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Higher Educational Attainment but not Higher Income is Protective for Cardiovascular Risk in Deaf American Sign Language (ASL) Users

Michael M. McKee, MD, MPH[1,2], **Kimberly McKee, MPH**[3], **Paul Winters, MS**[1], **Erika Sutter, MPH**[2], and **Thomas Pearson, MD, MPH, PhD**[2,3]

[1]Family Medicine Research Programs, Department of Family Medicine, University of Rochester School of Medicine and Dentistry, Rochester, NY

[2]National Center for Deaf Health Research, University of Rochester School of Medicine and Dentistry, Rochester, NY

[3]Department of Public Health Sciences, University of Rochester School of Medicine and Dentistry, Rochester, NY

Abstract

Background—Higher educational attainment and income provide cardiovascular protection in the general population. It is unknown if the same effect is seen among Deaf American Sign Language (ASL) users who face communication barriers in healthcare settings.

Objective—We sought to examine whether educational attainment and/or annual household income were inversely associated with cardiovascular risk in a sample of Deaf ASL users.

Methods—This cross-sectional study included 302 Deaf respondents aged 18-88 years from the Deaf Health Survey (2008), an adapted and translated Behavioral Risk Factor Surveillance System (BRFSS) administered in sign language. Associations between the self-reported cardiovascular disease equivalents (CVDE; any of the following: diabetes, myocardial infarction (MI), cerebral vascular attack (CVA), and angina) with educational attainment (≤high school [low education], some college, and ≥4 year college degree [referent]), and annual household income (<$25,000,

Corresponding Author: Michael M. McKee, MD, MPH, Assistant Professor, Department of Family Medicine, Family Medicine Research Programs, 1381 South Avenue, Rochester, NY, michael_mckee@urmc.rochester.edu, Phone 585-506-9484 x 124, Fax 585-473-2245.

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$25,000-<$50,000, or ≥$50,000 [referent]) were assessed using a multivariate logistic regression adjusting for age, sex, race/ethnicity, and smoking history.

Results—Deaf respondents who reported ≤high school education were more likely to report the presence of a CVDE (OR 5.92; 95% CI 2.12-16.57) compared to Deaf respondents who reported having ≥4 year college degree after adjustment. However, low-income Deaf individuals (i.e. household incomes <$25,000) were not more likely to report the presence of a CVDE (OR=2.24; 95% CI 0.76-6.68) compared to high-income Deaf respondents after adjustment.

Conclusion—Low educational attainment was associated with higher likelihood of reported cardiovascular equivalents among Deaf individuals. Higher income did not appear to provide a cardiovascular protective effect for Deaf respondents.

Keywords

Deaf; cardiovascular health; education; income; health disparities

Introduction

Low educational attainment and low income are inversely associated with higher rates of cardiovascular disease and worse cardiovascular outcomes among the general population and for several studied minority groups[1-4] but whether these associations hold for Deaf American Sign Language (ASL) users are unknown. Low education in minority populations is considered an important risk factor for cardiovascular disease (CVD) that can possibly explain some of the cardiovascular health disparities seen among these groups.[3] Adults who completed high school or less display lower literacy,[5] lower health literacy,[6,7] and lower cardiac health literacy (i.e. cardiac symptom recognition)[8] frequently leading to less effective health communication. Poor health communication can diminish the ability of individuals to adhere to healthy lifestyles and to convey pertinent health information to their health care providers.[9,10]

Individuals with low income also struggle with poor health care access,[11] which may affect their ability to prevent the onset of cardiovascular disease or to effectively manage their disease.[2,4] Poverty further reduces the ability of individuals to obtain health information and knowledge on CVD.[12] This is worrisome since the prevalence of ≥2 CVD risk factors increases dramatically with lower reported annual household incomes.[13]

Little is known about the impact of low educational attainment or low income on cardiovascular disease prevalence among Deaf American Sign Language (ASL) users, an underserved and under researched population. Deaf ASL users refer to a group of Deaf individuals who identify themselves as a linguistic minority community, with their own unique language and culture.[14,15] Deaf ASL users may lack proficiency in written English.[16,17] Deaf ASL users represent an overlooked yet sizeable population (most reliable estimates are ~500,000-1 million Deaf ASL users in the USA).[18] Communication and language barriers isolate this group from mass media, healthcare messages,[19-21] and health care communication[22,23] which lead to a lower general health knowledge,[21,24-28] including poor cardiovascular health knowledge. Margellos, et al. (2006) reported that many Deaf

