Factors Affecting DHH-Specific Quality of Life in Deaf/HH Adolescents Attending Mainstream Schools

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Abstract

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Background: The Youth Quality of Life – Deafness and Hard of Hearing (YQoL-DHH) module measures DHH-specific quality of life in adolescents across three domains – Participation, Self-Acceptance/Advocacy, and Perceived Stigma. QoL is an important concept to measure for DHH youth, as it reflects perceptions of ability to interact with peers, which is an important part of adolescent development. Few studies have examined the relationship between adolescents' difficulty understanding conversations and QoL outcomes among those attending mainstream schools.

Methods: This cross-sectional study utilized data collected in 2010 from sites across the U.S. The sample included 158 DHH adolescents, ages 11 to 18, attending mainstream schools either with (36%) or without (64%) a DHH program. This study examined the relationship between adolescents' perceived level of difficulty understanding conversations and DHH-specific QoL, and identified potential predictors of perceived difficulty understanding conversations. Data were analyzed using multiple regression and logistic regression analysis. The models controlled for multiple demographic factors including age, race/ethnicity, socioeconomic status, and geographic location.

Results: Results showed that perceived level of difficulty understanding conversations is significantly associated with lower scores in Participation QoL ($p<0.01$) and higher scores in the Perceived Stigma

domain ($p<0.05$), indicating higher DHH related perceived stigma in adolescents who reported higher levels of difficulty understanding conversations. Perceived level of difficulty understanding conversations was not significantly associated with Self-Acceptance/Advocacy QoL. Only preferred mode of communication was a significant predictor of self-reported level of difficulty understanding conversations. Adolescents who had equal preference for communication via sign language and speech reported significantly higher difficulty understanding conversations ($p<0.05$).

Conclusions: Results demonstrated that perceived level of difficulty understanding conversations impacts QoL in the Participation and Perceived Stigma domains, but is not significantly associated with Self-Acceptance/Advocacy. Equal preference for speech and sign language was associated with higher difficulty understanding conversations in this analysis, although it has been shown to be associated with higher QoL in previous studies. These results can help inform decision-making for clinicians, educators, and parents, and can be used to tailor interventions and programs to support DHH youth.

Background and Significance

Prevalence of hearing loss in U.S. adolescents has increased in the last 30 years.[1,2] Using audiometric and nationally representative data from the National Health and Nutrition Examination Survey (NHANES), Lin et al. estimated that 20.3% of Americans 12 years or older experienced bilateral hearing loss in 2001-2008.[2] While hearing loss can be acquired during childhood due to infection or trauma, congenital cases are also common, with 50-60% of congenital cases arising from genetic causes.[3] The CDC's Hearing Screening and Follow-up Survey estimates that in 2009 up to 4.6 per 1,000 babies were congenitally deaf, as identified through newborn hearing screening.[3] Mild and moderate hearing level is much more common than severe and children with mild to moderate hearing level are typically integrated into mainstream classrooms but may receive extra support in schools.[4,5] While the CDC estimates that about 71% of deaf or hard of hearing (DHH) young adults ages 21-25 were employed in 2009, 40% of those who became deaf or hard of hearing during their childhood years at least one limitation of daily functioning.[6]

The environment in which a child is raised can have a major impact on psychosocial development and may significantly affect communication skills and relationship formation.[7,8] For children with hearing impairment, exposure to communication and access to language can be an especially important factor in psychosocial development. Over 95% of children who are deaf or hard of hearing are born to hearing parents.[9] This means that the language used at home is often a spoken one and some children are not exposed to other forms of communication, such as American Sign Language (ASL), Pidgin Signed English (PSE), or Manually Coded English (MCE), until later in life, which can result in deficits in cognitive abilities and delays in language formation.[10] Adolescence is a time of rapid cognitive and psychosocial development, and DHH youth may experience added complexities during this stage because they are often required to interact with a mostly hearing world and their experiences around communication are therefore unique from those of hearing adolescents.[11]

Having access to educational and social support, technology, and communication at home is important to social and cognitive development for DHH adolescents.[11,12,13,14] As assistive technologies such as cochlear implants (CI) become more commonly used, several studies have shown that children and adolescents who are deaf or hard of hearing and use CI show comparable educational and

psychosocial development as children without hearing impairment, especially if they receive implants in early childhood.[15,16,17,18] In 2013, about 60% of DHH adolescents in the U.S. received education in mainstream classrooms and this proportion continues to increase, calling attention to the importance of adequate educational and social support for children with hearing imapairment.[19] It has been shown that DHH youth who feel that they have access to adequate communication at home and with peers report higher self-esteem.[13,12] The ability to communicate with peers and family is an important factor in the formation of social relationships and significantly contributes to social well-being and sense of belonging.[20,21,22] Recent studies have examined several of these factors in relation to measures of Quality of Life (QoL) in adolescents who are deaf or hard of hearing.[23,24,25,11]

QoL in this study will be defined using the WHO QoL Group's definition, which focuses on the individual's perception of position in life in the context of culture and value systems.[26] This definition highlights the subjective nature of factors influencing QoL and the importance of self-reported measures when assessing these relationships. Adolescence is a critical time for social, emotional, and cognitive development and is therefore an important time to assess QoL.[11] QoL is a particularly critical measure for adolescents who are deaf or hard of hearing because it provides a measure of subjective well-being and reflects the DHH youth's perception of ability to successfully interact with peers, which is an important part of development. While the functional outcomes of cognitive ability, expressive communication (spoken language and written communication), and psychosocial outcomes have been well studied, few studies have specifically considered the relationship between communication and QoL from the perspective of DHH adolescents.[27,28,29,30,31,32,33]

