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Prevalence and Trends of Childhood Hearing Loss Based on Federally-funded National Surveys: 1994–2013

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Abstract

A recent highly cited publication, using data from the National Health and Nutrition Examination Survey (NHANES), concluded that the prevalence of childhood hearing loss in the United States is increasing (Shargorodsky, Curan, Curhan, & Eavey, 2010). This article examines the accuracy of that conclusion based on additional data from three nationally-representative surveys of childhood health. Using data from NHANES, the National Survey of Children's Health (NSCH), and the National Health Interview Survey (NHIS), logistic regression was used to assess trends from audiometry-measured and parent-reported childhood hearing loss.

In contrast to prior research, the results were highly conflicting. NHANES suggested both an increasing (audiometry) and decreasing (parent-report) trend, NSCH (parent-report) suggested no trend, and NHIS (parent-report) suggested a possible increasing trend. Given the disagreements among these federally funded national surveys, administrators and policy makers should be very cautious about conclusions drawn from these surveys regarding prevalence and trends related to childhood hearing loss in the United States.

Key Words: hearing loss; prevalence; trend; NHANES; NHIS; NSCH

Acronyms: NHANES = National Health and Nutrition Examination Survey; NHIS = National Health Interview Survey; NSCH = National Survey of Children's Health; P/S Report = Parent/Self Report; PTA = pure tone averages

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Introduction

Hearing loss frequently has serious negative consequences, especially for children (Smith, Bale, & White, 2005). Childhood hearing loss impacts many aspects of the child's life. It hinders a child's development including speech, language, and social development (Theunissen et al., 2014; Tomblin, Oleson, Ambrose, Walker, & Moeller, 2014; Warner-Czyz, Loy, Roland, Tong, & Tobey, 2008; Yoshinaga-Itano, 2003). Even a mild loss in hearing for a child can seriously hamper the child's ability to develop language and succeed in school (Bess, Dodd-Murphy, & Parker, 1998; Blair, Peterson, & Viehweg, 1985; Davis, 1989; Davis, Elfenbein, Schum, & Bentler, 1986; Festen & Plomp, 1990), whether that loss is bilateral (both ears) or unilateral (one ear; Bess & Tharpe, 1986; Brookhouser, Worthington, & Kelly, 1991; Lieu, 2004; Lieu, Tye-Murray, & Fu, 2012).

Research has shown that early diagnosis of hearing loss (preferably before 6 months of age) and subsequent enrollment in intervention services improved the speech, language, and social-emotional development of the child (Moeller, 2000; Pimperton & Kennedy, 2012; White, 2004; Yoshinaga-Itano, 2003). Further, school self-esteem was positively associated with earlier identification and intervention in children with hearing loss (Leigh, Maxwell-McCaw, Bat-Chava, & Christiansen, 2009).

Interventions to alleviate the negative consequences of childhood hearing loss are more likely to be implemented when policy makers and program administrators have correct information about the prevalence of hearing loss and whether prevalence is increasing or decreasing over time. For example, policies in the late 1990s and early 2000s advanced opportunities to help children with hearing loss (White, 2003). But, in order to continue to allocate the proper amount of resources, to assess recent policy efforts, and to study the epidemiology of childhood hearing loss, accurate estimation of prevalence and the temporal trend of childhood hearing loss is necessary. Otherwise, resources are unlikely to be appropriately allocated and the effects of policies and programs are unlikely to be well understood.

The United States federal government expends considerable money and effort to collect data about national prevalence and trends of various health-related variables. Probably the most well known and highly respected nationally representative data collection efforts related to children's health in the United States are the National Health and Nutrition Examination Survey (NHANES; Curtin, Mohadjer, & Dohrmann, 2010; Zipf, Chiappa, Porter,

Ostchega, Lewis, & Dostal, 2013), the National Survey of Children's Health (NSCH, 2012), and the National Health Interview Survey (NHIS, 1997). Each is a systematically collected, well-documented survey collecting data on many health issues that affect the population of the United States. These cross-sectional surveys are designed to be nationally representative. Due to the high costs, both in time and resources, the federal government is likely the only entity capable of conducting such endeavors.

