

1

Hi, and welcome to Session 2, The SNHL problem. This session covers four topics.



2

First, you'll learn the major cause of SNHL and our common belief about it.



3

Then you'll learn about the scale and consequences

- 1 major cause and common belief
- 2 scale and consequences
- 3 who suffers and how

DATA & SCENARIO 1 | SESSION 2 - THE DATA PROBLEM

4

Then who suffers and how.

- 1 major cause and common belief
- 2 scale and consequences
- 3 who suffers and how
- 4 summary and forecast

DATA & SCENARIO 1 | SESSION 2 - THE DATA PROBLEM

5

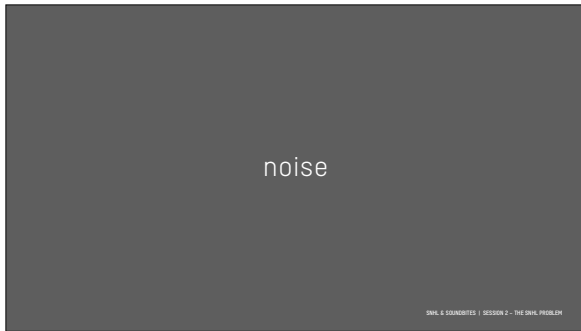
I'll end with a summary and a forecast. I'll be sharing lots of numbers, charts and graphs. It might help to download the handout version of the slides from the extra documents.

- 1 major cause and common belief

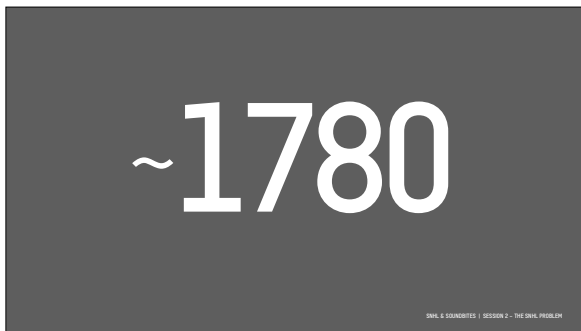
DATA & SCENARIO 1 | SESSION 2 - THE DATA PROBLEM

6

Let's start with the major cause and common belief.



When we talk about SNHL we have to talk about noise because noise is the major cause of hearing loss.



The hearing loss problem started escalating in the late eighteenth century with the invention of the steam engine and factories that burned fossil fuels, mainly coal and kerosene.



Ear trumpets were introduced in 1800 to help manage the growing problem. Ear trumpets amplified sound people needed to hear while filtering out background noise. Today's hearing aids and noise-cancelling earbuds are based on the same idea.

we believe hearing loss is inevitable

DMH & SOUNDWITNESSES | SESSION 2 - THE DMH PROBLEM

10

We came to believe hearing loss is inevitable, a belief often validated by personal experience.

those who suffer are hardly alone

DMH & SOUNDWITNESSES | SESSION 2 - THE DMH PROBLEM

11

Those who suffer are hardly alone.

vast public health problem

DMH & SOUNDWITNESSES | SESSION 2 - THE DMH PROBLEM

12

Hearing loss has become a vast public health problem. Today, about one-and-a-half billion people are affected.

- 1 major cause and common belief
- 2 scale and consequences

SNL & SOUNDWITNES | SESSION 2 - THE SNHL PROBLEM

13

Now let's look at the scale and the consequences of hearing loss.

#2
disability

SNL & SOUNDWITNES | SESSION 2 - THE SNHL PROBLEM

14

Hearing loss among adults over the age of 50 is the second most common chronic health disability worldwide.

#3
in America

SNL & SOUNDWITNES | SESSION 2 - THE SNHL PROBLEM

15

In the United States, the Centers for Disease Control and Prevention reports hearing loss is the third most common chronic health condition, following arthritis and joint problems like bad knees, backs, and hips. That makes hearing loss more prevalent than diabetes or cancer.

1.5
billion

16

The World Health Organization and the Lancet report that 1.5 billion people worldwide are now hearing impaired.

~25%
adults worldwide

17

That's about 25% of the nearly 6 billion adults over the age of 20 worldwide.

~360 million
hearing disabled

18

About a quarter of those with hearing loss, about 360 million people, are profoundly hearing disabled, meaning they've become functionally deaf.

hearing loss is starting earlier

SNL & SOUNDWITNESSES | SESSION 2 - THE SNAL PROBLEM

19

The problem started getting worse faster recently with the rapid, widespread adoption of digital sound processing technologies.