In particular, most studies focus on select groups of DHH youth, such as only those with cochlear implants, and consider only functional measures of communication without including self-reported perceptions of the adolescents themselves. These external measures may not necessarily correlate well with QoL because of the subjective nature of QoL and the factors that affect it.[34] In fact, Loy et al. found no difference in health–related QoL measures in DHH youth versus hearing youth.[24] Perceptions of one's ability to understand communication, on the other hand, are subjective and we therefore expect that this measure is more likely to be correlated with self-reported QoL.[33] In fact, studies have found that

adolescents who are more satisfied with communication at home reported higher self-esteem, social competence, and higher overall life satisfaction.[15,35]

While the relationship between self-reported level of difficulty understanding communication and QoL has not been well studied outside of communication with parents, it is clear that ability to communicate effectively is an important factor in QoL for DHH adolescents.[33] Both parents and clinicians who care for deaf or hard of hearing children are faced with complex decisions regarding assistive technology, exposure to spoken and signed language, school placement, intervention and therapy choices, and modes of communication.[11] Understanding the importance of perceived communication difficulty is especially critical as more DHH adolescents are attending mainstream schools and can be used to aid in decision-making for parents and to ensure that adequate support is provided in school and social environments.[36] Communication ability plays an important role in these decisions, and more knowledge is needed about whether adolescents receiving education in mainstream classrooms perceive difficulty in being able to understand conversations with peers and others outside of their parents and how this may affect their QoL. In addition, if factors such as technology use and communication preference impact level of difficulty understanding conversations in a mainstream school setting, this information can be crucial to shared decision making and clinical decision making for families and providers.

Specific Aims

Given the importance of effective communication in a primarily spoken language environment for DHH youth attending mainstream schools, this study assessed the relationship between DHH adolescents' self-reported level of difficulty understanding conversations and their DHH-specific QoL and examined potential predictors of perceived difficulty understanding conversations. A multivariate modeling framework was used to assess the following specific aims:

1. Examine the association between self-reported level of difficulty understanding conversations and the YQOL-DHH domains of Perceived Stigma, Participation, and Self-Acceptance/Advocacy. The item for understanding conversations can be applied across modes of communication; therefore, we will examine overall perceptions of difficulty understanding conversations.

2. Assess whether assistive technology use (cochlear implant, hearing aid, or none), communication preference (speech, sign, or equal preference), and hearing level (mild, moderate, moderate/severe, severe, profound) are significant predictors of the level of difficulty understanding conversations in DHH adolescents attending mainstream schools.

Having a better understanding of factors that improve perceptions of communication ability will help clinicians and educators working with DHH youth to provide adequate care, support, and design effective interventions to promote optimal QoL and better psychosocial outcomes. We know that some youth who are deaf or hard of hearing are more successful than others and go on to lead very productive lives; therefore, it is important to understand factors that contribute to well-being and positive outcomes for these individuals.[37]

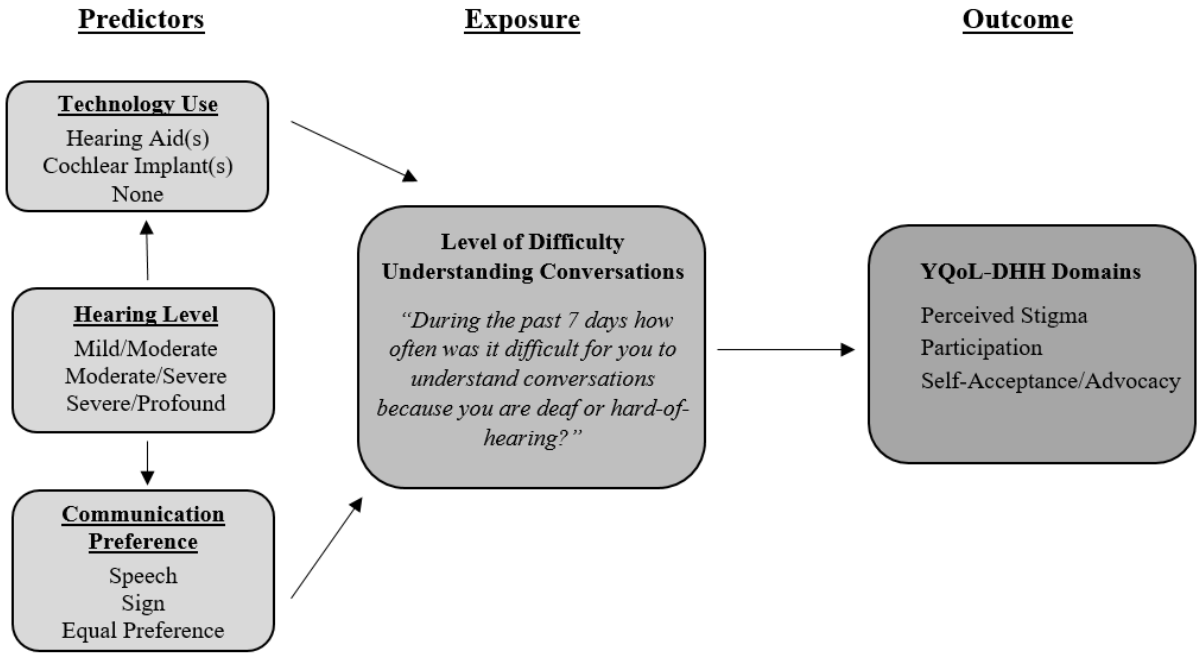
Conceptual Framework

The below conceptual framework describes the measures included in this analysis and the hypothesized relationships between factors which contribute to DHH youth QoL. The main association examined in this study is the effect of self-reported level of difficulty understanding conversations (as reported in the YQoL-DHH instrument) on DHH-specific QoL scores in three domains: Participation, Self-Acceptance/Advocacy and Perceived Stigma. Based on prior literature that looked at the effect of communication with parents on YQoL-DHH scores[33], we hypothesize that greater difficulty understanding conversations will be significantly associated with lower QoL scores in the Participation and Self-Acceptance/Advocacy domains as well as higher Perceived Stigma related to being deaf or hard of hearing.