The way in which data from these federally-sponsored surveys are used to make important policy and programmatic decisions was highlighted in a recent article by Shargorodsky, Curan, Curhan, & Eavey (2010). Shargorodsky et al. used NHANES data to conclude that there had been a 31% increase in the prevalence of hearing loss in 2005–2006 compared with 1988–1994. Using the NHANES data, Shargorodsky et al. (2010) also concluded that there is higher prevalence of hearing loss among males compared to females, a positive correlation between income and childhood hearing loss, and that "vaccination against Haemophilus influenzae and Streptococcus pneumoniae, as well as greater awareness of music-induced hearing loss," had not led to "…a reduction in the prevalence of hearing loss" (p. 776). They concluded that, "Further studies are needed to determine reasons for this increase and to identify potential modifiable risk factors to prevent the development of hearing loss" (p. 777).

There are many other cases where governmental, academic, and professional entities have used these federally-sponsored surveys to address important policy and administrative questions. For example, the Social Security Administration recently commissioned the Health and Medicine Division of the National Academies of Sciences, Engineering, and Medicine (NASEM: formerly known as the Institute of Medicine or IOM) to "identify past and current trends in the prevalence and persistence of speech and language disorders among the general U.S. population under 18 and compare those trends with trends among the SSI [Supplemental Security Income] childhood disability population (National Academies of Sciences, Engineering, and Medicine, 2016, p. 2). The report's conclusions about prevalence relied heavily on the NHANES, NSCH, and NHIS data sets.

The NHANES, NSCH, and NHIS data sets have been used extensively to study health and well-being among children in the United States (e.g., Bitsko, Holbrook, Robinson, Kaminski, & Ghandour, 2016; Cprek, Williams, Asaolu, Alexander, & Vanderpool, 2015), including the prevalence of hearing loss (e.g., Boulet, Boyle, & Schieve, 2009; Niskar et al., 1998). Yet, even though the individual data sets have been used frequently to study childhood hearing loss, no studies that compared prevalence and trend results from the NHANES, NSCH, and NHIS data sets could be located. Reports using these data sources independently have apparently assumed that each source would likely give similar results; therefore, only one source was referenced. This assumption needs to be tested to know if these sources are a reliable way to estimate childhood hearing loss. In addition, it is important to point out that Shargorodsky et al.'s (2010) widely cited conclusion that childhood hearing loss in the United States is increasing was based on only two points in time (1988–1994 compared to 2005–2006) and only one data set (NHANES). The fact that more data are available from NHANES and that data on prevalence are available from other nationally-collected data sets means that questions about prevalence and trends in childhood hearing loss can be addressed more comprehensively than has been previously reported.

The present study, therefore, aims to answer two important questions. First, do these nationally representative surveys (NHANES, NSCH, and NHIS) agree on the prevalence and the direction/magnitude of the temporal trend of childhood hearing loss? Second, if they do agree, is childhood hearing loss increasing in the United States? To answer these questions, publically available data from the NHANES, the NSCH, and the NHIS were analyzed.

Method

Data

Data from three major national surveys were used: the NHANES across the years 1994 to 2010, the NSCH across the years 2007 to 2012, and the NHIS across the years 2005 to 2013. These years for each survey were chosen due to their availability, having data on childhood hearing loss, and having questions that are identical across years. For simplicity, we refer to each release by its final year (e.g., 2005–2006 is referred to as 2006). Analyses were performed in the survey package in the R statistical software environment developed for analyses of complex survey designs (Lumley, 2010). Table 1 presents descriptive statistics of the samples stratified by each survey. Note that in drawing conclusions about prevalence and trends in childhood hearing loss, the clustering and the non-random probability-sample were taken into account and, consequently, the proportions of the demographics are adjusted to be representative of the United States.

