Hearing, Aging & Public Health

From Epidemiology to Public Policy in the United States

Frank Lin, MD PhD

Professor of Otolaryngology, Medicine, Mental Health & Epidemiology

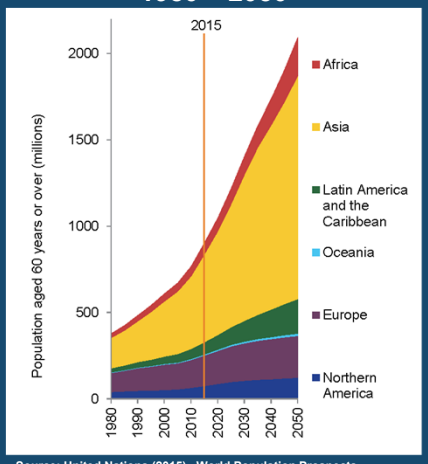
Director, Johns Hopkins Cochlear Center for Hearing & Public Health

Johns Hopkins University, Baltimore, USA

Public Health & Hearing Loss in Older Adults

Rationale

Population Ages 60+ by Region
1980 – 2050



Source: United Nations (2015). World Population Prospects

Eras of Public Health

1st – Infectious diseases (20th cent.)

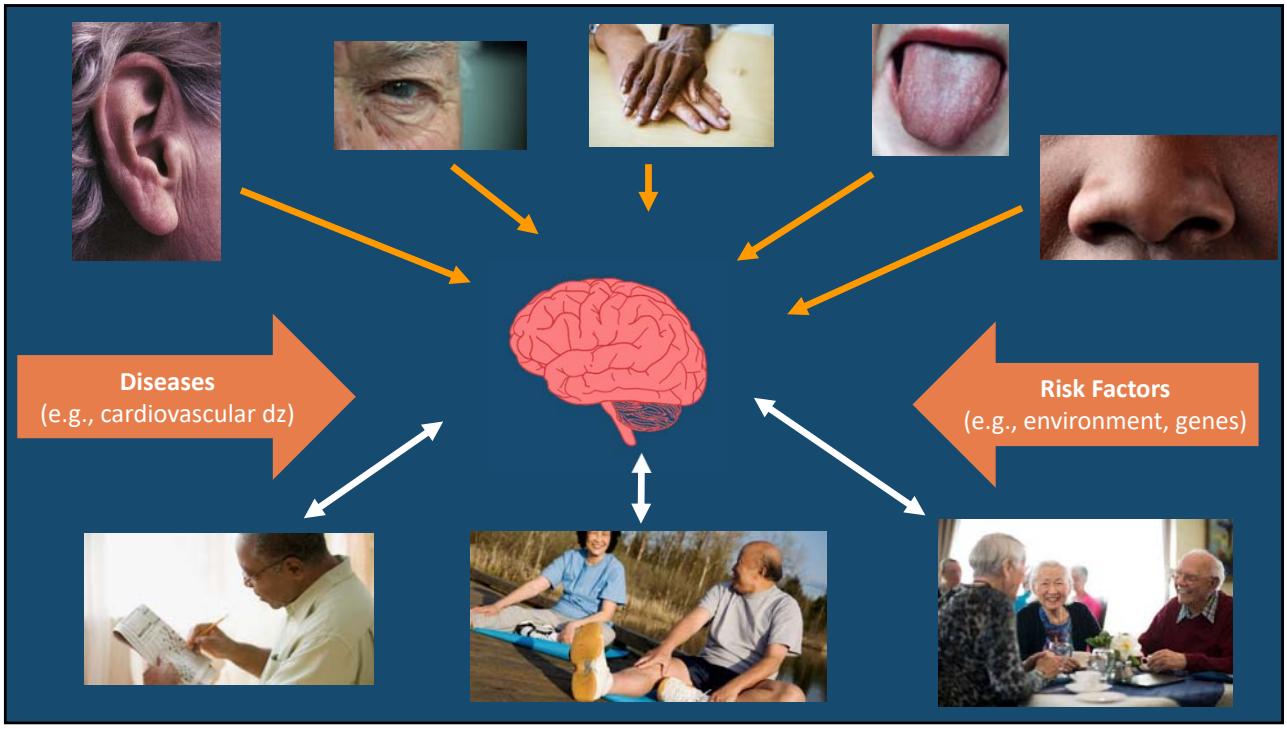
2nd – Chronic diseases (mid 20th cent. – now)

3rd – Aging processes (21st cent. & on)

Fries JF, 1982; Deaton A, 2013

In this 3rd era of public health, what health & policy strategies are needed to optimize healthy aging?

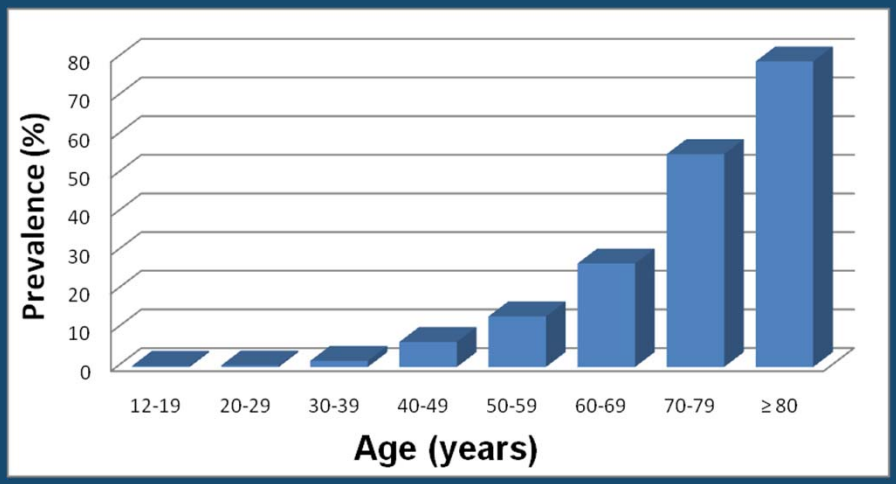
- Prevention/delay of disease → Compression of morbidity
- Effective treatment of disease → Managing multimorbidity
- Lifestyle factors → Diet, physical activity, etc.
- Biological processes underlying aging → Future drugs?
- **Optimizing sensory function?**