ASL users were unable to identify a single symptom of heart attack (40.2% of individuals surveyed) or stroke (62.6% surveyed) and a full 39% of surveyed respondents did not state that they would call 911 or access emergency services even if they were aware of having a heart attack or stroke.[29] Psychosocial stressors, especially from both a linguistically and socially marginalized group, may play an important role in explaining part of the possible causality of CVD within this population.[23,30]

Specific information on CVD burden and risk factors among Deaf ASL users are largely unknown. Currently existing national population-based surveys and cardiovascular research continue to largely exclude (i.e. telephone-based surveys requiring adequate hearing) or fail to categorize or identify Deaf ASL users in their study demographics.[31,32] Due to a variety of communication and language barriers, it is unclear whether higher educational attainments and income are associated with cardiovascular protection for this group. Results from an ASL-accessible survey were used to test the hypothesis that Deaf ASL users who report higher educational attainments and income are less likely to self-report cardiovascular disease equivalents (angina, myocardial infarction, cerebral vascular attack, and/or diabetes)[33] compared with those with lower educational attainment and income.

Methods

We examined data from the Deaf Health Survey (DHS),[34] an ASL adapted and translated Behavioral Risk Factor Surveillance System (BRFSS),[35] which was self-administered on a touch-screen computer kiosk with sign language models to maximize language accessibility for deaf individuals. We worked collaboratively with Deaf and hearing researchers and community members to develop a linguistically and culturally appropriate survey based on the Behavioral Risk Factor Surveillance System (BRFSS). We worked with community members to prioritize health survey topics and developed items to measure important deaf-related demographic information (e.g., age at onset of deafness) in addition to the standard BRFSS questions. We adapted existing English-language survey items through a process that included translation, back-translation, and in-depth individual cognitive interviews. A computer interface was used to present survey items in sign language (via video) and written English on a touch-screen kiosk. The NCDHR Deaf Health Survey contained 98 items. Development of the DHS and methods of recruitment have been published elsewhere.[34,36] Deaf respondents chose the survey language—ASL or signed English with written English support.

The Rochester, NY, metropolitan statistical area (MSA) was selected to administer the survey because of its high per capita population of Deaf ASL users. This study was a secondary analysis of data collected from March 2008 until September 2008. A total of 339 adults took the DHS in 2008. We recruited deaf individuals through deaf community organizations, via e-mail and posters, and face-to-face during community events. The current study was a secondary analysis of the cross-sectional surveillance data.

Educational attainment was categorized as ≤high school [low education], some college, and ≥4 year college degree [referent]). Annual household income was divided into three categories <\$25,000, \$25,000- <\$50,000, or ≥\$50,000 (referent). Household size was not available in the DHS data to calculate households' % Federal Poverty Level (%FPL).

Cardiovascular equivalents (CVDE) included the presence of any of the following self-reported health conditions: angina, myocardial infarction, cerebral vascular attack, and/or diabetes.[33]

For analyses reported here, respondents with missing responses (n=37) for age, race, gender, smoking history, and cardiovascular disease equivalents were excluded. Values for missing education (i.e. 7% of respondents) and income (i.e.14%) were imputed using sequential hot-deck multiple imputation (8 imputations) and SAS-callable SUDAAN version 10.0.[37] The University of Rochester Research Subjects Review Board approved the research study.

Statistical Analyses

We conducted univariate and bivariate analyses on all variables, and then used multivariable logistic regression to examine the association of the presence of a self-reported CVDE with the primary independent variables, educational attainment and annual household income, while adjusting for other covariates (age, race, gender, and smoking history).

Results

A high proportion of DHS respondents had some college or higher, earned a household income <\$25,000, aged 40-59 years, female, white, never smoked, and were insured. Respondents who reported the presence of CVDE were more likely to have ≤high school education, be aged 40-59 years, and to have insurance (Table 1) than those who did not report CVDE. The sample proportion of CVDE among low-income respondents decreased with higher educational attainment and higher income (Table 2).