National Health and Nutrition Examination Survey (NHANES). Releases of the NHANES data in 1994, 2006, 2008, and 2010 were used for the study because these are the only recent years with data on childhood hearing loss. The NHANES data set contains data on children ages 5–19 (although the 1994 NHANES data have information only on children ages 5–11). Although it would appear to be beneficial to include children up to age 17 as both the NSCH and the NHIS only include children 17 years old or younger (see descriptions of the NSCH and NHIS data sets below), NHANES stipulates that stratifying by age levels not predefined by the survey administrators can adversely affect the weighting scheme. Results were compared based on

Table 1: Descriptive Statistics of the Samples Stratified by Data Set.

	NHANES (*n* = 10,542) Count (%)	NSCH (*n* = 187,085) Count (%)	NHIS (*n* = 300,844) Count (%)
Parent/Self Report (Moderate +)*			
No Loss	4,672 (98.9%)	186,050 (99.4%)	299,463 (99.5%)
Loss	54 (1.1%)	1,035 (0.6%)	1,381 (0.5%)
Examination (40dB+)			
No Loss	10,477 (99.1%)	-	-
Loss	95 (0.9%)	-	-
dB Threshold, right ear, mean (*SD*)	5.90 (7.22)	-	-
dB Threshold, left ear, mean (*SD*)	6.01 (7.13)	-	-
Age, mean (*SD*)	13.40 (3.79)	9.00 (5.29)	8.51 (5.2)
Sex			
Male	5,262(49.9%)	96,744 (51.7%)	154,176 (51.2%)
Female	5,280(50.1%)	90,341 (48.3%)	146,668 (48.8%)
Race			
White	2,904 (27.4%)	136,143 (72.8%)	223,256 (74.2%)
Black	3,374 (32.0%)	18,877 (10.1%)	53,352 (17.7%)
Mexican American	3,389 (32.1%)	19,664 (10.5%)	-
Other	875 (8.3%)	4,441 (2.4%)	24,136 (8.0%)
Unkown	-	7,960 (4.3%)	-
End-Year Data Collected			
1994	6,166 (58.5%)	-	-
...	…	…	…
1998	-	-	13,634 (4.5%)
1999	-	-	12,895 (4.3%)
2000	-	-	13,365 (4.4%)
2001	-	-	13,565 (4.5%)
2002	-	-	12,509 (4.2%)
2003	-	-	12,239 (4.1%)
2004	-	-	24,313 (8.1%)
2005	-	-	24,321 (8.1%)
2006	2,003 (19.0%)	-	19,188 (6.4%)
2007	-	91,524 (48.9%)	18,535 (6.2%)
2008	1,134 (10.8%)	-	17,185 (5.7%)
2009	-	-	21,732 (7.2%)
2010	1,239 (11.8%)	-	21,878 (7.3%)
2011	-	-	24,724 (8.2%)
2012	-	95,561 (51.1%)	25,922 (8.6%)
2013	-	-	24,839 (8.3%)

*NHIS 4 is *a lot of trouble or more* instead of *moderate or more*.
Note. NHANES = National Health and Nutrition Examination Survey; NHIS = National Health Interview Survey; NSCH = National Survey of Children's Health

the suggested method and without 18 and 19 year olds, which demonstrated large differences in the estimated prevalence. Since this is likely due to the sampling design, we, therefore, followed the recommendations on age groups.

NHANES is a unique data set because results were collected using audiometry examinations and parent/self-report. The audiometry examination measured hearing loss based on an examination by a trained professional. Pure tone averages (PTA) were calculated using the decibel level the child was able to detect averaged over 500Hz, 1,000Hz, and 2,000Hz. As per American Speech-Language-Hearing Association recommendations (Clark, 1981), slight hearing loss was defined as bilateral or unilateral PTA ≥ 16 dB, mild loss as PTA ≥ 25 dB, and moderate loss as PTA ≥ 40 dB. There were 12,410 children between the ages 6 and 19 in the data set. After excluding individuals with missing data on audiometry measures (n = 1,868), 10,542 children remained in the audiometry analyses.

The parent/self-report measure was collected during an interview with the parent and/or child. As noted in the documentation for the NHANES (National Health and Nutrition Examination Survey, 2016) participants under 16 years of age, unless there was no one living in the household who was older than 16, were interviewed via a proxy (generally the participant's parent or guardian); otherwise children reported for themselves. There were no significant differences in responses by parent or child report from what could be ascertained from this guideline.