Our ability to hear & engage with the people & environment around us is fundamental to our health & well-being

Prevalence of Hearing Loss by Age Decade



Hearing loss defined as a better-ear pure tone average of 0.5-4kHz tones > 25 dB

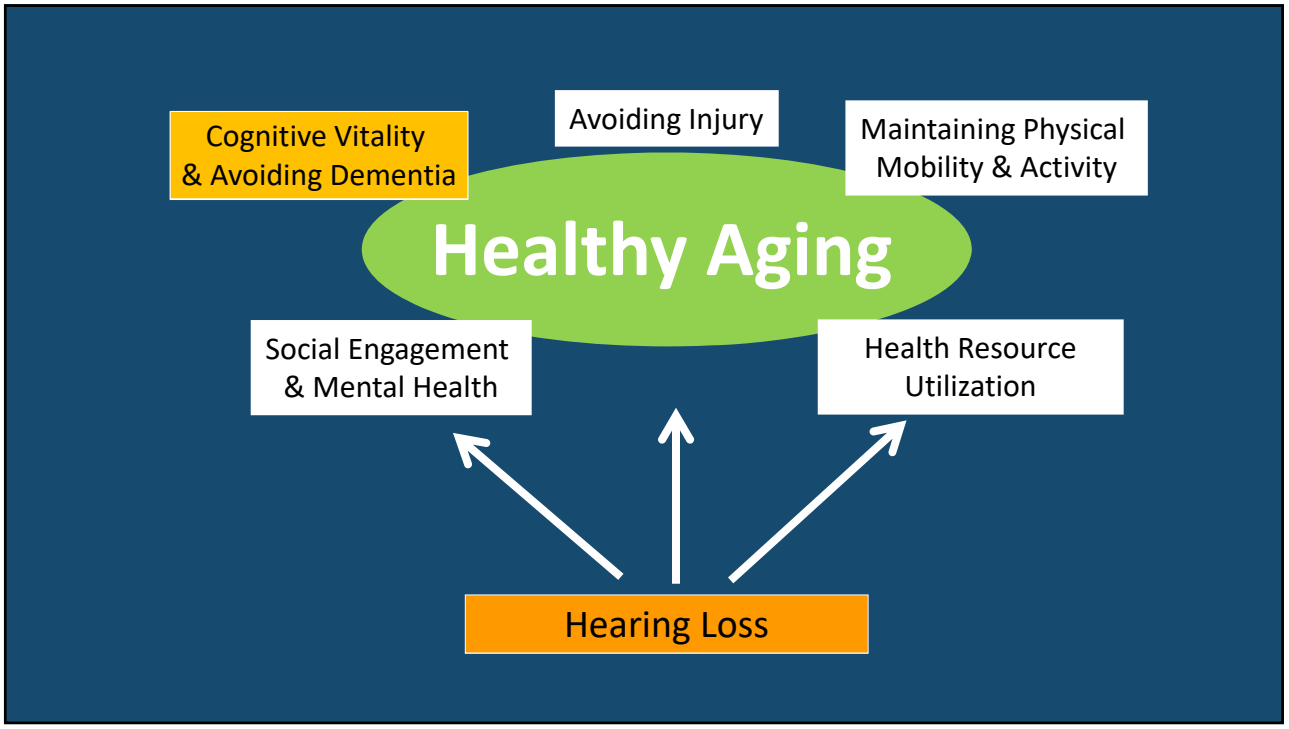
Arch Int Med. 2011

Hearing Loss & Aging

Critical Public Health Questions

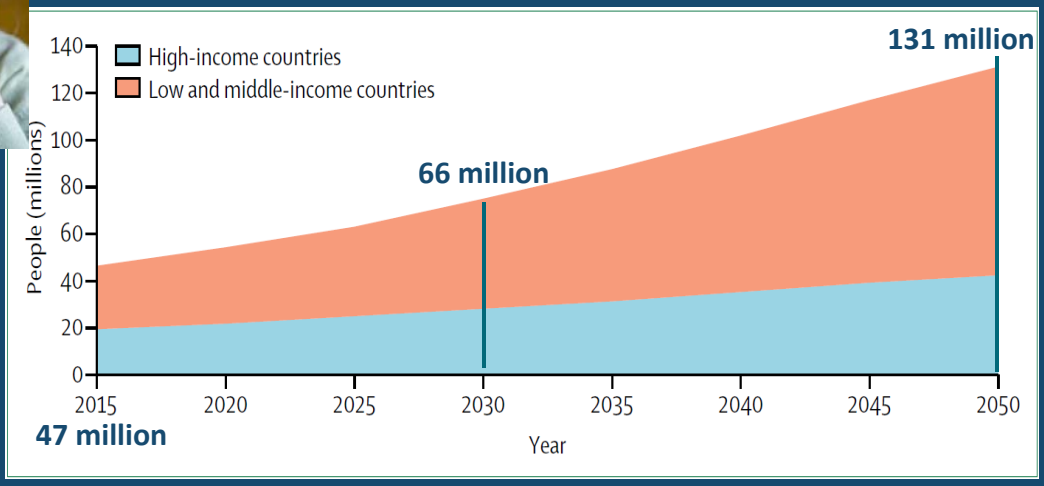
- What are the consequences of HL for older adults?
  - Epidemiology; Health economics
- What is the impact of treating HL on older adults?
  - Clinical trials
- How can HL be effectively addressed in society?
  - Policy; Development of new approaches to hearing care