~14.9%
children 6-19

SNL & SOUNDWITNESSES | SESSION 2 - THE SNAL PROBLEM

20

Just under 15% of American children ages 6–19 already suffer hearing loss from noise exposure. That number jumped 20% between 2021 and 2023, from 12.5% to about 15%.

1.1+
billion

SNL & SOUNDWITNESSES | SESSION 2 - THE SNAL PROBLEM

21

Today, the rate of hearing loss in young adults is climbing faster than ever. 1.1 billion people aged 12 to 35 are at risk much earlier in life than their parents, mainly from loud music.

risk of hearing loss within minutes

SNHL & SOUNDWITNESSES | SESSION 2 - THE SNHL PROBLEM

22

Sound pressure levels in earbuds and headphones and at live events can easily exceed safe levels, creating the risk of hearing loss within minutes.

muffled hearing and temporary tinnitus

SNHL & SOUNDWITNESSES | SESSION 2 - THE SNHL PROBLEM

23

Most people know this intuitively. Also, the ears send warning signals that are hard to ignore, mainly fuzzy hearing or at worst, sudden total hearing loss, and temporary tinnitus.



SNHL & SOUNDWITNESSES | SESSION 2 - THE SNHL PROBLEM

24

The word tinnitus comes from tintinnabulum, the 14th century word for a small bell.

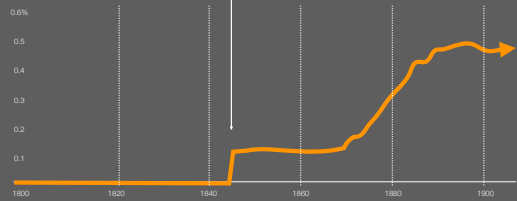
tinnitus is brain noise

SNL & SOUNDITES | SESSION 2 - THE SNAL PROBLEM

25

We call tinnitus ringing in the ears, but it's actually brain noise.

tinnitus used in print



Data from Google Books Ngram viewer

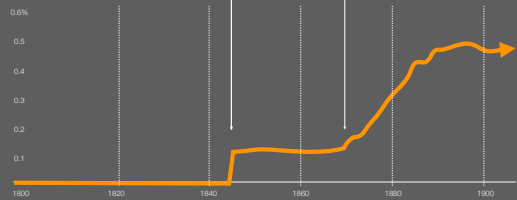
SNL & SOUNDITES | SESSION 2 - THE SNAL PROBLEM

26

The first use of the word tinnitus in print can be traced to the 1840s.

tinnitus used in print

industrial revolution begins



Data from Google Books Ngram viewer

SNL & SOUNDITES | SESSION 2 - THE SNAL PROBLEM

27

Curiously, the word became much more popular at the start of industrialization in the 1870's, adding evidence to the correlation between tinnitus and hearing loss.

~70%
tinnitus

SNHL & SOUNDWITNESSES | SESSION 2 - THE SNHL PROBLEM

28

Roughly 70% of those with hearing loss are said to suffer tinnitus, and we know millions of people suffer permanent tinnitus as a consequence of hearing loss. Tinnitus statistics rely on subjective, self-reported data, so we don't have reliable data. At its worst, tinnitus is a cause of suicide.

hearing loss changes brain function

SNHL & SOUNDWITNESSES | SESSION 2 - THE SNHL PROBLEM

29

Hearing loss deprives the brain of input, which appears to change brain function, making hearing loss a potential major risk factor for cognitive dysfunction and dementia.

pandemic

SNHL & SOUNDWITNESSES | SESSION 2 - THE SNHL PROBLEM

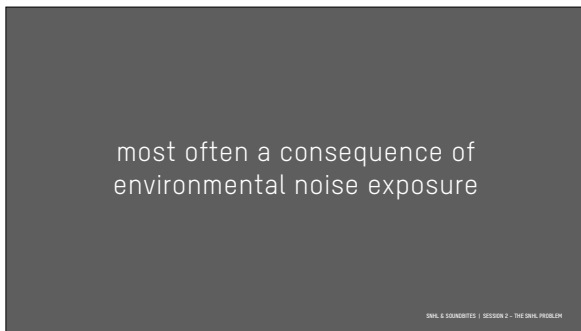
30

Hearing loss is a pandemic.



31

But we have to be careful using that word, because unlike pandemics caused by pathogens like the SARS virus that caused the Covid-19 pandemic, viruses and bacteria are relatively uncommon causes of hearing loss.



32

Instead, hearing loss is most often a consequence of environmental noise exposure.



33

Collectively, we're responsible for the hearing loss problem. Humans are doing this to ourselves in the name of progress.

noise triggers biological
dysfunction in inner ear hearing cells

SNHL & SOUNDWITNESSES | SESSION 2 - THE SNHL PROBLEM

34

Noise triggers biological dysfunction in inner ear hearing cells. We'll learn about that in Session 4.

