

## An Economic Analysis of Hearing Aid Affordability in the United States Using Big Data

Anna Marie Jilla, Au.D.  
Carole E. Johnson, Ph.D., Au.D.  
Nick Huntington-Klein, Ph.D.

Hearing Evaluation, Rehabilitation, and Outcomes (HERO) Laboratory  
University of Oklahoma Health Sciences Center  
Herbert J. Oyer Award Recipient 2018

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## Conflict of interest

- No financial interests

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## Overview

- I. Context of affordability and accessibility in hearing healthcare
- II. Measuring affordability in healthcare
- III. Applications to hearing healthcare
- IV. Study aims
- V. Methods
- VI. Results
- VII. Conclusions and discussion

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## Hearing loss as a global public health concern

- **1 billion** affected worldwide by 2050<sup>1</sup>
- **750 billion dollars** of global economic burden<sup>2</sup>
- **1.6 billion** people in the 65+ demographic by 2050<sup>3</sup>
- **83.7 million** Americans 65+ by 2050<sup>4</sup>
- **33%** of those between 65 and 74<sup>5</sup>
- **50%** of those 75 and over<sup>5</sup>

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## Efforts in affordability and accessibility

- National Institute on Deafness and Other Communication Disorders (NIDCD) working group (2009)<sup>6</sup>
- Patient Protection and Affordable Care Act (2010)<sup>7</sup>
- Medicare Access and CHIP Reauthorization Act (2015)<sup>8</sup>
- President's Council of Advisors on Science and Technology (2015)<sup>9</sup>
- National Academies of Sciences, Engineering, and Medicine (NASEM, 2016)<sup>10</sup>
- Food and Drug Reauthorization and Over-the-Counter (OTC) Hearing Aid Act (2017)<sup>11</sup>



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## Context of poor uptake and utilization

- Uptake rates
  - Great Britain—35%<sup>12</sup>
  - Australia—20%<sup>13</sup>
  - United States—14 to 33%<sup>14-15</sup>
- Utilization: up to 30% of owners never use their devices<sup>16-19</sup>

\*national healthcare programs provide hearing aids at no cost

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## Application to hearing healthcare

### American Community Survey (ACS)<sup>28</sup>

- 3.5 million individuals
- Income and demographics
- Hearing, vision, cognition, mobility, and self-care added in 2008
  - "Is this person deaf or does he/she have serious difficulty hearing?"
  - Self-report underestimates prevalence of hearing loss  
3.5%<sup>29</sup>, 5-9%<sup>30</sup>
  - Representative sample of people with significant, self-reported hearing difficulty



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## Study aims

- To conduct catastrophic and impoverishment economic analyses using data from the ACS to determine what proportion of Americans  $\geq 18$  years old would face financial hardship as a result of the purchase
- To determine how affordability varies by price, self-reported hearing status, race, age, gender, geographic location, and educational attainment

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## Methods

- ACS 2016 data
- Catastrophic (3%\*, 5%, and 10% of annual income)
- Impoverishment (1.0\*, 1.3, and 1.5 times US Federal Poverty Level)
- Minimum acceptable quantity of the good = **one** hearing aid
- Price points<sup>23</sup>
  - \$250, \$500 to \$3500 in \$500 increments
  - \$2363 (overall average)\*

\*reference values

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## Methods (continued)

### Logistic regression

- Self-reported hearing problem (yes, no\*)
- Gender (male\*, female)
- Race (Asian, Black, Hispanic, White\*, Mixed/Other)-mutually exclusive
- Age (18 to 64 years\*, 65 and over)
- Geographic region (Midwest, Northeast\*, South, West)
- Educational attainment (less than high school diploma, high school graduate/GED, some college or vocational school, college or vocational degree, and graduate degree\*)

\*reference values

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## WARNING!

The results you are about to see...

- Poverty for the year
- Thresholds must be cited
- One hearing aid
- Hypothetical purchase