Healthy Aging


Cognitive Vitality & Avoiding Dementia
Avoiding Injury
Maintaining Physical Mobility & Activity
Healthy Aging
Social Engagement & Mental Health
Health Resource Utilization
Hearing Loss



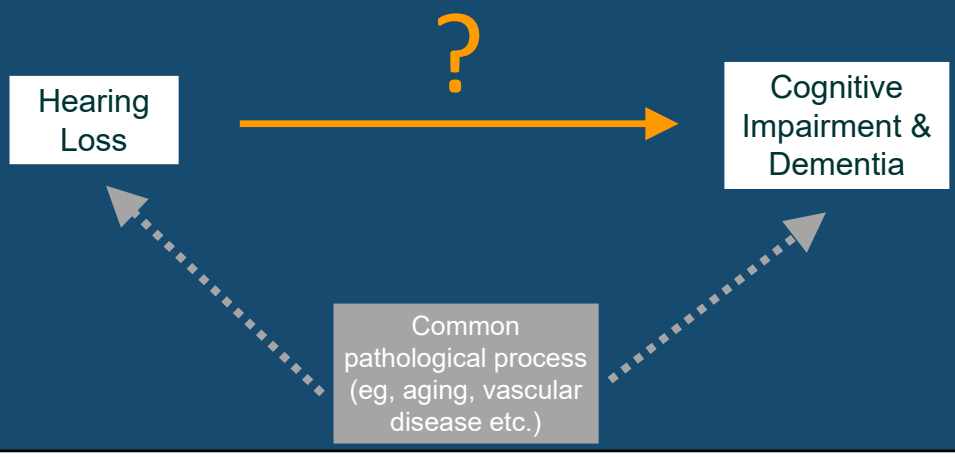
Global Dementia Prevalence

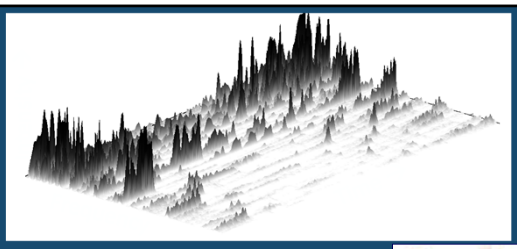


Livingston et al. Lancet Commission 2017

Hearing Loss & Cognition

Common Cause or *Modifiable Risk Factor*





"Sunday"



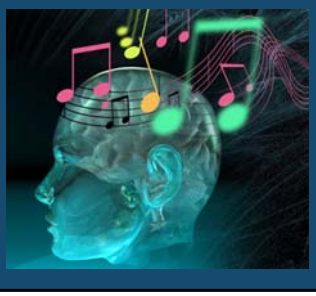
Hearing Loss & Cochlear impairment

↓

Decreased sensitivity & distortion in sound encoding

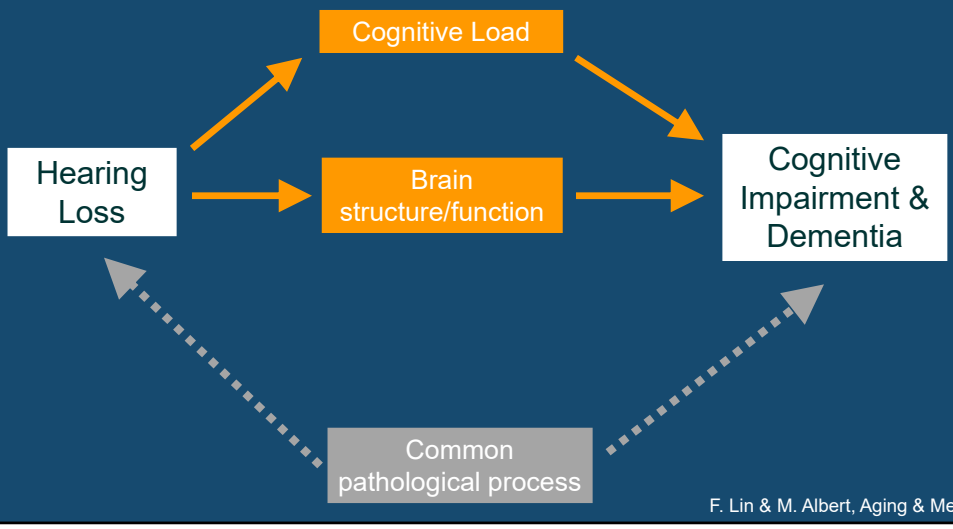
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"Effortful listening"