Aim 2 examines potential predictors of difficulty understanding conversations (depicted on the left in the below framework), including technology use, preferred mode of communication, and hearing level. An individual's hearing level may impact the type of assistive technology that the person chooses to use, or has access to, as well as their preferred mode of communication.[38] All three of these factors are examined as potential predictors of level of difficulty understanding conversations in this study. While hearing level has not been found to be a significant predictor of both DHH-specific and generic QoL, its relationship to difficulty understanding conversations has not been previously evaluated.[23,33,39] Preferred mode of communication was found to be associated with self-perceived stigma associated with being

deaf or hard of hearing in Kushalnagar et al.'s study and exposure to conditions that support communication in DHH youth has been found to be important to self-esteem and general life satisfaction for this population.[33,21] Studies of the impact of assistive listening devices on communication ability and life satisfaction in DHH youth show varied results. Most recent studies focusing on young CI users showed that while DHH youth using CI may have comparable psychosocial and educational outcomes as hearing youth, they may still face difficulties in understanding spoken language, social cognition, and participating in communication in group settings.[30,31,40,15]

Figure 1. Conceptual Framework of Factors that Impact DHH-Specific QoL in DHH Youth Attending Mainstream Schools.



Study Design and Methods

Study Design and Data Source: This cross-sectional study was carried out using data collected during the QoL of Deaf and Hard-of-Hearing Children and Youth (YQOL-DHH) study, as part of the validation of the YQOL-DHH instrument.[41] The instrument measures DHH-specific QoL in DHH adolescents and collects information on technology use, communication preferences, and demographics. All study data is de-identified; therefore, IRB approval was not required for this secondary analysis.

YQOL-DHH Instrument: The YQOL-DHH is a validated, hearing-loss specific, youth Quality of Life instrument composed of 32 items across three domains (10-item Participation, 14-item Self-Acceptance/Advocacy, and 8-item Perceived Stigma). The instrument allows for multiple administration methods, including paper-and-pencil, web-based written English, American Sign Language (ASL) DVD, Pidgin Signed English (PSE) DVD, and interviewer-administered ASL DVD, which was used for participants who did not meet reading level requirements and lived within proximity to a research site. Two native adult signers translated the survey into ASL and PSE.[39]

Study Setting: Recruitment for the QoL of Deaf and Hard-of-Hearing Children and Youth study was purposive, with a focus on diversity of the study sample including an equal distribution of hearing levels (mild, moderate, moderate-severe, severe, profound) and technology use (cochlear implant, hearing aid or none). Participants were recruited from different types of school settings including DHH schools, mainstream schools with a DHH program, and mainstream schools without a DHH program. The present analysis includes only participants who attended mainstream schools (n=158). Youth and parents interested in participating contacted the study team via web, email, instant messaging, toll-free telephone number, or videophone. The final study sample included participants from the South (30%), Northeast (4%), Midwest (25%), and Western (41%) regions of the U.S.[39]

Study Population: Participants were classified by hearing level based on better ear pure tone average (PTA) or average unaided air conduction thresholds at 500Hz, 1000Hz, and 2000Hz. Hearing level was categorized as mild, moderate, moderate-severe, severe, or profound and participants with a cochlear implant were categorized separately. Participant hearing level was confirmed by an American Speech Language and Hearing Association certified audiologist. Of the total parent study sample, one hundred and twenty (52%) participants completed the paper-and-pencil self-administered survey, 68 (29%) completed the web-based version, and 20 (9%) completed the ASL or PSE DVD self-administered version. Nine participants received the interviewed-assisted ASL DVD version and 13 (6%) participated in a group interviewer assisted administration.[39] Parent consent and youth assent were obtained from all participants prior to study participation.

Inclusion/Exclusion Criteria: Adolescents ages 11-18 were eligible to participate if they met the definition of deaf or hard-of-hearing in their school and had an Individualized Education Program (IEP) in place.

Other eligibility criteria included being deaf or hard of hearing in both ears, permission to contact the child's audiologist to confirm hearing level, education and residence in the U.S., and ability to read English, sign ASL or PSE at least at a 4rd grade reading level, access to DVD or web technology, or ability to fill out a paper or web questionnaire. Exclusion criteria included presence of multiple sensory disorders (i.e. deaf-blindness), parental report of other physical conditions (i.e. impaired mobility, chronic diseases, craniofacial anomalies), or presence of serious mental health conditions (i.e. ADHD, bipolar disorder, schizophrenia, or severe depression) that have a greater QoL impact than being deaf or hard of hearing (as judged by the parent). Eligibility screening was conducted with parents.

