who were DHH retrospectively reported their direct communication with caregivers as difficult to understand (*a little or none at all*). For indirect family communication/inclusion, 39% reported *often* or *always* feeling excluded or left out from family conversations.

Here, only significant relationships between the main predictors and certain medical conditions are reported. Table 2 lists all significant and nonsignificant results.

Inadequate access to direct child–caregiver communication increased a person’s risks of being diagnosed with diabetes by 12% (95% CI=1%, 24%), hypertension by 10% (95% CI=3%, 17%), and heart disease by 61% (95% CI=39%, 87%) relative to people who have adequate access to direct child–caregiver communication.

If a person had inadequate access to direct child–caregiver communication, the ARI for acquiring each condition was as follows: 8% for diabetes (95% CI=5%, 8%), 13% for hypertension (95% CI=10%, 15%), and 7% for heart disease (95% CI=6%, 10%). The NNH for a person to be harmed by inadequate access was about 1 in 13 for diabetes (95% CI=10, 17), 1 in 8 for hypertension (95% CI=7, 10), and 1 in 15 for heart disease (95% CI=12, 20).

Inadequate access to indirect family communication and inclusion significantly increased a person’s RR for depression/anxiety disorders by 34% (95% CI=25%, 44%) and lung disease by 19% (95% CI=7%, 33%) compared with people who had adequate access to indirect family communication/inclusion.

If a person had inadequate access to indirect family communication and inclusion while growing up, the ARI for acquiring each medical condition was as follows: 7% for depression/anxiety (95% CI=5%, 10%) and 4% for lung disease (95% CI=2%, 6%). The NNH for 1 person to be harmed by inadequate access was about 1 in 13 for depression/anxiety disorder (95% CI=10, 19) and 1 in 25 for lung disease (95% CI=17, 44).

**Table 1.** Unweighted Sociodemographic Characteristics of Respondents Who Answered Early Life Communication Experiences Items (n=1,524)

Variables	n (%) <sup>a</sup>
Age, mean (SD)	45.83 (18.12)
Age onset of hearing loss, mean (SD)	0.94 (1.94)
Sociodemographics	
Birth sex	
Male	613 (40)
Female	905 (59)
Race/ethnicity	
White	999 (66)
Black	143 (9)
Asian	94 (6)
Latinx	209 (14)
Other	72 (5)
Education	
High school diploma or less	652 (43)
College degree (includes associates and bachelors)	871 (57)
Parents’ hearing status	
Deaf	417 (27)
Hearing	1,101 (72)
Assistive hearing device	
Do not use	809 (56)
Hearing aids	484 (34)
Cochlear implants	135 (9)
Other types of listening devices	6 (<1)
Self-reported ability to understand speech in a quiet room (listening, speechreading, lipreading, or combined)	
Can understand everything	130 (7)
Can understand most	491 (26)
Can understand some to little	794 (41)
Cannot understand anything	512 (27)
Health status	
Very good/excellent	830 (55)
Good	520 (34)
Poor/fair	167 (11)

<sup>a</sup>Frequencies not summing to total reflect missing data.

## DISCUSSION

This study is the first to gather and utilize patient-reported outcome data from a large U.S. sample of adults who were DHH to explore the association of adverse childhood communication experiences—both direct and indirect—with adulthood health outcomes. Direct and indirect adverse communication experiences were differentially associated with increased risk for chronic health conditions.

After adjusting for demographics and health correlates, adverse direct child–caregiver communication was