Hearing Loss & Cognition

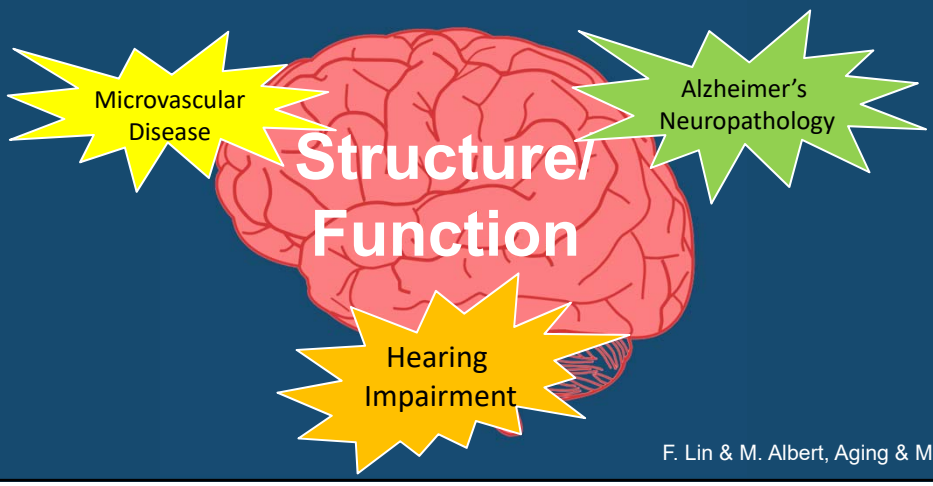
Common Cause or *Modifiable Risk Factor*



F. Lin & M. Albert, Aging & Mental Health, 2014

Risk Factors for Dementia – Multi-Hit Theoretical Model

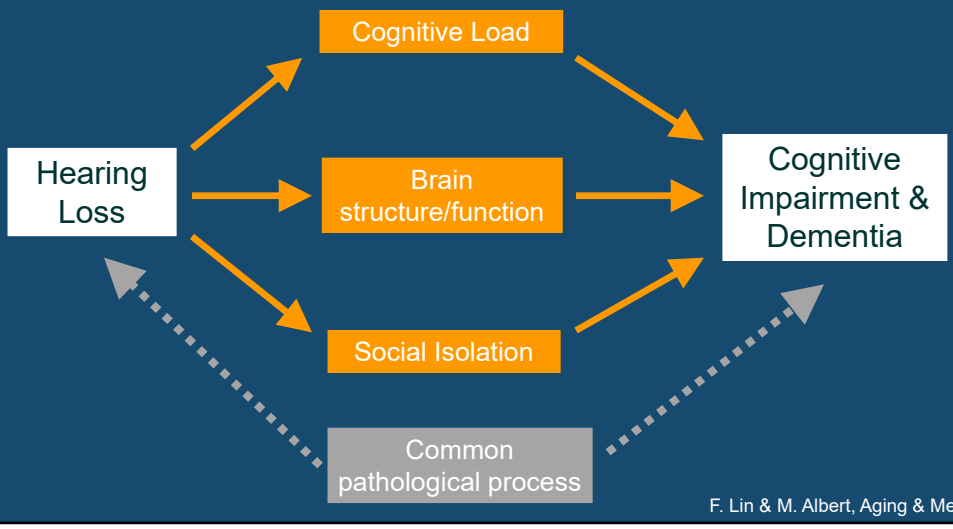
Hearing Loss & Brain Structure/Function



F. Lin & M. Albert, Aging & Mental Health, 2014

Hearing Loss & Cognition

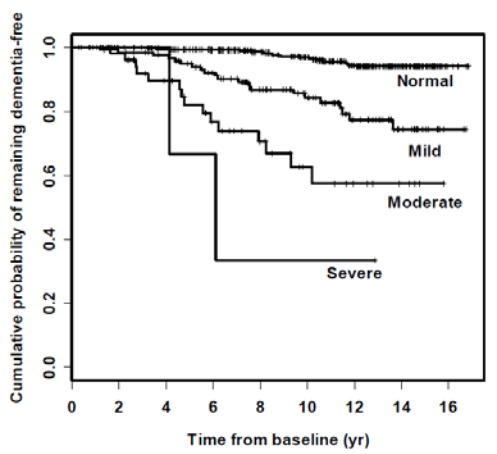
Common Cause or *Modifiable Risk Factor*



F. Lin & M. Albert, Aging & Mental Health, 2014

Hearing Loss & Incident Dementia

Dementia incidence in 639 adults followed for >10 years in the Baltimore Longitudinal Study of Aging



Risk of incident all-cause dementia (compared to normal hearing)[a]

	HR	95% CI	p
Mild	1.89	1.00 – 3.58	0.05
Moderate	3.00	1.43 – 6.30	.004
Severe	4.94	1.09 – 22.4	.04

[a] Adjusted for age, sex, race, education, DM, smoking, & hypertension

Lin et al., Arch Neuro., 2011

Hearing Loss & Incident Dementia

Dementia Incidence in 1057 Men Followed for 17 years in the Caerphilly Prospective Study (U.K.)