Study Analysis

Analytic Variables: In aim 1, the independent variable was self-reported level of difficulty understanding conversations, as measured by the following question in the YQoL-DHH instrument: "*During the past 7 days how often was it difficult for you to understand conversations because you are deaf or hard-of-hearing?*" The response options for this question were: Never, Rarely (Once during Week), Sometimes (2-3 Times), Often (Daily), or Very Often (More than Once per Day). These were coded 0-4, with Never coded as zero and Very Often coded as four. This variable was treated as categorical in the present analysis. This YQoL-DHH item was written in a negative direction, meaning that someone who reports never having difficulty understanding conversations during the past week actually has a high level of understanding and experiences low difficulty, signifying a positive answer. For aim 2, the independent variables included technology use, preferred mode of communication, and hearing level. Technology use was classified as either using a cochlear implant, a hearing aid, or no assistive technology. Communication preference was classified as either preferring to communicate via speech, preferring to communicate via sign language, or having equal preference for both speech and sign language. Finally, hearing level was classified as either mild/moderate, moderate/severe, or severe/profound. These variables were also treated as categorical in the present analysis.

The outcome of interest in aim 1 was the DHH-specific QoL scores in three domains (Participation, Self-Acceptance/Advocacy, and Perceived Stigma). The YQOL-DHH instrument measures QoL on a scale of 0-100 and scores are reported separately for each of the three domains. While the

domains are related, the scores are not summed up across domains. This outcome variable was treated as continuous in the present analysis. The outcome of interest for aim 2 was self-reported level of difficulty understanding conversations, which was measured by the previously mentioned instrument question. This outcome was dichotomized into two categories, either a high level of difficulty understanding or a low level of difficulty understanding.

Statistical Analysis: The present analysis was restricted to participants who attended mainstream schools (either with or without a DHH program), in order to focus on the impact of navigating a mostly hearing environment on DHH youth QoL. For the first aim, multiple regression models were used to examine the relationship between self-reported level of difficulty understanding conversations and the YQOL-DHH scores by domain. Based on prior studies and the research literature, each model controlled for the following demographic variables: age group, sex, Mother's Educational level (as a proxy of participant socioeconomic status), geographic region, and race/ethnicity. The primary language used at home was also included in these models. Hearing level was not included as a confounder because it was not found to be significantly associated with differences in QoL outcomes in previous studies.[23,33,39]

The following models were used for the analysis of Aim 1:

Participation Domain = $\beta_0 + \beta_1$(Level of Difficulty Understanding) + β_2(Age Group) + β_3(Sex) + β_4(SES) + β_5(Geographic Region) + β_6(Race/Ethnicity) + β_7(Home Language)

Self-Acceptance/Advocacy Domain = $\beta_0 + \beta_1$(Level of Difficulty Understanding) + β_2(Age Group) + β_3(Sex) + β_4(SES) + β_5(Geographic Region) + β_6(Race/Ethnicity) + β_7(Home Language)

Perceived Stigma Domain = $\beta_0 + \beta_1$(Level of Difficulty Understanding) + β_2(Age Group) + β_3(Sex) + β_4(SES) + β_5(Geographic Region) + β_6(Race/Ethnicity) + β_7(Home Language)

For the second aim, logistic regression models were used to assess the relationship between the three categorical predictors of interest (technology use, communication preference, and hearing level) and the outcome of level of difficulty understanding conversations. The outcome variable was treated as dichotomous. The answer categories of Never, Rarely (Once during week), and Sometimes (2-3 times) represented a low level of difficulty understanding conversations, coded as 0 in the analysis, and the answer categories of Often (daily), and Very Often (more than once per day) represented a high level of difficulty understanding conversations and were coded as 1 in the analysis. The same covariates were

included in the model as in Aim 1 in order to account for demographic factors and language exposure. All analyses were completed using STATA 14.[42]

The following models were used for the analysis of Aim 2:

Level of Difficulty Understanding = $\beta_0 + \beta_1$(Technology Use) + β_2(Age Group) + β_3(Sex) + β_4(SES) + β_5(Geographic Region) + β_6(Race/Ethnicity) + β_7(Home Language)

Level of Difficulty Understanding = $\beta_0 + \beta_1$(MOC) + β_2(Age Group) + β_3(Sex) + β_4(SES) + β_5(Geographic Region) + β_6(Race/Ethnicity) + β_7(Home Language)

Level of Difficulty Understanding = $\beta_0 + \beta_1$(Hearing Level) + β_2(Age Group) + β_3(Sex) + β_4(SES) + β_5(Geographic Region) + β_6(Race/Ethnicity) + β_7(Home Language)

Results

Participants: Demographic characteristics and the distribution of the study sample are summarized in Table 1. Study participants (n=158) included adolescents aged 11-18, with different hearing levels, who attended mainstream schools either with or without a DHH program (64% without DHH program, 36% with DHH program). The sample was evenly distributed by gender (47.5% female and 52.5% male) and slightly skewed toward the younger age group (58.2% ages 11-14 and 41.2% ages 15-18). The mean age of study participants was 14 years old. The majority of participants were Caucasian (63%), preferred to communicate via speech only (72.1%), communicated via spoken English at home (82.9%), and reported that their mother was a college graduate (63.5%). Mother's highest education level was used as an indicator of family socioeconomic status (SES). This indicator is commonly used in epidemiologic studies as a proxy measure of socioeconomic status.[43] Over half of participants used hearing aids (54.4%), and 34.3% used cochlear implants. Participants had the option of selecting more than one type of assistive technology (i.e. 1 hearing aid and 1 cochlear implant) depending on their specific technology use. Self-reported level of difficulty understanding conversations during the past 7 days was normally distributed as shown in Table 2.