In multivariable logistic regression analyses adjusted for age, race, gender, and smoking history, Deaf respondents who reported ≤high school education were more likely to report the presence of a cardiovascular disease equivalent (OR 5.76; 95% CI 2.04-16.31) compared to Deaf respondents who reported having a ≥4 year college degree) (Table 3). However, Deaf respondents who reported annual income of <\$25,000 were not significantly more likely to report the presence of a cardiovascular disease equivalent (OR 2.24; 95% CI 0.75-6.68) compared to Deaf respondents who reported annual incomes of ≥\$50,000. Deaf individuals with incomes >= \$50,000 and a high school degree or less were more likely to report CVD equivalents compared to those with some college or ≥4 year college (OR= 12.03; 95% CI=1.83, 78.94 and p=0.1295) (Table 4) while among low income individuals, higher levels of education were cardiovascular protective but less so (OR= 4.56; 95% CI=1.00, 20.74; p= 0.1776) although neither contrast reached significance. Furthermore, income showed only a modest correlation with educational attainment (r=0.355).

Discussion

Low educational attainment among Deaf ASL users is associated with greater likelihood of reported cardiovascular disease equivalents, even after controlling for respondent demographic characteristics and smoking history. This finding is consistent with similar trends among the general population and several minority populations.[1-3]

Cardiovascular protection from higher educational attainment may occur through a variety of factors. First, higher educational attainment may enable individuals to communicate more effectively with their health care providers. For example, Smith et al. (2009) demonstrated that higher educated individuals interact with their providers differently compared to those with lower education.[38] This included higher rates of shared decision-making, verification of health information exchanged at a provider's visit, advocating for better communication in the health care settings, and being proactive in researching health information, which resulted in increased "social capital."[38,39]

Secondly, Deaf individuals with higher educational attainment may have additional information-gathering tools or communication skills that those with lower educational attainment may lack. For example, higher educated Deaf individuals may be able to rely more effectively on a variety of strategies to overcome potentially poor health communication and comprehension. This may include the ability to understand higher-grade level written English (i.e. access health materials in print form), and improved capability to communicate with health care providers.

Third, education may confer cardiovascular protection by increasing knowledge of healthy behaviors and adherence. Individuals with lower educational attainment have been found to comprehend and recall less information exchanged at a health visit[40] resulting in a decreased ability to adhere to recommended health behaviors and medical treatments to prevent and/or manage CVD, including diabetes.[2,41]

Finally, improved health literacy among higher educated Deaf individuals may play a significant role in cardiovascular protection. Deaf individuals are at particularly high risk for inadequate health literacy.[42] It has been demonstrated in the general population that low educational attainment is associated with low health literacy and less effective health communication, which affects patients' abilities to convey pertinent health information to their providers. [43]

The effect of higher income on cardiovascular protection was not significant among Deaf DHS respondents in the multivariable logistic regression analyses, which departs from well-established trends among the general population. The lack of cardiovascular protective effects from higher income was surprising. This may be due to several factors. First, income was not strongly correlated with educational attainment (r=0.355), which may reflect underlying social barriers. Blanchfield et al. (2001) analyzed data from multiple national datasets (NHIS, NHANES, NHISD) and found that individuals with hearing loss were significantly more likely to be publicly insured, unemployed, and have lower family incomes.[44] In our data, despite the relatively high educational attainment of the sample population, the sample still yielded a large proportion of individuals reporting low income (i.e. annual household income <$25,000);[34] this incongruence may suggest fewer professional opportunities accessible to educated Deaf individuals.

A second explanation for the lack of observed results with regard to income may be due to the high rate of health insurance coverage of the sample. Our results did not suggest that access to health care may be a barrier to cardiovascular health even for those with low incomes; 96% of the sample was insured, and 100% of the reported CVDE equivalents were among the insured.

Lastly, the relatively small sample size of this study may have explained the lack of association we observed (i.e. the lack of significance may have been due to the fact that the study may have been underpowered). Lack of power likely explains the lack of association between gender and CVDE. A post-hoc power analysis showed that the sample size was inadequate for detecting a gender difference between males and females. Recent national data appear to corroborate these results that the gender gap in CVD prevalence has narrowed.[45]

Limitations

There are some limitations of our results. First, DHS data are cross-sectional, and the responses are self-reported. The authors did not confirm cardiovascular equivalent diagnoses (e.g. verified by chart abstraction) for accuracy of self-reporting. Deaf individuals, in particular due to communication barriers, may not be aware of their CVDE diagnoses or fail to share their health concerns effectively with their health care providers, resulting in fewer diagnoses. This may have shifted our results to the null. Future studies should include chart audits and additional questions regarding cardiovascular disease and risk.