**Table 2.** RRR Estimates, ARI, NNH, for Each Medical Condition by PROMIS-Deaf Profile\_ELCEs Domain

Medical condition	PROMIS-Deaf Profile_ELCEs					
	Direct child–caregiver communication			Indirect family communication/inclusion		
	RRR <sup>a</sup> (95% CI)	ARI (95% CI)	NNH (95% CI)	RRR <sup>a</sup> (95% CI)	ARI (95% CI)	NNH (95% CI)
Diabetes	<b>1.12 (1.01, 1.24)</b>	0.08 (0.06, 0.10)	13 (10, 17)	1.05 (0.95, 1.17)	0.04 (0.02, 0.06)	24 (16, 42)
Hypertension	<b>1.10 (1.03, 1.17)</b>	0.13 (0.10, 0.15)	8 (7, 10)	0.94 (0.88, 1.01)	0.04 (0.02, 0.06)	25 (16, 59)
Heart condition	<b>1.61 (1.39, 1.87)</b>	0.07 (0.05, 0.08)	15 (12, 20)	1.07 (0.92, 1.24)	0.02 (0.007, 0.04)	49 (29, 138)
Lung disease	1.04 (0.93, 1.16)	0.02 (0.001, 0.04)	52 (26, 797)	<b>1.19 (1.07, 1.33)</b>	0.04 (0.02, 0.06)	25 (17, 44)
Cancer	0.87 (0.75, 1.01)	0.02 (0.003, 0.03)	56 (29, 402)	1.11 (0.097, 1.26)	0.04 (0.02, 0.05)	26 (18, 44)
Arthritis	1.00 (0.92, 1.09)	0.09 (0.07, 0.11)	11 (9, 15)	0.99 (0.91, 1.08)	0.05 (0.03, 0.07)	19 (13, 30)
Depression	0.92 (0.84, 1.01)	0.05 (0.03, 0.07)	20 (14, 35)	<b>1.34 (1.25, 1.44)</b>	0.07 (0.05, 0.10)	13 (10, 19)
Anxiety disorder						

Note: Boldface indicates statistical significance ( $p < 0.05$ ). Adequate access is the reference group.

<sup>a</sup>Adjusted for age, sex, race, education, parent hearing status, and health status.

ARI, absolute risk increase; ELCE, Early Life Communication Experience; NNH, number needed to harm; PROMIS, Patient-Reported Outcomes Measurement Information System.

associated with significantly higher RR for being diagnosed with diabetes, hypertension, and heart disease than adequate access to direct child–caregiver communication. The absolute risk estimates show that approximately 1 person in 13 who understood little to none of what their primary caregiver said and vice versa while growing up would be affected by diabetes, 1 in 8 by hypertension, and 1 in 15 by heart disease.

Compared with adequate access to and inclusion in indirect family communication, ongoing exclusion from indirect family conversations was associated with an increased risk of lung disease and depression/anxiety disorders. Among people who reported always or often experiencing exclusion from indirect family communication in childhood years, 1 in 13 would experience a depression/anxiety disorder and 1 in 25 would experience lung disease.

This study is adequately powered to make the distinction between 2 types of adverse childhood communication experiences (direct and indirect) and their relationships with specific chronic health outcomes. The clinical significance for NNH for each type of adverse childhood communication experience is clear. A future direction for this research is to incorporate these constructs into standardized adverse childhood communication screening measures and targeted interventions to prevent or remediate the toxic stress exposure of language deprivation and communication neglect. In addition to creating and implementing evidence-based assessment and intervention, action must be taken to develop clinical practice as well as early intervention and educational policies that emphasize direct and indirect communication access for children who are DHH. Language and communication, both direct and indirect, need to be made accessible to the

child who is DHH; the child who is DHH needs to feel included in family communication. This will in turn promote healthy child development and well-being and ultimately may reduce the risk for developing chronic disease in adulthood.

On the basis of this study results, adverse early life communication experiences such as language deprivation and communication neglect are in fact ACEs, which can potentially alter physiological (e.g., neuroendocrine activation and regulation) and psychological (e.g., coping) mechanisms during critical periods of development and consequently increase risk for adulthood chronic disease.<sup>25–28</sup> For these reasons, future studies that explore ACEs and developmental outcomes in individuals who are DHH should include a history of early life communication adversity. Future studies might also elucidate the long-term impact of biological and psychological mechanisms associated with adverse childhood communication experiences on chronic diseases during adulthood and whether this impact may potentially be moderated by resilience or other protective factors. As screening for ACEs is gradually becoming a standard practice in health care, adverse communication experiences should be included in regular ACEs screenings for individuals who are DHH. Interventions designed to target the underlying mechanisms of language-related stress may be a potential strategy to offset the impact of toxic stress associated with early life communication adversity on chronic health conditions.

### Limitations

Limitations of this study include the use of self-reported health information rather than medical record review. Study participants' family history of chronic medical conditions was also not evaluated because most

participants reported that they did not know their family history. As a retrospective study, only correlation can be established between the exposure of early life toxic stress in the form of language deprivation and communication neglect and health outcomes. Designing a study aimed to establish causation, however, would be challenging based on the ethical implications of purposefully subjecting children to a linguistically poor environment in a randomized manner.