Since the question asked in the 1994 release of NHANES in the interview differed significantly from those asked from 2006–2010, only those from 2006–2010 were used for the analyses based on parent/self report. After removing any individuals with missing data (n = 1), n = 4,726 children were included in the analyses. To assess hearing loss, the interviewer asked: "Which statement best describes [the child's] hearing (without a hearing aid)? Would you say [his/her] hearing is excellent, good, that [the child] has a little trouble, moderate trouble, a lot of trouble, or is [the child] deaf?" Hearing loss was defined as moderate trouble, a lot of trouble or deaf. This was done to best match the other measures in the study (see NSCH and NHIS).

National Survey of Children's Health (NSCH). Two releases of the NSCH data (2007 and 2012) were used in this study. Data collected in both years contained data on childhood hearing loss in ages 0–17. The parent who said he or she knew the most about the child's health and health care was asked the interview questions. The parent-report measure interview question stated: "Would you describe [child name]'s hearing problems as mild, moderate, or severe?" Hearing loss was defined for the analyses in this article as moderate or severe because those designations most closely resembled that of the other surveys, both in theoretical meaning and in overall prevalence. This question closely follows both the NHANES and the NHIS interview questions, making for fairly simple comparisons between the three parent/self-report measures. After removing individuals with missing data on hearing loss (n = 15) or sex (n = 219), n = 187,085 children remained in the NSCH data set for analyses.

National Health Interview Survey (NHIS). Sixteen releases of the NHIS data (1998–2013) that contained data on childhood hearing loss for ages 0–17 were used for the analyses reported in this article. An adult in the home answered the interview questions. Between 1998 and 2007, the interview specifically asked: "Which statement best describes the child's hearing without a hearing aid: good, a little trouble, a lot of trouble, or deaf?" From 2008 to 2013, the question is identical but additional options are included, namely excellent and moderate trouble. Due to these additions, we cannot combine the two versions without introducing a spurious trend due to changes in the response options. Thus, the data for 1998–2007 (referred to as NHIS 4) are reported separately from the data for 2008–2013 (referred to as NHIS 6) with the number referring to the amount of options available. For NHIS 4, hearing loss was defined in these analyses as a lot of trouble or deaf. For NHIS 6, loss was defined as moderate trouble, a lot of trouble, or deaf. These definitions were used because they most closely resembled that of the other surveys, both in theoretical meaning and in overall prevalence.

Note that the NHANES parent/self-report measure question is nearly identical to that of the parent report measure in NHIS 6 data (both in the question and the options available) and only differs from NHIS 4 by the number of hearing loss options. After removing individuals with missing data on hearing loss (n = 357), n = 300,844 children from the NHIS data set remained for the analyses (NHIS 4, n = 164,564; NHIS 6, n = 136,280).

Data Analysis

Results of descriptive statistics for each survey are shown in Table 1, including counts on hearing loss (whether examined audiometrically or parent/self-report), age, sex, race, and year of data collection. However, these descriptive statistics do not take into account the non-random sampling and the weighting that can be used to make the estimates nationally representative. Nonetheless, these descriptive statistics do provide information that is useful in understanding some of the factors that may be contributing to differences among the results of the surveys.

[1]The missing data in the race variable was produced as an unknown category in the analyses. This resulted in an unknown race of n = 7,960 children.