Table 1. Study sample characteristics (n= 158).

	No. (%)
Age, y (n= 158)	
11-14	92 (58.2)
15-18	66 (41.8)
Mean ±	13.92 ± 2.15
Gender (n= 158)	

Female	75 (47.5)
Male	83 (52.5)
Geographic Region (n= 158)	
Northeast	6 (3.8)
Midwest	48 (30.4)
South	48 (30.4)
West	56 (35.4)
Race/Ethnicity (n= 154)	
Caucasian	97 (63)
African American	10 (6.5)
Asian/Pacific Islander	3 (1.9)
Native American	6 (3.9)
Hispanic	22 (14.3)
Other/mixed/not specified	16 (10.4)
Mother's Education (n= 145)	
Less Than High School	9 (6.2)
High School/GED	20 (13.8)
Some College	24 (16.5)
College Graduate	92 (63.5)
School Type (n= 158)	
Mainstream without D/HH Program	101 (63.9)
Mainstream with D/HH Program	57 (36.1)
Technology Use (n=158)*	
Binaural Hearing Aids	61 (38.6)
One Hearing Aid	25 (15.8)
Cochlear Implant (1 ear)	36 (22.8)
Cochlear Implant (2 ears)	18 (11.4)
Do Not Use	21 (13.3)
Other	8 (5.1)
Language Used at Home (n= 157)	
English	131 (82.9)
ASL	12 (7.6)
PSE or MCE	2 (1.3)
Spanish	7 (4.4)
Other	5 (3.2)
Preferred Mode of Communication (MOC) (n= 158)	
Speech	114 (72.1)
Sign	23 (14.6)
Equal Preference	21 (13.3)
Hearing Level (Audiogram) (n= 156)	
Mild/Unilateral	25 (16.0)
Moderate/Moderate-Severe	38 (24.4)
Severe/Profound	40 (25.6)
Cochlear Implant	53 (34.0)

* Multiple selections allowed for this question.

Table 2. Distribution of the Level of Difficulty Understanding Conversations.

During the past 7 days, how often was it difficult for you to understand conversations because you are deaf or hard of hearing? (n=158)	No. (%)
Never	19 (12.0)
Rarely (Once During week)	30 (18.9)
Sometimes (2-3 times)	50 (31.6)
Often (Daily)	41 (25.9)

Very Often (More Than Once Per Day)			18 (11.4)
# Observations	**Mean**	**Std. Dev.**	**Variance**
158	2.06	1.18	1.39

Level of Understanding and YQoL-DHH by Domain: In univariate analyses, level of difficulty understanding conversations was significantly associated with age group ($p<.05$) and geographic region ($p<.01$) of the participants, but did not differ significantly by gender, school type (with or without a DHH program), or language used at home (Table 3).

Table 3. Mean Level of Difficulty Understanding Conversations by School Type, Gender, Age Group, Mother's Education, and Language Used at Home.

School Type (P=0.31)	**Level of Difficulty Understanding Conversations (Reverse Coded 0-4)***		
	Mean	**Std. Dev.**	**No. (%)**
Mainstream without DHH Program	2.13	1.19	101 (63.9)
Mainstream with DHH Program	1.93	1.16	57 (36.1)
Gender (P=0.71)			
Female	2.09	1.15	75 (47.5)
Male	2.02	1.21	83 (52.5)
Age Group (*P=0.012*)			
11-14	1.86	1.14	92 (58.2)
15-18	2.33	1.18	66 (41.8)
Mother's Education (P=0.074)			
Less than High School	1.44	1.33	9
High School/GED	1.8	1.11	20
Some College	2.5	1.06	24
College Graduate	2.08	1.17	92
Geographic Region *(P=0.003)*			
West	2.39	1.20	56
Midwest	2.19	1.08	48
Northeast	1.33	0.52	6
South	1.63	1.16	48
Language Used at Home (P=0.15)			
English	2.11	1.16	131
ASL	1.83	1.11	12
PSE or MCE	2	0	2
Spanish	1	1	7
Other	2.4	1.82	5

* 0 = Never; 1 = Rarely (Once during Week); 2 = Sometimes (2-3 times); 3 = Often (Daily); 4 = Very Often (More than once per day)

Participation QoL Domain: In a multivariate model, level of difficulty understanding conversations was significantly associated with Participation QoL, when controlling for demographic variables and language used at home ($p<0.01$). Adolescents who reported higher difficulty understanding conversations had a significantly lower Participation score. Compared to adolescents who reported never having difficulty understanding conversations (during the past week), those who had difficulty understanding conversations once during the week reported a Participation score that was on average 14.1 points lower ($p<.05$). Those who reported having difficulty understanding conversations 2-3 times during the week had a Participation score that was on average 23.1 points lower and those who reported having difficulty understanding conversations daily or more than once per day had scores that were 32.8 and 31.6 points lower on average respectively ($p<0.001$).

Although age group was not significant in this model, older participants (15-18 years old) were more likely to report lower Participation scores ($p=0.057$). Adolescents whose mother was a college graduate reported significantly higher scores compared to those whose mothers had less than a high school education ($p <.05$). The other categories of mother's education were not significantly associated with Participation scores, although participants whose mother had any level of education above a high school level were more likely to report higher Participation scores.