## CONCLUSIONS

Concerningly high rates of poor direct and indirect child–caregiver communication were reported in this U. S. study sample. Approximately 11% of participants reported poor direct caregiver communication as a child, whereas 39% of participants reported feeling excluded from indirect family communication. Given the observed relationship between inadequate language and communication access during childhood and adverse health outcomes later in life, it is imperative for the medical and public health communities to implement interventions to improve early life communication experiences of children who are DHH. Medical providers are critical in this process because they have frequent interactions with young children who are DHH and their families at preventative health visits and are in a position to screen for adverse childhood communication experiences. Ideally, efforts should be made to educate behavioral health and medical providers on language deprivation and communication neglect in children who are DHH and also develop tools for tracking language development and engagement in indirect family conversations.

The establishment of such evidence-based screeners and interventions is critical to improve access to language and engagement in family conversations by teaching caregivers how to create inclusive and accessible communication environments for their children who are DHH. It is hoped that by reducing the incidence of adverse early life communication experiences as a source of toxic stress, children who are DHH will have a lower risk of developing chronic diseases and mental health disorders in adulthood.

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PK conceptualized and designed the study, translated the measures to American Sign Language, gathered and analyzed the data, drafted the manuscript, and approved the final manuscript as submitted. CR gathered data, assembled the tables, drafted the manuscript, and approved the final manuscript as submitted. RP translated the measures to American Sign Language, drafted the manuscript, and approved the final manuscript as submitted. AS drafted the manuscript and approved the final manuscript as submitted. SG revised the manuscript and approved the final manuscript as submitted. All authors approved the final manuscript as submitted and agreed to be accountable for all aspects of the work.

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## REFERENCES

1. Kushalnagar P, Miller CA. Health disparities among mid-to-older deaf LGBTQ adults compared with mid-to-older deaf non-LGBTQ adults in the United States. *Health Equity*. 2019;3(1):541–547. <https://doi.org/10.1089/heq.2019.0009>.
2. Kushalnagar P, Moreland CJ, Simons A, Holcomb T. Communication barrier in family linked to increased risks for food insecurity among deaf people who use American Sign Language. *Public Health Nutr*. 2018;21(5):912–916. <https://doi.org/10.1017/S1368980017002865>.
3. Kushalnagar P, Reesman J, Holcomb T, Ryan C. Prevalence of anxiety or depression diagnosis in deaf adults. *J Deaf Stud Deaf Educ*. 2019;24(4):378–385. <https://doi.org/10.1093/deafed/enz017>.
4. Simons AN, Moreland CJ, Kushalnagar P. Prevalence of self-reported hypertension in deaf adults who use American Sign Language. *Am J Hypertens*. 2018;31(11):1215–1220. <https://doi.org/10.1093/ajh/hpy111>.
5. Franke HA. Toxic stress: effects, prevention and treatment. *Children (Basel)*. 2014;1(3):390–402. <https://doi.org/10.3390/children1030390>.
6. Institute of Medicine Board on Health Sciences Policy Committee on Assessing Interactions Among Social, Behavioral, and Genetic Factors in Health. In: Hernandez LM, Blazer DG, eds. *Genes, Behavior, and the Social Environment: Moving Beyond the Nature/Nurture Debate*, 2006, The National Academies Press; Washington, DC <https://doi.org/10.17226/11693>
7. Shonkoff JP, Garner AS, Committee on Psychosocial Aspects of Child and Family Health. The lifelong effects of early childhood adversity and toxic stress. *Pediatrics*. 2012;129(1):e232–e246. <https://doi.org/10.1542/peds.2011-2663>.
8. Felitti VJ, Anda RF, Nordenberg D, et al. Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults: the Adverse Childhood Experiences (ACE) Study. *Am J Prev Med*. 1998;14(4):245–258. [https://doi.org/10.1016/S0749-3797\(98\)00017-8](https://doi.org/10.1016/S0749-3797(98)00017-8).
9. Humphries T, Kushalnagar P, Mathur G, et al. Language acquisition for deaf children: reducing the harms of zero tolerance to the use of alternative approaches. *Harm Reduct J*. 2012;9:16. <https://doi.org/10.1186/1477-7517-9-16>.
10. Koehlinger KM, Van Horne AJO, Moeller MP. Grammatical outcomes of 3- & 6-year-old children who are hard of hearing. *J Speech Lang Hear Res*. 2013;56(5):1701–1714. [https://doi.org/10.1044/1092-4388\(2013\)12-0188](https://doi.org/10.1044/1092-4388(2013)12-0188).
11. Szagun G. Individual differences in language acquisition by young children with cochlear implants and implications for a concept of 'sensitive phase'. *Int Congr Ser*. 2004;1273:308–311. <https://doi.org/10.1016/j.ics.2004.08.016>.