To address the question of the temporal trend in childhood hearing loss by data set, two strategies were used. First, model-based parameters were estimated. Second, prevalence by year was plotted. The first used seven design-based logistic regressions (Lumley, 2010), four for NHANES (PTA ≥ 16 dB, PTA ≥ 25 dB, PTA ≥ 40 dB, and parent/self-report), one for NSCH (parent/self-report), one for NHIS 4 (parent report), and one for NHIS 6 (parent report). The basic model is shown in the following equation,[2] where *i* is the *i*th individual, Prob (Y_i=1) is the probability that the *i*th individual has hearing loss as measured by either audiologic examination or parent/self-report:

$$Ln\left(\frac{Prob(Y_i = 1)}{1 - Prob(Y_i = 1)}\right) = \beta_0 + \beta_1 Year_i + \beta_2 Sex_i + \beta_3 Race_i + \beta_4 Age_i + \varepsilon_i$$

The estimated β's were then transformed to odds ratios via a simple exponentiation to make the interpretation of the model more straightforward. As odds ratios, the resulting interpretation of the year variable (i.e., the estimated trend in childhood hearing loss) becomes the change in the odds of childhood hearing loss given a one-year increase controlling for sex, race, and age. For example, an odds ratio greater than 1 means the odds of hearing loss is increasing over time; an odds ratio less than 1 suggests a decrease in the odds of any given child having hearing loss over time.

Additionally, prevalence by year was displayed graphically as depicted in Figure 1 to show the overall pattern across time for each of the three surveys. This shows the variability within each survey and the agreement among the surveys with regard to the trend in childhood hearing loss in addition to the parametric modeling.

Results

In Table 1, unadjusted proportions are shown for both the parent/self-report measures and for the audiometry examination. These vary between 0.5–1.1%. However, these proportions do not account for the complex survey design (i.e., the clustering and non-random sampling of specific demographics) and are therefore not representative of the United States population. Each survey has similar demographics, although both NSCH and NHIS have high proportions of white children participating in the survey whereas NHANES is similar across the included race categories.

The results of the seven logistic regressions are shown in Table 2. The NHANES audiometrically measured estimate of the prevalence of hearing loss at a PTA ≥ 16 dB demonstrated a statistically significant increasing trend (OR = 1.022, p = .035). Similarly, at PTA ≥ 25 dB the odds are increasing over time although it is not statistically significant (p = .218). Hearing loss measured by NHANES audiometric data at PTA ≥ 40 dB showed decreasing prevalence estimates across time, although this is not statistically significant (p = .590). Parent/self-reported hearing loss in NHANES showed a statistically significant decreasing trend (OR = 0.772, p = .002). The parent-report in NSCH leans negative but is not statistically significant (p = .827). NHIS 4 had a statistically significant downward trend at 7.3% per year (p < .001). NHIS 6 showed a positive trend with the odds of hearing loss in children increasing 7.1% per year, although this is not statistically significant at the .05 level (p = .113).