Table 4. YQOL-DHH – Participation Domain Score by Predictor Variables

DHH YQoL Participation	Coefficient	STD Error	P-Value
Level of Understanding – Rarely (Once During Week)	**-14.067**	**5.856**	**0.018**
Sometimes (2-3 Times)	**-23.061**	**5.442**	**0.000**
Often (daily)	**-32.819**	**5.638**	**0.000**
Very Often (More Than Once Per Day)	**-31.604**	**6.685**	**0.000**
Age Group 15-18	-6.452	3.363	0.057
Sex – Male	2.295	3.090	0.459
Mother's Education – HS/GED	11.610	9.272	0.213
Some College	11.612	9.271	0.213
College Grad	**21.177**	**8.844**	**0.018**
Geographic Region – Midwest	-4.874	3.928	0.217
Northeast	6.036	8.792	0.494
South	1.891	4.068	0.643
Race/Ethnicity - Hispanic	-4.744	5.974	0.429
African American	2.616	6.529	0.689
Asian/Pacific Islander	2.809	12.810	0.827
Native American	-8.563	9.176	0.353
Other	-1.437	5.096	0.778
Language Used at Home – ASL	6.393	6.463	0.325
PSE or MCE	11.024	18.685	0.556

Spanish	12.858	11.194	0.253
Other	-12.667	10.671	0.238
Constant	67.072	9.910	0.000

N = 139, P = <0.001, R-squared = 0.43

Self-Acceptance/Advocacy QoL Domain: Level of difficulty understanding conversations was not significantly associated with Self-Acceptance/Advocacy QoL when controlling for demographic variables and language used at home. Although the overall model was not significant, adolescents who reported having difficulty understanding conversations daily during the past week had scores that were on average 10.5 points lower than adolescents who never had difficulty understanding (p<.05). All levels of difficulty understanding conversations were associated with lower Self-Acceptance/Advocacy QoL, although only those who reported having difficulty understanding conversations daily reported significantly lower scores in this domain.

Table 5. YQOL-DHH – Self-Acceptance/Advocacy Domain Score by Predictor Variables

Self-Acceptance/Advocacy	Coefficient	STD Error	P-Value
Level of Understanding – Rarely (Once During Week)	-1.587	4.923	0.748
Sometimes (2-3 Times)	-6.110	4.556	0.182
Often (daily)	**-10.492**	**4.775**	**0.030**
Very Often (More Than Once Per Day)	-9.247	5.700	0.107
Age Group 15-18	-0.096	2.876	0.973
Sex – Male	3.794	2.673	0.158
Mother's Education – HS/GED	8.946	7.254	0.220
Some College	2.749	7.463	0.713
College Grad	8.760	7.094	0.219
Geographic Region – Midwest	-7.662	3.338	0.023
Northeast	1.530	8.180	0.852
South	-3.259	3.443	0.346
Race/Ethnicity - Hispanic	1.617	5.125	0.753
African American	-4.872	5.606	0.387
Asian/Pacific Islander	-3.033	10.994	0.783
Native American	-7.041	7.878	0.373
Other	-3.438	4.385	0.435
Language Used at Home – ASL	-1.693	5.525	0.774
PSE or MCE	-25.721	16.019	0.111
Spanish	-8.362	8.831	0.346
Other	3.008	9.151	0.743
Constant	77.972	8.172	0.000

N = 139, P=0.205, R-squared = 0.19

Perceived Stigma QoL Domain: The Perceived Stigma domain scores were reverse coded so that a higher score indicates higher DHH related perceived stigma. In a multivariate model, the level of difficulty understanding conversations was significantly associated with Perceived Stigma QoL, when controlling

for demographic variables and language used at home (p<.05). Although the overall model was significant, only the two highest levels of difficulty understanding conversations were significantly associated with higher scores in Perceived Stigma (p<.05). Similar to the other two domains, the greatest difference in YQOL-DHH scores was seen in those adolescents that reported having daily difficulty understanding conversations (p >.05).

Table 6. YQOL-DHH – Perceived Stigma Domain Score by Predictor Variables

Perceived Stigma	Coefficient	STD Error	P-Value
Level of Understanding – Rarely (Once During Week)	6.927	7.167	0.336
Sometimes (2-3 Times)	11.768	6.617	0.078
Often (daily)	**16.801**	**6.829**	**0.015**
Very Often (More Than Once Per Day)	15.389	7.853	0.053
Age Group 15-18	-3.514	3.885	0.368
Sex – Male	-6.480	3.572	0.072
Mother's Education – HS/GED	-14.076	10.498	0.183
Some College	-6.197	10.462	0.555
College Grad	-12.402	9.957	0.216
Geographic Region – Midwest	14.479	4.466	0.002
Northeast	-0.623	12.156	0.959
South	7.265	4.778	0.131
Race/Ethnicity - Hispanic	6.399	6.690	0.341
African American	10.936	9.194	0.237
Asian/Pacific Islander	2.821	14.294	0.844
Native American	10.243	10.272	0.321
Other	1.956	5.747	0.734
Language Used at Home – ASL	6.446	7.881	0.415
PSE or MCE	26.931	20.784	0.198
Spanish	4.279	12.526	0.733
Other	12.666	11.927	0.291
Constant	21.707	11.398	0.060

N = 129, P= 0.025, R-squared = 0.26

Technology Use: For the second aim of this analysis, the level of difficulty understanding conversations variable was dichotomized into a high level of difficulty and a low level of difficulty, as described in the Study Methods. In a multivariate logistic regression model, technology use approached significance in predicting level of difficulty understanding conversations (p=0.05), when controlling for demographic variables and language used at home. Although the overall model approached significance, none of the different types of assistive technology used showed significant relationships with the level of difficulty understanding conversations and all coefficients were close to zero. The only covariate that was significantly associated with the level of difficulty understanding conversations in this model was age

group, with older adolescents (15-18) having a 3.08 times higher odds of reporting a high level of difficulty understanding conversations compared to younger adolescents (11-14) (p <.01).