Secondly, the use of diabetes as a surrogate measure for CVDE may be a limitation, although it is widely accepted as such in the cardiovascular literature.[33] There is significant evidence in the predictive value for CVD; several studies have shown that absolute risk for first major coronary events for persons with diabetes approximates that for recurrent events in non-diabetic persons with clinical CVD.[46-50]

Thirdly, the participants were also predominately white (85.8%), similar to demographics of Deaf samples in other published studies.[31,51,52] Future research should explore the epidemiologic and genetic reasons for the strong association between white race and deafness and the cardiovascular risk of non-white Deaf individuals.

Fourth, the relatively small sample size of this study may have explained the lack of significance and the wide confidence intervals we observed for the income and education contrasts (Table 4) although the magnitude of the point estimates was positive.

Finally, the research findings may not be generalizable to other Deaf communities. Rochester, NY, is unique with its high per capita population of Deaf ASL users, the high number of community resources, and accessible health care opportunities. The educational attainment of the DHS participants was higher than reported for deaf adults in published research using national data sets.[31,51] This may be partially reflective of convenience sampling biases of the DHS but may also relate to increased educational and employment opportunities for the Deaf at nearby educational institutions (i.e. graduates and faculty of Rochester School for the Deaf and the National Technical Institute for the Deaf at the

Rochester Institute of Technology). It is unlikely that other communities would demonstrate similarly high rates of college level educational attainment.

Conclusion

This is the first known study documenting that low educational attainment is associated with higher likelihood of reported cardiovascular disease among Deaf individuals. However, higher income (i.e. >=$50,000 per year) did not appear to provide a cardiovascular protective effect in contrast to that observed in the general population. This may be partially explained by the poor correlation between educational attainment and income in the study sample (r=0.355).

Health communication and health literacy may be the main drivers for cardiovascular risk in this population. Due to Deaf ASL users' risk for social and language marginalization in our society and health care setting, increased attention must be given to ensure that the population is provided with accessible health information and care. Accessible health communication and education of Deaf individuals with lower educational attainment could be addressed by working with language-concordant providers and interpreter services and following the principles of clear communication (e.g. teach-back) to address ongoing cardiovascular health disparities.

The use of community health coaches and telehealth technology may be additional avenues to improve language concordance and cultural competency between ASL-fluent healthcare services use in this population and improved cardiovascular health knowledge among the Deaf ASL population. Further research is needed to examine how relevant cardiovascular information is disseminated and identify any barriers, especially among lower educated Deaf individuals.

Further research is needed to better understand the mechanisms by which education may confer CVD protection in Deaf ASL users (e.g. through health literacy and whether health literacy interventions can improve educational disparities in Deaf ASL users). Additional research is needed to understand the incongruence of income and education in the Rochester Deaf community.

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Table 1

Demographic Characteristics by Cardiovascular Disease Equivalents

Variable	Total* (*n* = 302)	CVDE (*n* = 45)	No CVDE (*n* = 257)	*p*-value Chi-square
Education				0.0001
High school or less	16.80% (51)	42.22% (19)	12.35% (32)	
Some college	34.44% (104)	35.56% 16)	34.24% (88)	
4-year degree or above	48.76% (147)	22.22% (10)	53.41% (137)	
Income				0.0104
<$25,000	36.18% (109)	23.11% (25)	76.89% (84)	
$25,000 - < $50,000	33.98% (103)	12.42% (13)	87.58% (90)	
$50,000 +	29.84% (90)	7.77% (7)	92.23% (83)	
Sex				0.544
Male	44.70% (135)	48.89% (22)	43.97% (113)	
Female	55.3% (167)	51.11% (23)	56.03% (144)	
Age				0.0007
18-39	34.44% (104)	13.33% (6)	38.13% (98)	
40-59	53.31% (161)	64.44% (29)	51.36% (132)	
60+	12.25% (37)	22.22% (10)	10.51% (27)	
Race				0.1965
White	85.76% (259)	91.11% (41)	84.82% (218)	
Non-White	14.24% (43)	8.89% (4)	15.18% (39)	
Smoking				0.459
Ever smoked	45.03% (136)	40.00% (18)	45.91% (118)	
Never smoked	54.97% (166)	60.00% (27)	54.09% (139)	
Insurance				0.0007
Yes	95.61% (283)	100.00% (45)	94.82% (238)	
No	4.39% (13)	0.00% (0)	5.18% (13)	