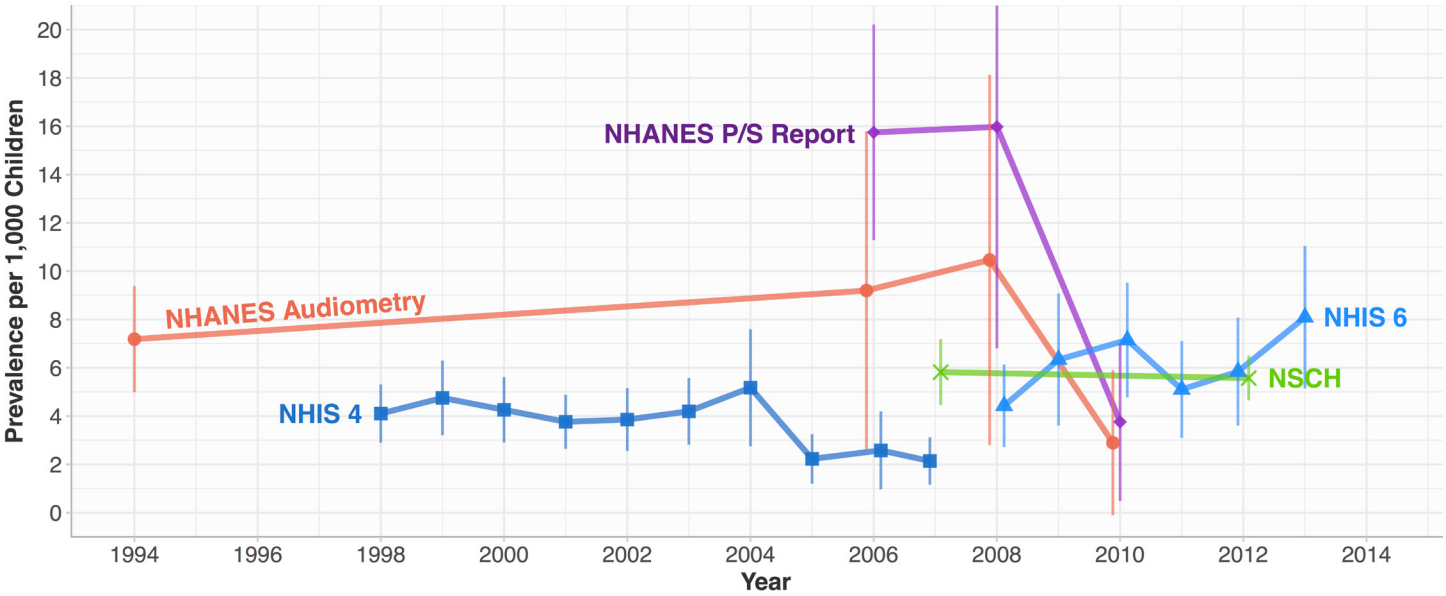

Figure 1. Prevalence per 1,000 Children Over Time Based on NHANES, NSCH, and NHIS.
Prevalence in Figure 1 is based on audiometric bilateral and unilateral hearing loss in NHANES at PTA ≥ 40 dB, P/S Report in NHANES, NSCH, and NHIS 6 at moderate or more loss and NHIS 4 at a lot of trouble or more. The vertical lines represent the 95% confidence intervals for each point. The upper limit of NHANES P/S Report for year 2008 is above the plot range (at 25.2 per 1,000). NHANES = National Health and Nutrition Examination Survey; NHIS = National Health Interview Survey; NSCH = National Survey of Children's Health; P/S Report = Parent/Self Report; PTA = pure tone averages.

[2]Note, for simplicity, that the equation does not show the design-based aspects of the model (the accounting for the clustering and weighting adjustments).

Table 2: The Results of the Modeling of Hearing Loss (or Hearing Threshold) on the Year of the Survey (i.e., the Estimated Trend), the Sex, Race/Ethnicity and the Age of the Child.

Variable	PTA ≥ 16 dB	PTA ≥ 25 dB	PTA ≥ 40 dB	Parent Report	Parent Report	Parent Report[a]	Parent Report[b]
Year	1.022*	1.02	0.989	0.772**	0.994	0.927***	1.071
Covariates							
Sex	0.958	1.062	1.241	1.281	0.650*	0.665***	1.029
Female							
Race/Ethnicity (White)[c]					1.111		
Black	0.959	1.124	1.025	0.797	1.007	1.23	0.611
Mexican American	1.084	0.84	1.172	0.423*	1.117	-	
Other	0.973	1.121	1.141	0.214*	1.106	0.611	0.906
Unkown	-	-	-	-			
Age	0.988	0.987	1.028	1.089	1.062***	1.044***	1.028
N	8,812	8,812	8,812	3,577	187,085	164,564	136,280

* significant at 0.05 level, ** significant at the 0.01 level, *** significant at the 0.001 level.
Note. NHANES has ages 12–19, NSCH has ages 0–17, and NHIS has ages 0–17. Examination and parent reported measures were modeled using a Generalized Linear Model with a logit link and a binomial distribution (i.e., logistic regression). The results are reported in odds ratios. The effects are adjusted for the complex survey design. All parent-reported rates are at *Moderate or more loss* except where noted. NHANES = National Health and Nutrition Examination Survey; NHIS = National Health Interview Survey; NSCH = National Survey of Children's Health; PTA = pure tone averages.
[a]Parent Report between 1998–2007 which only had 4 categories: *good, a little trouble, a lot of trouble, deaf. Loss was defined at a lot of trouble or deaf.*
[b]Parent Report between 2008–2013 which had 6 categories: *excellent, good, a little trouble, moderate trouble, a lot of trouble, deaf.* Loss was defined at *moderate trouble, a lot of trouble,* or *deaf.*
[c]NHIS did not have a Mexican American category.