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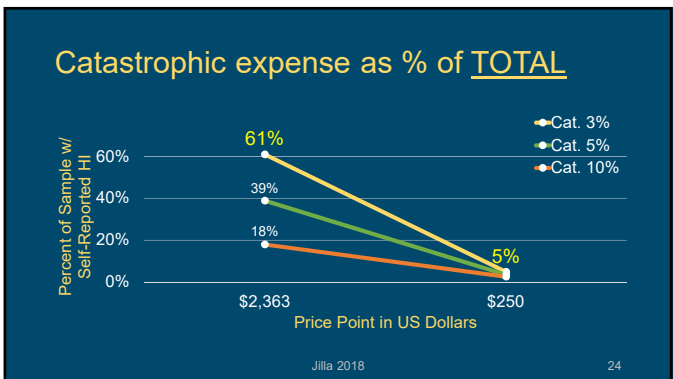
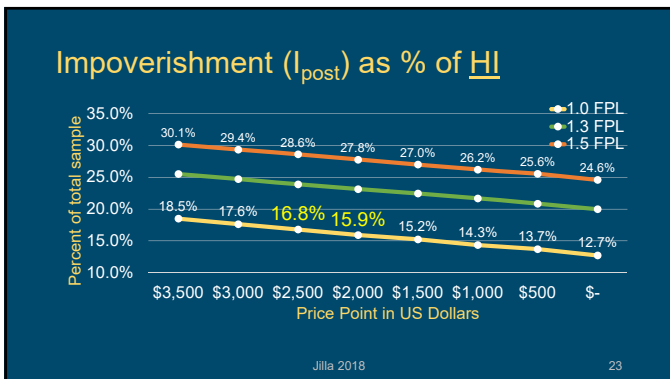
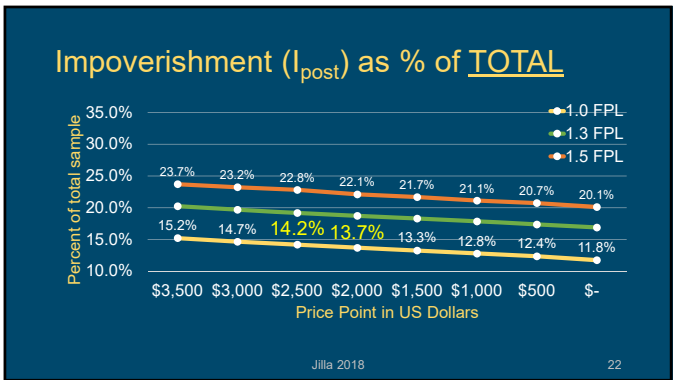
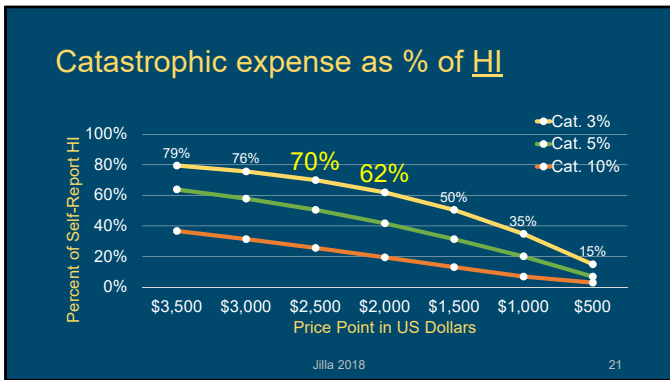
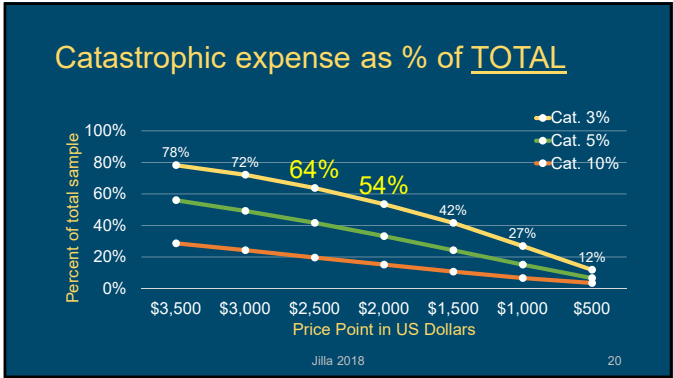
## Results