Table 2

Sample Proportion by Education and Income

	Total		Income <$25k		Income $25k-<$50k		Income $50k+	
Education Level	**No CVDE**	**CVDE**	**No CVDE**	**CVDE**	**No CVDE**	**CVDE**	**No CVDE**	**CVDE**
<HS education	12.45% (32)	42.22% (19)	20.73% (17)	44.00% (11)	12.22% (11)	53.85% (7)	4.71% (4)	14.29% (1)
Some College	34.24% (88)	35.56% (16)	48.78% (40)	44.00% (11)	37.78% (34)	30.77% (4)	16.47% (14)	14.29% (1)
>=4 yr. degree	53.30% (137)	22.22% (10)	30.49% (25)	12.00% (3)	50.00% (45)	15.38% (2)	78.82% (67)	71.43% (5)

Table 3

Logistic Regression Results for Probability of CVD Equivalents

Variable	Odds Ratio	Lower 95% Limit OR	Upper 95% Limit OR	*p*-value Wald F
Education				0.0034
<=High school	5.76	2.04	16.31	
Some college	1.76	0.74	4.16	
4-year degree or above	1.00	1.00	1.00	
Income				0.1794
<$25,000	2.24	0.75	6.68	
$25,000 - < $50,000	1.12	0.38	3.33	
$50,000 +	1.00	1.00	1.00	
Sex				0.2463
Male	1.53	0.74	3.16	
Female	1.00	1.00	1.00	
Age				0.0523
18-39	1.00	1.00	1.00	
40-59	3.11	1.22	7.94	
60+	3.33	0.98	11.32	
Race				0.1898
White	1.00	1.00	1.00	
Non-White	0.45	0.14	1.48	
Smoking status				0.5493
Ever smoked	0.80	0.38	1.69	
Never smoked	1.00	1.00	1.00	

Table 4

Risk of CVDE by Income and Education

Contrast	OR	95% Lower CI OR	95% Upper CI OR	*p*-value Wald F
<$25K vs. $50k+ for those with HS or less	1.37	0.07	27.02	0.8276
<$25K vs. $50k+ for those with some college	5.47	0.53	55.89	0.2631
<$25K vs. $50k+ for those with 4yr college+	1.82	0.37	8.87	0.4999
$25-<$50k vs. $50k+ for those with HS or less	1.23	0.06	26.61	0.8885
$25-<$50k vs. $50k+ for those with some college	1.93	0.18	20.93	0.615
$25-<$50k vs. $50k+ for those with 4yr college+	0.64	0.12	3.40	0.6186
<$25K vs. $25-<$50k for those with HS or less	1.09	0.27	4.30	0.8625
<$25K vs. $25-<$50k for those with some college	2.84	0.81	9.90	0.2239
<$25K vs. $25-<$50k for those with 4yr college+	2.86	0.41	19.78	0.3626
HS or less vs some college for those with income <$25K	2.14	0.69	6.60	0.2854
HS or less vs 4yr college for those with income <$25K	4.56	1.00	20.74	0.1776
Some college vs 4yr college for those with income <$25K	2.13	0.50	9.11	0.3811
HS or less vs some college for those with income $25-<$50k	5.58	1.20	25.93	0.1576
HS or less vs 4yr college for those with income $25-<$50k	12.03	1.83	78.94	0.1295
Some college vs 4yr college for those with income $25-<$50k	2.15	0.39	11.84	0.4337
HS or less vs some college for those with income $50k+	5.58	1.20	25.93	0.1576
HS or less vs 4yr college for those with income $50k+	12.03	1.83	78.94	0.1295
Some college vs 4yr college for those with income $50k+	2.15	0.39	11.84	0.4337

Sex, age, race, and smoking status also included in model.