The conflicting results for whether the prevalence of childhood hearing loss is increasing or decreasing are shown graphically in Figure 1. Not only do the prevalence estimates vary substantially across time between surveys, there is also a great deal of variation within some of the surveys across years. Even though the prevalence estimates are within the same general range with the lowest at about 2 per 1,000 and the highest at about 16 per 1,000, it is important to note that this is an eight-fold difference in prevalence. (Note that the prevalence and the 95% confidence interval for each survey at each point in time are shown in Table 3 for reference on the precise values.)

The vertical error bars for each point in Figure 1 show the 95% confidence interval around each estimate of prevalence. These bars emphasize the differences between the prevalence estimates. For example, in 2007, there is no overlap between NSCH and the NHIS error bars suggesting very different estimates of prevalence. Additionally, there is no overlap in the error bars for the 2008 estimates of prevalence based on the NHANES and the NHIS parent/self report even though the parent/self-report questions are essentially identical for both surveys (see Methods section). In 2006, NHANES audiometry and NHANES parent/self report are very different, even though both are at moderate or greater levels of loss, with parent/self report at 15.7 and audiometry at 9.2 per 1,000 children.

Consistent with the data from the logistic regression models in Table 2, it is also clear from Figure 1 that the temporal trends among the surveys do not agree either in direction or magnitude. The NHANES measures show a noteworthy drop from 2008 to 2010 while NHIS 6 has a generally upward trend. NSCH holds relatively steady during the time that NHIS increases and NHANES drops. These varying results could have been affected by the relatively low number of children with hearing loss in the NHANES sample where there were only 95 children with hearing loss at PTA ≥ 40 dB summed across the four years available for the audiometry measure in NHANES. Similarly, only 54 children had hearing loss according to the parent/self-report in NHANES across the three time points.

Table 3: Prevalence per 1,000 by data set and year as shown in Figure 1 for reference.

	NHANES Audiometry		NHANES PS		NHIS4		NHIS6		NSCH	
Year	Prevalence	95% CI	Prevalence	95% Ci	Prevalence	95% CI	Prevalence	95% CI	Prevalence	95% CI
1994	7.184	(4.98,9.39)								
...										
1998					4.104	(2.90,5.31)				
1999					4.751	(3.21,6.30)				
2000					4.259	(2.91,5.61)				
2001					3.762	(2.64,4.88)				
2002					3.855	(2.55,5.16)				
2003					4.196	(2.82,5.58)				
2004					5.174	(2.75,7.59)				
2005					2.226	(1.20,3.25)				
2006	9.198	(2.59,15.8)	15.747	(11.28,20.21)	2.578	(0.96,4.19)				
2007					2.140	(1.16,3.12)			5.818	(4.46,7.18)
2008	10.463	(2.80,18.13)	15.976	(6.80,25.15)			4.425	(2.71,6.14)		
2009							6.339	(3.60,9.07)		
2010	2.893	(0.00,5.90)	3.759	(0.48,7.03)			7.149	(4.78,9.52)		
2011							5.103	(3.10,7.11)		
2012							5.841	(3.60,8.08)	5.572	(4.65,6.50)
2013							8.091	(5.14,11.04)		

Note. CI = confidence interval; P/S Report = parent/self-report; NHANES = National Health and Nutrition Examination Survey; NHIS4 = National Health Interview Survey 1998–2007; NHIS6 = National Health Interview Survey 2008–2013; NSCH = National Survey of Children's Health.

Discussion

The primary question addressed by these analyses was whether estimates from the different surveys had similar estimates of prevalence for childhood hearing loss and the direction and magnitude of the temporal trend. Although all of the estimates are in a range of 2–16 children per 1,000 from 1994 to 2013, there are noteworthy differences within this range. For example, estimates ranged between 4.4 per 1,000 to 16.0 per 1,000 in 2008 alone with essentially identical questions. Based on these estimates, there would be somewhere between 326,040 children and 1,185,600 children with hearing loss in the United States in 2010. The resources needed to provide diagnostic and habilitation services for 326,040 children are very different than what would be needed for 1,185,600 children. Such a wide range in estimates indicates that funders, administrators, and policy makers do not have the precise information they need to make decisions.