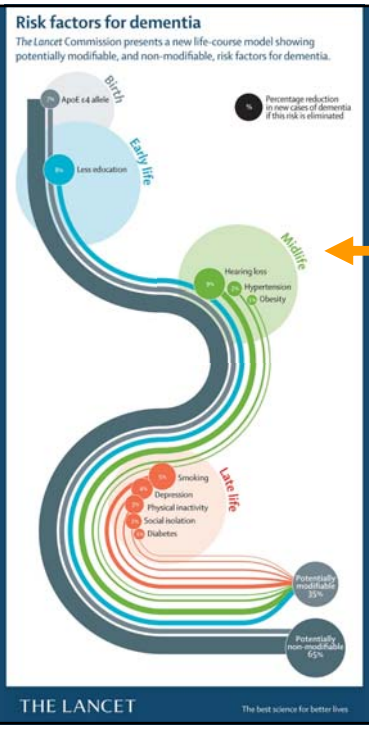
Cognitive impairment	Model 1: adjusted for age, OR[a] (95% CI), *p* value	Model 2: adjusted for age, social class, anxiety, OR[a] (95% CI), *p* value	Model 3: adjusted for age, social class, anxiety, premorbid intelligence, OR[a] (95% CI), *p* value
All dementia (n = 79)	4.07 (2.21-7.50), <0.001	3.26 (1.71-6.21), <0.001	2.67 (1.38-5.18), 0.004
Vascular dementia (n = 38)	3.83 (1.69-8.65), 0.001	2.93 (1.24-6.94), 0.015	2.40 (0.99-5.83), 0.05
Nonvascular dementia (n = 41)	4.20 (1.84-9.55), 0.001	3.58 (1.50-8.51), 0.004	2.96 (1.21-7.22), 0.017
CIND (n = 146)	2.32 (1.50-3.59), <0.001	1.72 (1.09-2.74), 0.021	1.24 (0.77-2.01), 0.38
All dementia (n = 46), omitting men with evidence of early cognitive decline	2.23 (1.04-4.77), 0.039	1.64 (0.72-3.73), 0.24	1.32 (0.57-3.12), 0.52

Abbreviations: CI = confidence interval; CIND = cognitive impairment no dementia; OR = odds ratio; PTA = pure-tone average (threshold).
[a] Odds ratio is the effect per 10-dB_A rise in usual PTA.

Neurology 79 October 9, 2012

J. Gallacher et al., Neurology, 2012

Lancet Commission on Dementia Prevention, Intervention & Care



Hearing loss in mid & late life identified as the single risk factor for dementia with the greatest population attributable fraction of risk

G. Livingston et al., Lancet, 2017

Cognitive Vitality & Avoiding Dementia

Avoiding Injury

Maintaining Physical Mobility & Activity

Healthy Aging

Social Engagement & Mental Health

Health Resource Utilization

Epidemiological Studies of Hearing & Aging Outcomes

Cognition/Dementia/Brain Aging

J Gerontol A Biol Sci Med Sci. 2016 Apr 12.
Am J Epidemiol. 2015 May 1;181(9):680-90.
Aging Ment Health. 2014;18(6):671-3.
Neuroimage. 2014 Apr 15;90:84-92.
JAMA Intern Med. 2013 Feb 25;173(4):293-9.
Neuropsychology. 2011 Nov;25(6):763-70.
Gerontol A Biol Sci Med Sci. 2011 Oct;66(10):1131-6.
Arch Neurol. 2011 Feb;68(2):214-20.

Injury/Physical Functioning

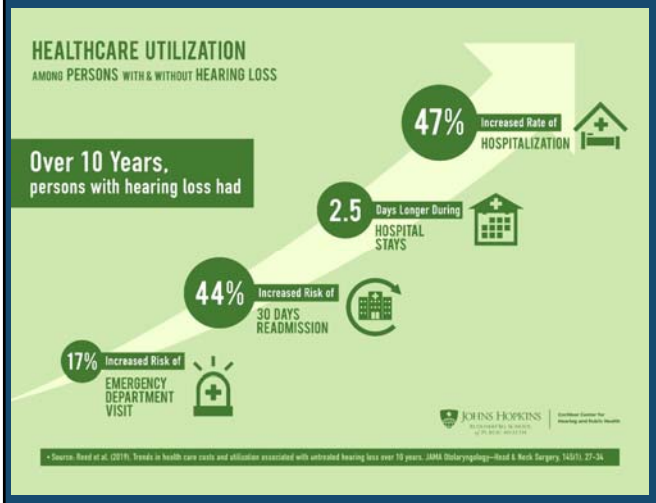
J Aging Health. 2016 Aug;28(5):890-910.
J Aging Health. 2016 Jun;28(4):644-60.
J Am Geriatr Soc. 2016 Apr;64(4):906-8.
J Gerontol A Biol Sci Med Sci. 2015 May;70(5):654-61.
J Am Geriatr Soc. 2014 Aug;62(8):1427-33.
J Am Geriatr Soc. 2014 Jun;62(6):1186-8.
Am Geriatr Soc. 2014 May;62(5):850-6.
Gait Posture. 2013 May;38(1):25-9.

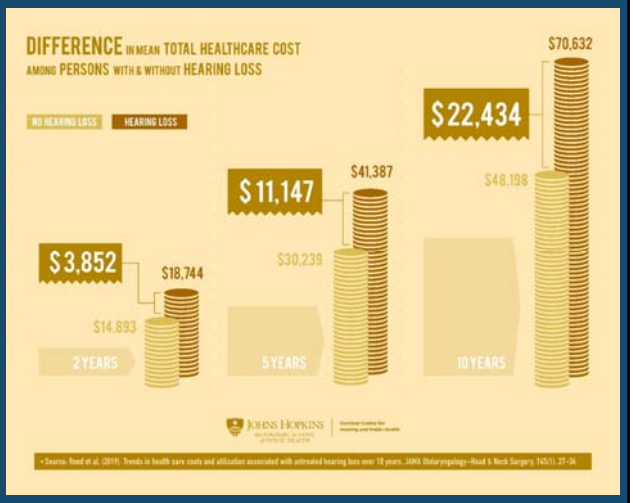
Social Engagement/Mental Health

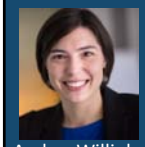
J Aging Health. 2016 Sep;28(6):979-94.
J Gerontol B Psychol Sci Soc Sci. 2016 May;71(3):400-4.
J Aging Health. 2016 Feb 24.
Otolaryngol Head Neck Surg. 2014 Mar;150(3):378-84.
J Am Geriatr Soc. 2013 Sep;61(9):1627-9