Table 7. Technology Use and Level of Difficulty Understanding Conversations

Difficulty Understanding	Coefficient	STD Error	P-Value
Binaural Hearing Aids	-0.792	1.153	0.492
One Hearing Aid	-0.656	0.966	0.497
CI (1 ear)	-0.420	1.029	0.683
CI (2 ears)	-0.256	1.230	0.835
Do Not Use	-2.048	1.247	0.100
Other	0.361	1.358	0.790
Age Group 15-18	**1.124**	**0.441**	**0.011**
Sex – Male	0.305	0.442	0.491
Mother's Education – HS/GED	-0.997	1.480	0.500
Some College	0.589	1.388	0.671
College Grad	-0.335	1.348	0.804
Geographic Region – Midwest	-0.890	0.515	0.084
South	-1.875	0.596	0.002
Race/Ethnicity – Hispanic	-0.143	0.839	0.865
African American	-0.965	0.969	0.319
Asian/Pacific Islander	-0.999	1.517	0.510
Native American	0.231	1.312	0.860
Other	-1.509	0.824	0.067
Language Used at Home – ASL	-0.764	0.888	0.389
Other	-0.439	1.482	0.767
Constant	1.063	1.797	0.554

N = 128, P=0.050, Pseudo R-squared = 0.18

Preferred Mode of Communication: Preferred mode of communication was a significant predictor of level of difficulty understanding conversations, when controlling for demographic variables and language used at home (p<.01). Compared to adolescents who preferred to communicate via speech, those who had an equal preference for sign language and speech were 11.8 times more likely to report a high level of difficulty understanding conversations (p<.05). Age group was also a significant predictor in this model, with older adolescents (15-18) being 3.3 times more likely to report a high level of difficulty understanding compared to younger adolescents (p=.01). This association is consistent with those seen in the previous models, where older adolescents reported lower YQOL-DHH scores and higher difficulty understanding conversations. In this model, adolescents who reported a race/ethnicity of "Other", which includes those identifying as more than one race/ethnicity, were also less likely to report a high level of difficulty understanding conversations (p<.05).

Table 8. Preferred Mode of Communication and Level of Difficulty Understanding Conversations.

Difficulty Understanding	Coefficient	STD Error	P-Value
Communication Mode – Sign	-0.921	0.813	0.257
Equal Preference	**2.467**	**1.129**	**0.029**
Age Group 15-18	**1.189**	**0.464**	**0.010**
Sex – Male	0.423	0.441	0.337
Mother's Education – HS/GED	0.443	1.765	0.802
Some College	1.391	1.649	0.399
College Grad	1.051	1.675	0.530
Geographic Region – Midwest	-1.095	0.530	0.039
South	-1.652	0.578	0.004
Race/Ethnicity – Hispanic	-0.524	0.814	0.520
African American	-1.619	1.170	0.166
Asian/Pacific Islander	-0.662	1.369	0.629
Native American	0.492	1.183	0.677
Other	**-1.726**	**0.838**	**0.040**
Language Used at Home – ASL	-1.222	1.048	0.243
Other	-2.539	1.725	0.143
Constant	-1.016	1.730	0.557

N=128, P=0.0035, Pseudo R-squared = 0.20

Hearing Level: In a multivariate logistic regression model, hearing level was a significant predictor of level of difficulty understanding conversations, when controlling for demographic variables and language used at home ($p<.05$). However, although the model itself was significant, none of the hearing levels significantly predicted a difference in difficulty understanding conversations, compared to a Mild hearing level ($p>0.05$). Age group was borderline significant, with older adolescents being 2.4 times more likely to report a high level of difficulty understanding conversations ($p=0.06$). This relationship is consistent with the results of the previous models.

Table 9. Hearing Level and Level of Difficulty Understanding Conversations

Difficulty Understanding	Coefficient	STD Error	P-Value
Moderate/Mod-Severe	0.056	0.706	0.936
Severe/Profound	1.141	0.806	0.157
Cochlear Implant	0.985	0.652	0.131
Age Group 15-18	0.859	0.453	0.058
Sex – Male	0.474	0.442	0.283
Mother's Education – HS/GED	-0.828	1.496	0.580
Some College	0.761	1.389	0.584
College Grad	0.042	1.341	0.975
Geographic Region – Midwest	-0.950	0.513	0.064
South	-1.961	0.614	0.001
Race/Ethnicity – Hispanic	-0.030	0.793	0.969
African American	-1.113	1.03	0.278
Asian/Pacific Islander	-0.764	1.610	0.635
Native American	0.478	1.210	0.693
Other	-1.358	0.829	0.102

Language Used at Home – ASL	-1.541	1.020	0.130
Other	-0.432	1.369	0.752
Constant	-0.595	1.484	0.689

N=126, P=0.015, Pseudo R-squared = 0.19

Discussion

The aim of this study was twofold. In the first aim, we hypothesized that self-reported level of difficulty understanding conversations is significantly associated with DHH-specific QoL. This hypothesis was partially supported by the study results. While adolescents who reported higher difficulty understanding conversations had significantly lower Participation QoL and higher Perceived Stigma scores, no significant differences were seen in the Self-Acceptance/Advocacy domain. These results suggest that overall perceived ability to understand conversations generally most heavily impacts QoL domains that are associated with interactions with others, rather than adolescent self-perception. However, the interpretation of these results is limited by the broad nature of the item measuring level of difficulty understanding conversations. The item does not specify communication modality or a specific setting making it difficult to interpret these results beyond a general association.