Information about childhood hearing loss are similarly problematic with the trend. Similar to the estimates of prevalence, the estimates of the trend vary greatly between surveys. For example, audiometry measures at PTA ≥ 40 dB and the parent/self-report measures in the NHANES data suggested a decreasing trend of hearing loss, while PTA ≥16 dB and ≥ 25 dB in NHANES and the NHIS 6 (parent report) suggested an increasing prevalence across time (although only PTA ≥16 dB was increasing at a statistically significant level). Further, the parent-report in NSCH showed no change in the prevalence across time. This high degree of variability shown in Figure 1 is striking and has important implications for administrative, policy, and resource allocation decisions.

Considering data from all three surveys at the same time raises fundamental questions about the accuracy of prevalence and trend data from these surveys. The results suggest that there must be some aspect of the measures that are not reliable. For a start, no well-documented research has addressed whether parent/self-report measures of childhood hearing loss are aligned with audiometry measures. Future research should address this important question. Additionally, for the parent/self-report measures, the phrasing is likely important. Although giving the parent the freedom to rate their child's hearing loss may seem advantageous, it appears that such a rating may not be reliable. Research needs to examine whether the way in which questions are worded affects the accuracy of parent/self-report.

A second research question was whether there was agreement between the surveys about the trend in the prevalence of hearing loss in the United States. In the report by Shargorodsky et al. (2010), the trend appeared to be steady and consistent. However, subsequent data from NHANES results in a less clear answer. Instead of a steady increase, there appears to be a sizable increase and then an even larger decrease in prevalence thereafter. This is especially true at PTA ≥ 40 dB, but a similar pattern is also found at PTA ≥ 16 and PTA ≥ 25 dB. In light of those next data points, and the results from the other surveys, there is no clear answer from federally funded surveys about whether the prevalence of childhood hearing loss is increasing or decreasing.

[3]There were an estimated 74.1 million children in the United States in 2010 (America's Children: Key National Indicators of Well-Being, 2016).

Limitations

In interpreting the results of this study, it should be noted that each of these surveys was designed for slightly different purposes. Whereas the NHANES and NHIS are designed for researching both adults and children, the NSCH is designed specifically for children. This may explain some of the more stable estimates for children. The analyses were reliant on the surveys' designs and weighting information. Factors such as missing data could obstruct the resulting weighting scheme from maximally being nationally representative. However, none of the surveys had a high rate of missing values in any of the variables of interest.

Each survey, in an attempt to accommodate the needs of the country's health research, occasionally changed which questions were used or how responses about hearing loss were worded. This limited some of the analyses to specific years (e.g., NHANES parent/self-report from 1994 could not be combined with 2006–2010 and NHIS data from 1998–2007 could not be combined with 2008–2013).

Finally, the results bring into question the use of the data for prevalence and trend analyses and measurement (especially parent report) in regards to childhood hearing loss. The results do not indicate whether a similar pattern would be found for other health factors. Further, the results do not indicate that the data cannot be used for other purposes (e.g., testing relationships among the data without reference to being nationally representative).

Conclusions

The NHANES, NSCH, and NHIS data sets are arguably the best data available about children's health in the United States. They are widely respected because of the systematic and state-of-the art way in which information is collected, and data from each of these surveys have been used frequently to make important policy and administrative decisions. Given this, it is troubling how much disagreement there is among these three data sets about the prevalence and trends of childhood hearing loss in the United States. While all of the surveys suggest that childhood hearing loss is a substantial problem, affecting somewhere between 2 to 16 children per 1,000 over the last two decades, these large, federally-funded surveys do not provide good enough data to be confident about estimates of either prevalence or trend. Thus, until additional research is done to explain why there is so much disagreement within and between the data sets, we only have a rough estimate of the prevalence of childhood hearing loss in the United States and we do not know whether the trend is increasing or decreasing.

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