Health Resource Utilization

J Aging Health. 2016 Feb;28(1):68-94.
JAMA Otolaryn Head Neck Surg. 2015 Oct;141(10):944-6.
J Am Geriatr Soc. 2015 Jun;63(6):1146-52.
J Gerontol A Biol Sci Med Sci. 2015 Jan;70(1):85-90.
J Am Geriatr Soc. 2014 Nov;62(11):2207-9.
J Am Geriatr Soc. 2014 Jun;62(6):1188-9.
JAMA. 2013 Jun 12;309(22):2322-4.







Amber Willink, PhD

OPTUM Labs®

AARP®



Nick Reed, AuD



Jennifer Deal, PhD

Hearing Loss & Aging

Critical Public Health Questions

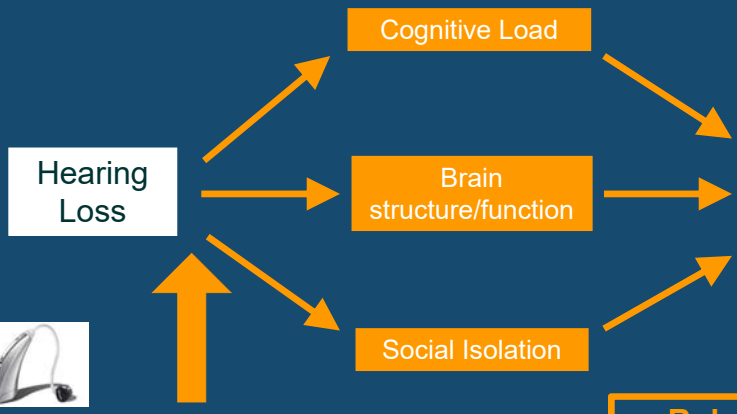
- What are the consequences of HL for older adults?
  - Epidemiology; Health economics
- What is the impact of treating HL on older adults?
  - Clinical trials
- How can HL be effectively addressed in society?
  - Policy; Development of new approaches to hearing care

The question of whether treating hearing loss could delay cognitive decline or dementia remains unknown

There has never been a randomized controlled trial of treating hearing loss to explore effects on reducing the risk of cognitive decline/dementia

Hearing Loss & Dementia

Hearing Loss as a Modifiable Risk Factor



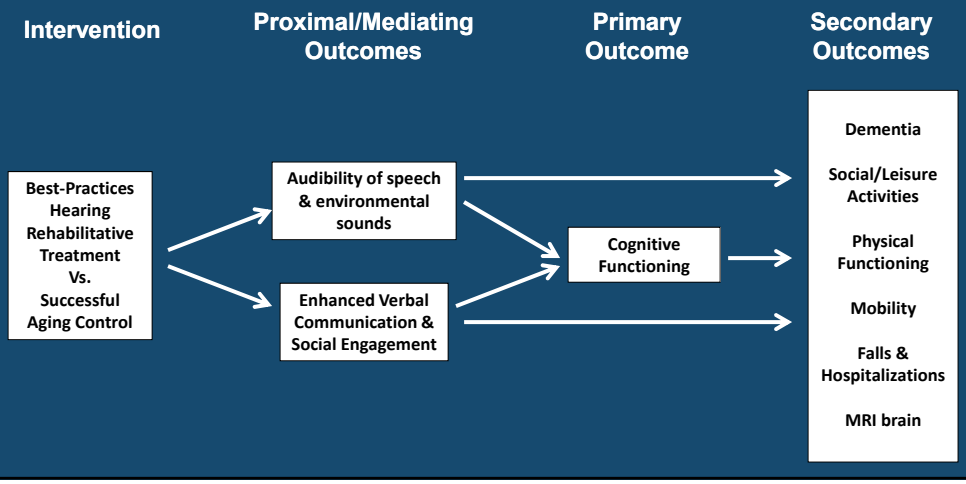
Hearing loss intervention could:

- Reduce the cognitive load of processing degraded sound
- Provide increased brain stimulation
- Improve social engagement

Role of HL as a potentially modifiable risk factor in late-life for cognitive decline & dementia

Aging & Cognitive Health Evaluation in Elders Randomized Trial (N > 850)

2017-2022



ACHIEVE Trial Design

Study Sites & Inclusion Criteria



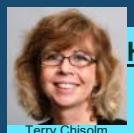
Supported by National Institutes of Health

Main study inclusion criteria:

- 70-84 y.o. community-dwelling adults
- Mild-moderate hearing loss
- No cognitive impairment
- No self-reported disability in >1 ADL
- No self-reported hearing aid use in the past year

ACHIEVE Trial Design

Interventions


Terry Chisolm

Hearing Loss Intervention – Univ S. Florida


Vicky Sanchez

-Could help promote better social engagement & reduce load of hearing loss on the brain

- 4 sessions with a study audiologist to receive hearing loss education & hearing devices

- Semiannual visits thereafter for 3 years to receive booster sessions & track cognitive/physical health