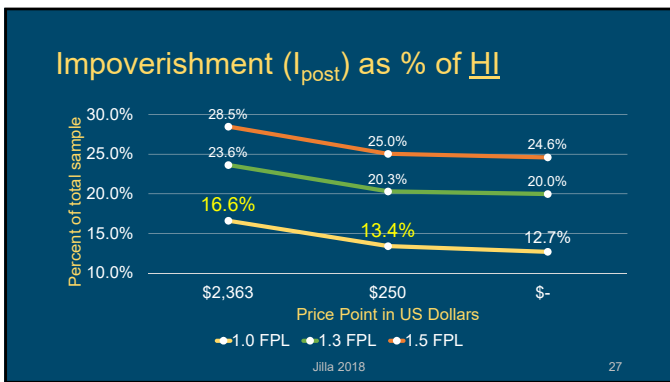
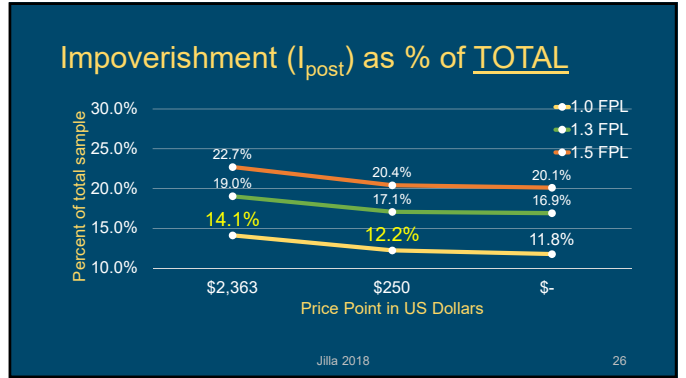
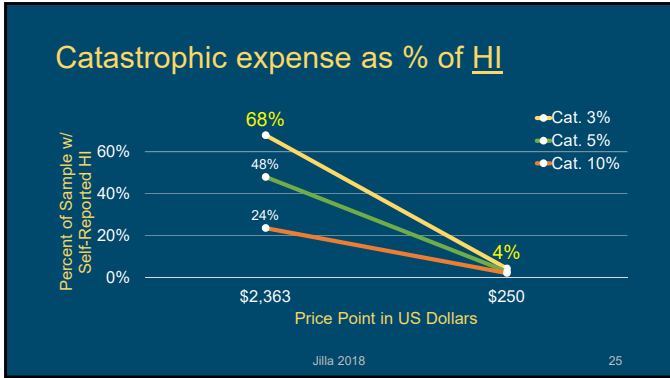
- **2,348,374** respondents from the ACS (2016)
- **132,537 (5.6%)** with self-reported hearing difficulty
- **6%** did not provide income data (Cohen's d)
  - More likely to be ages 18 to 25 (0.73)
  - Black (0.32)
  - Male (0.23)
  - Less than high school degree (0.25)

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# Descriptive Statistics





## Logistic Regression

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### Catastrophic Results (\$2,363)

Hearing Problem	Age	Gender	Race	Education	Geographic Region
No	18 to 64	Male	White	Grad. Degree	Northeast
Yes	65+	Female	Black	Bach. Degree	Midwest
OR = 1.345***	OR = 1.878***	OR = 1.225***	OR = 1.799***	OR = 1.701***	OR = 1.388***
			Asian	Some college	West
			OR = 0.849***	OR = 3.805***	OR = 1.162***
			Hispanic	HS/GED	South
			OR = 1.552***	OR = 5.368***	OR = 1.363***
			Other/Mixed	Less than HS	
			OR = 1.429***	OR = 8.787***	
*** p<0.01	3% annual income				

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### Catastrophic Results (\$250)

Hearing Problem	Age	Gender	Race	Education	Geographic Region
No	18 to 64	Male	White	Grad. Degree	Northeast
Yes	65+	Female	Black	Bach. Degree	Midwest
OR = 1.127***	OR = 0.579***	OR = 1.257***	OR = 1.813***	OR = 1.496***	OR = 1.070***
			Asian	Some college	West
			OR = 1.387***	OR = 2.981***	OR = 1.149***
			Hispanic	HS/GED	South
			OR = 1.106***	OR = 3.075***	OR = 1.129***
			Other/Mixed	Less than HS	
			OR = 1.787***	OR = 4.898***	
*** p<0.01	3% annual income				

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### Impoverishment Results (\$2,363)

Hearing Problem	Age	Gender	Race	Education	Geographic Region
No	18 to 64	Male	White	Grad. Degree	Northeast
Yes	65+	Female	Black	Bach. Degree	Midwest
OR = 1.255***	OR = 0.732***	OR = 1.355***	OR = 2.017***	OR = 1.681***	OR = 1.097***
			Asian	Some college	West
			OR = 1.237***	OR = 4.113***	OR = 1.172***
			Hispanic	HS/GED	South
			OR = 1.473***	OR = 5.381***	OR = 1.203***
			Other/Mixed	Less than HS	
			OR = 1.871***	OR = 11.272***	
*** p<0.01		1.0 FPL			

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### Impoverishment Results (\$250)

Hearing Problem	Age	Gender	Race	Education	Geographic Region
No	18 to 64	Male	White	Grad. Degree	Northeast
Yes	65+	Female	Black	Bach. Degree	Midwest
OR = 1.219***	OR = 0.633***	OR = 1.348***	OR = 2.013***	OR = 1.643***	OR = 1.085***
			Asian	Some college	West
			OR = 1.260***	OR = 3.987***	OR = 1.172***
			Hispanic	HS/GED	South
			OR = 1.472***	OR = 5.078***	OR = 1.187***
			Other/Mixed	Less than HS	
			OR = 1.890***	OR = 10.780***	
*** p<0.01		1.0 FPL			