12. Mayberry RI, Chen JK, Witcher P, Klein D. Age of acquisition effects on the functional organization of language in the adult brain. *Brain Lang*. 2011;119(1):16–29. <https://doi.org/10.1016/j.bandl.2011.05.007>.
13. Boons T, De Raeve L, Langereis M, Peeraer L, Wouters J, van Wieringen A. Expressive vocabulary, morphology, syntax and narrative skills in profoundly deaf children after early cochlear implantation. *Res Dev Disabil*. 2013;34(6):2008–2022. <https://doi.org/10.1016/j.ridd.2013.03.003>.
14. Lyness CR, Woll B, Campbell R, Cardin V. How does visual language affect crossmodal plasticity and cochlear implant success? *Neurosci Biobehav Rev*. 2013;37(10, pt 2):2621–2630. <https://doi.org/10.1016/j.neubiorev.2013.08.011>.
15. Gulati S. Language deprivation syndrome. In: Glickman NS, Hall WC, eds. *Language Deprivation and Deaf Mental Health*, New York, NY: Routledge, 2018. <https://doi.org/10.4324/9781315166728-2>
16. Kushalnagar P, Topolski TD, Schick B, Edwards TC, Skalicky AM, Patrick DL. Mode of communication, perceived level of understanding, and perceived quality of life in youth who are deaf or hard of hearing. *J Deaf Stud Deaf Educ*. 2011;16(4):512–523. <https://doi.org/10.1093/deafed/enr015>.
17. Kushalnagar P, Bruce S, Sutton T, Leigh IW. Retrospective parent–child communication difficulties and risk of depression in deaf adults. *J Dev Phys Disabil*. 2017;29(1):25–34. <https://doi.org/10.1007/s10882-016-9501-5>.
18. Hall WC, Smith SR, Sutter EJ, DeWindt LA, Dye TDV. Considering parental hearing status as a social determinant of deaf population health: insights from experiences of the “dinner table syndrome”. *PLoS One*. 2018;13(9):e0202169. <https://doi.org/10.1371/journal.pone.0202169>.
19. Hindley PA. Mental health problems in deaf children. *Curr Paediatr*. 2005;15(2):114–119. <https://doi.org/10.1016/j.cupe.2004.12.008>.
20. Mitchell RE, Karchmer MA. Chasing the mythical ten percent: parental hearing status of deaf and hard of hearing students in the United States. *Sign Lang Stud*. 2004;4(2):138–163. <https://doi.org/10.1353/sls.2004.0005>.
21. Kushalnagar P, Harris R, Paludneviene R, Hoglind T. Health Information National Trends Survey in American Sign Language (HINTS-ASL): protocol for cultural adaptation and linguistic validation of a National Survey. *JMIR Res Protoc*. 2017;6(9):e172. <https://doi.org/10.2196/resprot.8067>.
22. Kushalnagar P, Atcherson S, Paludneviene R, Cella D. PROMIS-ASL: patient reported outcomes measure for deaf/HH adults. *Quality of Life Research*. 2016;25(S1):161.
23. Kushalnagar P, Paludneviene R, Kallen M, Atcherson S, Cella D. PROMIS-Deaf profile measure: cultural adaptation and psychometric validation in American Sign Language. *J Patient Rep Outcomes*. In press. Online June 9, 2020. <https://doi.org/10.1186/s41687-020-00208-7>
24. Zou G. A modified Poisson regression approach to prospective studies with binary data. *Am J Epidemiol*. 2004;159(7):702–706. <https://doi.org/10.1093/aje/kwh090>.
25. Hughes K, Bellis MA, Hardcastle KA, et al. The effect of multiple adverse childhood experiences on health: a systematic review and meta-analysis. *Lancet Public Health*. 2017;2(8):e356–e366. [https://doi.org/10.1016/S2468-2667\(17\)30118-4](https://doi.org/10.1016/S2468-2667(17)30118-4).
26. Heerman WJ, Krishnaswami S, Barkin SL, McPheeters M. Adverse family experiences during childhood and adolescent obesity. *Obesity (Silver Spring)*. 2016;24(3):696–702. <https://doi.org/10.1002/oby.21413>.
27. Murphy MO, Cohn DM, Loria AS. Developmental origins of cardiovascular disease: impact of early life stress in humans and rodents. *Neurosci Biobehav Rev*. 2017;74(Pt B):453–465. <https://doi.org/10.1016/j.neubiorev.2016.07.018>.
28. Slavich GM, Irwin MR. From stress to inflammation and major depressive disorder: a social signal transduction theory of depression. *Psychol Bull*. 2014;140(3):774–815. <https://doi.org/10.1037/a0035302>.