Michelle Arnold

Successful Aging Education Intervention – U. Univ Pittsburg


Nancy Glynn

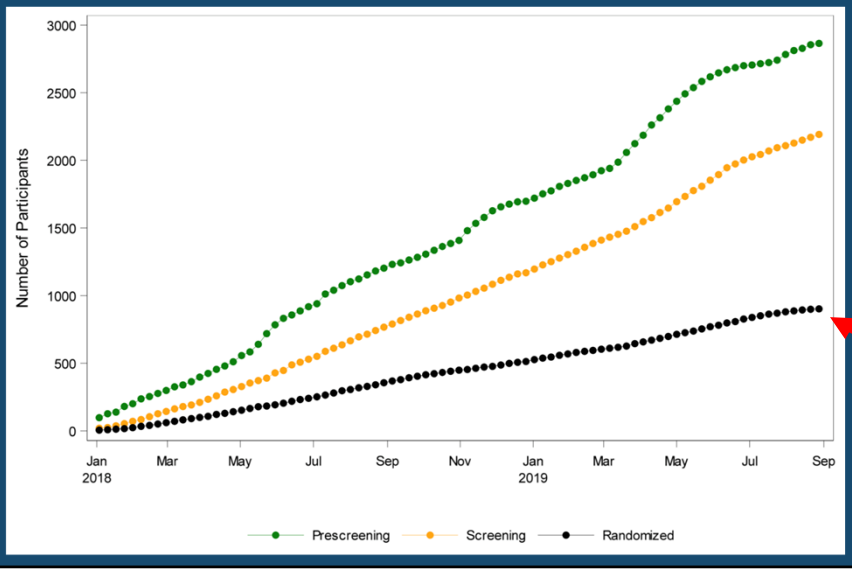
- Established program that helps promote better understanding of key health topics (nutrition, etc.) important for healthy aging

- 4 sessions with a health educator to cover the 10 Keys™ program

- Semiannual visits thereafter for 3 years to receive booster sessions & track cognitive/physical health

ACHIEVE Trial

Recruitment Status



N = 902

ACHIEVE Trial

Timeline

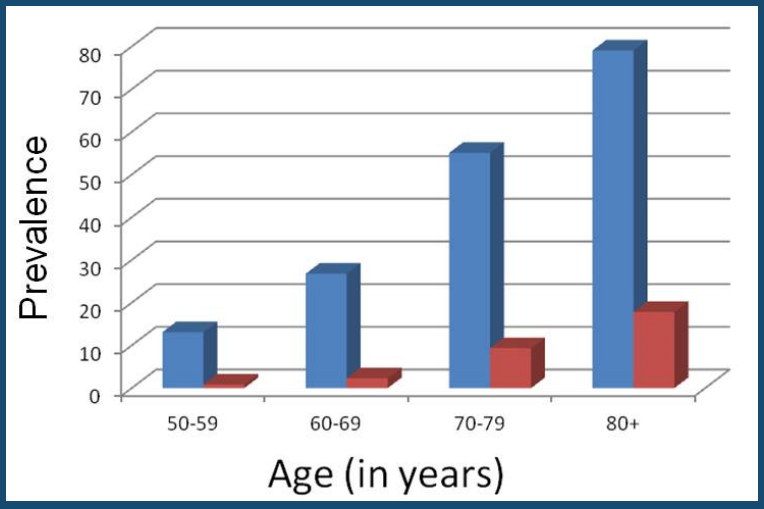
- **2011- 2013**
  - Epidemiological studies establishing association of hearing loss & dementia
- **2014 - 2016**
  - Trial planning grant (NIH R34AG046548)
  - Pilot study, development of protocol/operations manual, submission of grant for full-scale trial
- **2017**
  - ACHIEVE grant funded by the NIA (R01AG055426); Agreement with Sonova to provide hearing devices in kind
- **2018 - 19** Recruitment at field sites until October 11, 2019 (estimated N ~ 940)
- **2019 - 22** Follow-up

Hearing Loss & Aging

Critical Public Health Questions

- What are the consequences of HL for older adults?
  - Epidemiology; Health economics
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  - Policy; Development of new approaches to hearing care

Hearing Loss & Hearing Aid Use Prevalence Among Older Adults in the U.S.



Arch Int Med, 2012

Multiple Barriers Limit Uptake of Hearing Care in Adults

- Awareness & Understanding
- Cost/Affordability
- Access to Services &Technology
- Technology Design & Utility

Addressing these barriers requires new policies & new approaches to hearing care



Addressing Barriers Requires Top-Down National Initiatives to Change Policy

Initiatives in the United States since 2014

- National Academies of Science, Engineering & Medicine Workshop on Hearing Loss & Healthy Aging - 2014
- White House President's Council of Advisors on Science & Technology - 2015
- National Academies Consensus Study on Accessible & Affordable Hearing Care Consensus Study - 2016

Both White House & the National Academies recommend that re-regulation of hearing aids to allow for over-the-counter sales could have the most immediate impact on lowering costs & increasing uptake

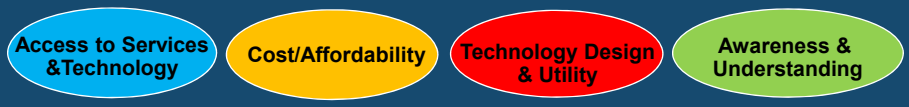
No country in the world has a regulated market for over-the-counter (OTC) hearing aids that would ensure safety & effectiveness

- FDA-approved hearing aids can only be sold through a licensed provider (e.g., audiologist, dispenser, physician)