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### Catastrophic Results (\$2363) HI ONLY

Age	Gender	Race	Education	Geographic Region
18 to 64	Male	White	Grad. Degree	Northeast
65+	Female	Black	Bach. Degree	Midwest
OR = 1.629***	OR = 1.339***	OR = 1.465***	OR = 1.565***	OR = 1.395***
		Asian	Some college	West
		OR = 0.495***	OR = 3.420***	OR = 1.048**
		Hispanic	HS/GED	South
		OR = 1.171***	OR = 4.879***	OR = 1.245***
		Other/Mixed	Less than HS	
		OR = 1.507***	OR = 8.055***	
*** p<0.01		** p<0.05		

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### Impoverishment Results (\$2363) HI ONLY

Age	Gender	Race	Education	Geographic Region
18 to 64	Male	White	Grad. Degree	Northeast
65+	Female	Black	Bach. Degree	Midwest
OR = 0.571***	OR = 1.709***	OR = 1.999***	OR = 1.253***	OR = 1.045
		Asian	Some college	West
		OR = 1.306***	OR = 2.358***	OR = 1.076***
		Hispanic	HS/GED	South
		OR = 1.550***	OR = 3.182***	OR = 1.199***
		Other/Mixed	Less than HS	
		OR = 1.991***	OR = 6.578***	
*** p<0.01				

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- ### Limitations (Underestimations)
- Self-reported hearing loss prevalence in the ACS is low
  - One hearing aid, not two
  - Missing income data from groups that earn lower income on average (i.e., younger, black, less than a high school degree)
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- ### Discussion & Conclusions
- WHO (3%, catastrophic, \$2363)
    - 61% of all Americans
    - 68% of HI
  - Choice of threshold (10%)
    - 20% of all Americans
    - 25% of HI
  - Comparisons of prevalence
    - Hearing loss (~13%)
    - Type 2 diabetes (~10%)
  - Groups at highest risk
    - Age, race, educational attainment
  - Future use to inform policy for insurance coverage, third-party payers, and product development in hearing healthcare
  - Implications for patient-centered care
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## Future research

Willingness to pay & predictors of willingness to pay

- Hearing aids
- OTC devices
- Hearing aid services

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**An Economic Analysis of Hearing Aid Affordability in the United States Using Big Data**

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**Outline**

- I. Context of affordability and accessibility in hearing healthcare
- II. Measuring affordability in healthcare
- III. Application to hearing healthcare
  - A. Hearing, vision, cognition, mobility, self-care added to ACS in 2008
  - B. “Is this person deaf or does he/she have serious difficulty hearing?” (yes/no)
- IV. Study aims
  - A. Catastrophic and impoverishment economic analyses of Americans  $\geq 18$  years old using the ACS 2016 data
  - B. Price, self-reported hearing status, race, age, gender, geographic location, and educational attainment
- V. Methods (Niëns et al, 2012)
  - A. Catastrophic (3%\*, 5%, 10% of annual income)
  - B. Impoverishment (1.0\*, 1.3, 1.5 times the US federal poverty level)
- VI. Results
  - A. Descriptives
    1. Catastrophic (3%)—At a current average selling price of \$2363, 61% of Americans would experience a catastrophic medical expense if forced to purchase one hearing aid. Among those with self-reported hearing impairment, 68% would experience financial catastrophe.
    2. Impoverishment (1.0 US FPL)—2.3% of Americans would enter impoverishment for the year as a result of hearing aid purchase. 3.9% of Americans with self-reported hearing loss would fall below the poverty level for the year if forced to purchase one hearing aid. These numbers are in addition to those already at the poverty level (11.8% and 12.7% overall and among hearing impaired, respectively).
  - B. Logistic regression
    1. Those with hearing impairment were consistently at higher risk for hearing aid affordability issues, regardless of analysis or price point, type of analysis, or threshold of unreasonable burden.
    2. Catastrophic—At an average selling price of \$2363, African-Americans and those 65 and older are at a 1.8 and 1.9 fold risk for experiencing catastrophic expenditure, respectively. Educational attainment revealed the largest disparities for those not having a college degree at a 3 to 9 fold risk for affordability issues (ORs: less than high school = 8.8, HS/GED = 5.4, some college = 3.8).
    3. Impoverishment—Those younger than 65 were at higher risk of impoverishment, regardless of price point. The largest disparities were among African-Americans (OR=2.0) and those with less than a college degree (ORs: less than high school = 11.3, HS/GED = 5.4, some college = 4.1).
- VII. Conclusions and discussion

REMINDERS:

- Cite your thresholds
- Poverty *for the year*
- One hearing aid
- Hypothetical purchase



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