The Participation domain results are consistent with Kushalnagar et al.'s study of the effect of perceived ability to understand communication with parents on DHH-YQoL. The study found that adolescents who were better able to understand communication with parents reported higher Participation and Self-Acceptance/Advocacy QoL but did not find significant differences in Perceived Stigma QoL. The present analysis, however, did not find significant differences in Self-Acceptance/Advocacy QoL but did find that higher difficulty understanding conversations in general was significantly associated with higher perceived stigma related to being deaf or hard of hearing. This is an important difference to consider, especially for youth attending mainstream schools. Perceptions of stigma and the ability to participate fully in classroom and social settings are important factors for socioemotional development, and these factors showed significant associations with QoL scores in the present analysis. The magnitude of the difference in Participation QoL scores for adolescents who reported daily difficulty understanding conversations in this the present analysis was particularly large (32.2 points lower mean Participation QoL scores) and should be further investigated in order to tailor interventions and educational programs to best support these adolescents. While Kushalnagar et al.

found a similar association between perceived ability to understand conversations with parents and Participation QoL, the magnitude of differences were not as large in that study.

Several demographic variables were also significantly associated with YQOL-DHH outcomes, including higher Participation domain scores in children of college-educated mothers. Similar to the results of the YQOL-DHH instrument validation study, older participants reported lower QoL scores across all 3 domains, however these findings were not significant in the present analysis.[39] Sex was not significantly associated with any differences in QoL scores or the reported levels of difficulty understanding conversations, which is consistent with previous analyses of this data.[33,39]

Previous studies using this data have not controlled for geographic region or family SES and these findings may prove useful when considering how best to support DHH youth attending mainstream schools. SES may be related to the quality of education a child has access to as well as access to high quality healthcare, more costly interventions and assistive technologies. Indeed, Participation was significantly associated with SES, the only domain to be so. School settings may vary significantly by program type (i.e. mainstream program with DHH services; mainstream program without DHH services), which may impact the level of support and assistance offered to DHH adolescents.[9] Additional studies of factors that facilitate high QoL and communication in DHH adolescents are needed to further investigate these associations.

The most significant predictor of adolescents' self-reported level of difficulty understanding conversations was preferred mode of communication, with those who had equal preference for sign language and speech being much more likely to report high difficulty understanding conversations. Since the equal preference for signed and spoken languages is associated with *lower* self-perceived stigma about being DHH but unrelated to other aspects of generic and DHH-specific QoL in Kushalnagar et al.'s study, the role of understanding conversations appears to be specific to language proficiency in the youth's setting. In other words, if the DHH youth is mainstreamed and does not always have access to spoken language in school or even at home with an all-hearing family, then it is not surprising that this DHH youth would self-report higher level of difficulty understanding conversations. This result may be partially explained by the fact that the majority of the present study sample preferred to communicate via speech and used mostly spoken English to communicate at home. Having access to additional

communication modalities may improve QoL outcomes, but this may depend on the type of communication modality that adolescents use the most and the types of environments they interact in. Differences in the type of assistive technology used and hearing level of the adolescent did not significantly predict difficulty in understanding conversations. While we know that hearing level per se is not a significant predictor of QoL, findings on the impact of assistive technology use on QoL and adolescent development have not been consistent.[33,30,40,44]

In logistic regression models, age group again showed consistent associations with the outcome. In all three models, adolescents in the older age group (15-18) were more likely to report a high level of difficulty understanding conversations. Older adolescents may be exposed to a more complex social and school environment. This finding highlights the need for clinicians and educators to create a supportive communication environment for DHH adolescents, especially those who are older. Given the importance of educational support and exposure to language for DHH youth, these patterns may indicate differential access to services, quality of schools, and different language modalities, which can lead to important challenges in DHH adolescent development and should be further investigated.

Limitations

This study is limited in its ability to assess temporality and causality due to its cross-sectional design. Although the study sample is diverse, participants were recruited through convenience sampling and thus this sample is not representative of the U.S. population of school aged youth with hearing level ranging from mild to profound. Due to self-selection biases, this study may have oversampled adolescents with higher QoL compared to the general population of DHH youth; however, the study sample was demographically diverse and included a range of hearing levels by design. Finally, this study focused only on a small subset of the characteristics identified as important to youth QoL; therefore, it is possible that other important associations related to the impact of communication were left out of the present analysis. The YQoL-DHH instrument presents an opportunity to examine multiple factors that may be important barriers and facilitators of DHH youth QoL, and the results of the present study highlight the need for further studies of QoL in this population. Specifically, future studies should include better sampling methods and potentially a larger sample size in order to allow for better generalizability.

Conclusion

The results of this study build on previous analyses of factors that are important to DHH youth QoL and further highlight the need for adequate support of DHH youth both at home and in the classroom. In addition, this study included confounders that have not previously been assessed such as age, which might present opportunities for additional insight into factors that impact youth QoL. The majority of findings of this study are consistent with prior research and may prove useful to parents, clinicians, and educators working with DHH youth. This sample, although it was a subset of the original study, includes a diverse range of hearing levels and assistive technology use. Understanding barriers and facilitators of communication and QoL from the perspective of DHH youth is critical to both clinical and educational decision-making and the results of the current study can be used to improve support provided to DHH adolescents in school and social settings.

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