- Currently, OTC hearing 'devices' are unregulated & poor quality despite strong evidence that safe and effective OTC hearing devices are technologically possible (Reed et al, JAMA 2017)

With a separate Food & Drug Administration regulatory classification for OTC hearing aids…

- Individuals have direct access to hearing aids that will meet strict performance criteria for safety and effectiveness
- Entry of consumer electronics manufacturers (e.g., Bose, Samsung, etc.) & ability of all manufacturers to sell directly to consumers will lead to reduction in prices
- Devices are created for end-user in mind with integration with consumer electronics, wireless connectivity, etc.
- Broader adoption of hearing technologies among even those with “normal” hearing



Convergence of medical devices (hearing aids) & consumer electronics (“hearables”)



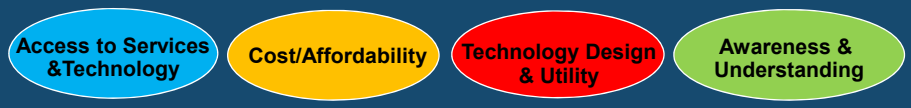




OTC Hearing Aid Bill introduced into U.S. Congress in March 2017 & signed into law in August 2017

This law overturns > 40 years of regulatory precedent in the U.S. & around the world

FDA regulation for OTC hearing aids in the U.S. to go into effect by 2020



Importance of addressing health problems with rigorous public health research that can inform public policy

Hearing Loss & Aging

Critical Public Health Questions

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Animations

Why hearing matters to public health (1:59 min)

What the Johns Hopkins Cochlear Center is doing (1:33 min)

Animations available at www.jhucochlearcenter.org

JOHNS HOPKINS
BLOOMBERG SCHOOL
of PUBLIC HEALTH

Cochlear Center for Hearing and Public Health

Cochlear Center for Hearing & Public Health

Quick Facts



- 7 core faculty members, 9 associate faculty, 12 staff members, 13 trainees
- Center mission – Training a generation of clinicians & researchers to understand & address the impact of HL on public health
  - Focus on trainees from Asia & Latin America
- Multiple training opportunities (1 week - 4 years) available for MD, PhD, audiologists, etc. interested in developing a public health approach to HL


Jennifer Deal

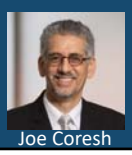

Nick Reed


Josh Betz

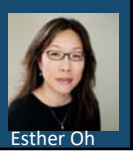

Carrie Nieman


Adele Goman


Amber Willink


Joe Coresh


Moyses Szklo


Esther Oh

Thank you!



www.jhucochlearcenter.org
flin1@jh.edu @DrFrankRLin

Johns Hopkins Cochlear Center for Hearing and Public Health

Unregulated PSAPs – Many Bad, Some

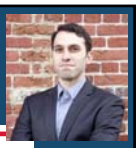




Table. Accuracy in Speech Understanding in Noise From Unaided to Aided With PSAPs and a Hearing Aid Among 42 Older Adults With Mild to Moderate Hearing Loss[a]

	Cost, US $[b]	Mean Accuracy, % (95% CI)	Change From Unaided Hearing, Percentage Points (95% CI)	Difference Between PSAP and Hearing Aid Change, Percentage Points (95% CI)
Unaided hearing		76.5 (72.7 to 80.3)		NA
Oticon Nera 2 hearing aid[c]	1910.00	88.4 (84.5 to 92.4)	11.9 (9.8 to 14.0)	
PSAP				
Sound World Solutions CS50+	349.99	87.4 (83.5 to 91.4)	11.0 (8.8 to 13.1)	−1.0 (−2.7 to 0.8)
Soundhawk	349.99	86.7 (82.7 to 90.6)	10.2 (8.0 to 12.3)	−1.8 (−3.5 to 0)
Etymotic BEAN	299.99	84.1 (80.2 to 88.1)	7.7 (5.5 to 9.8)	−4.3 (−6.1 to −2.5)
Tweak Focus	269.99	81.4 (77.4 to 85.3)	4.9 (2.8 to 7.0)	−7.0 (−8.8 to −5.3)
MSA 30X Sound Amplifier	29.99	65.3 (60.1 to 70.4)	−11.2 (−15.2 to −7.3)	−23.1 (−26.9 to −19.4)

Abbreviations: NA, not applicable; PSAP, personal sound amplification products.

[a] The pure-tone average was 500-4000 Hz; the mean dB HL was 34.7 in the right ear and 36.1 in the left ear.

[b] The cost of the hearing aid was the wholesale price paid by the Johns Hopkins University Audiology Clinic. PSAPs were purchased online (Sound World Solutions CS50+, Soundhawk, Etymotic BEAN, Tweak Focus) and storefront retail (MSA 30X Sound Amplifier). All devices were purchased between January 2016 and April 2016.

[c] Oticon Nera 2 is a US Food and Drug Administration–regulated hearing aid, whereas all other devices are PSAPs.

Reed et al., JAMA, 2017

FEDERAL TRADE COMMISSION
PROTECTING AMERICA'S CONSUMERS

FTC Settlement Turns Down the Volume on Deceptive Sound Amplifier Ads

Defendants could not back up efficacy claims made for their MSA 30X device

"indepe … better."

judgment of $47 million

clearly, without missing a word, in crowded places like movie theaters or restaurants.

https://www.ftc.gov/news-events/press-releases/2018/05/ftc-settlement-turns-down-volume-deceptive-sound-amplifier-ads