- 1 major cause and common belief
- 2 scale and consequences
- 3 who suffers and how

SNHL & SOUNDWITNESSES | SESSION 2 - THE SNHL PROBLEM

35

Next, let's use public health data to see who suffers and how.

Global Burden of Disease Studies (GBD)



Institute of Health Metrics and Evaluation
University of Washington

SNHL & SOUNDWITNESSES | SESSION 2 - THE SNHL PROBLEM

36

The data come from the Global Burden of Disease Studies, called the GBD, collected by the Institute of Human Metrics and Evaluation at the University of Washington. The GBD is a collaboration among thousands of researchers in hundreds of countries, originally funded by the World Bank.

Disability-Adjusted Life Year = DALY

DAHL & SANDHEDT | SESSION 2 - THE DALY PROBLEM

37

GBD data uses the disability-adjusted life year, abbreviated DALY. The DALY expresses death and disability from major diseases, injuries, and risk factors as a numerical score.

Years of Life Lost to premature mortality (YLLs)

DAHL & SANDHEDT | SESSION 2 - THE DALY PROBLEM

38

DALYs for a disease or a health disability are determined by adding the number of years of life lost due to premature mortality, called YLLs...

years of life lost to premature mortality (YLLs)
+ Years of healthy Life lost to Disability (YLDs)

DAHL & SANDHEDT | SESSION 2 - THE DALY PROBLEM

39

...and years of healthy life lost due to disability, called YLDs, due to the prevalent cases of the disease or health condition in a population.

loss of one year of full health = 1 DALY

DALY & QALY DEFINITIONS | SESSION 2 - THE DALY PROBLEM

40

The loss of one year of full health equals one DALY.

1 DALY =

DALY & QALY DEFINITIONS | SESSION 2 - THE DALY PROBLEM

41

To be clear, one DALY...

1 DALY = 1 year of morbidity =

DALY & QALY DEFINITIONS | SESSION 2 - THE DALY PROBLEM

42

is the same as one year of morbidity...

1 DALY = 1 year of morbidity = 1 year of suffering

43

...which is the same as one year of suffering.

the hearing loss disability is included in GBD studies

44

The hearing loss disability has been included in GBD studies since the first report in 1990.

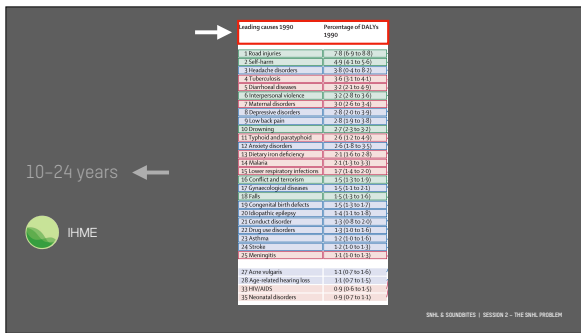
Leading causes 1990	Percentage of DALYs 1990
1 Ischaemic heart disease	28.0% to 8.0%
2 Stroke	44.0% to 5.0%
3 Infectious diseases	33.0% to 8.7%
4 Cardiovascular	30.0% to 4.4%
5 Diarrhoeal diseases	22.0% to 6.5%
6 Unintentional injuries	12.0% to 1.6%
7 Mental disorders	10.0% to 1.4%
8 Depression disorders	28.0% to 3.9%
9 Stroke	24.0% to 3.8%
10 Drowning	27.0% to 3.7%
11 Tuberculosis	24.0% to 4.4%
12 Anxiety disorders	28.0% to 3.5%
13 Energy malnutrition	21.0% to 1.4%
14 Malaria	21.0% to 3.1%
15 Lower respiratory infections	17.0% to 2.0%
16 Conflict and terrorism	15.0% to 1.0%
17 Cervical cancer	15.0% to 1.0%
18 HIV/AIDS	14.0% to 1.1%
19 Complications of childbirth	14.0% to 1.1%
20 Birth asphyxia and birth trauma	14.0% to 1.1%
21 Conflict disorders	11.0% to 1.0%
22 Drug use disorders	11.0% to 1.4%
23 Asthma	11.0% to 1.0%
24 Suicide	11.0% to 1.1%
25 Arthritis	11.0% to 1.3%
26 Overweight	11.0% to 1.3%
27 Arterial hypertension	11.0% to 1.6%
28 Age-related hearing loss	11.0% to 1.5%
29 HIV/AIDS	8.0% to 1.5%
30 Muscular disorders	8.0% to 1.5%

45

The GBD data I'll be showing you is organized by age group...

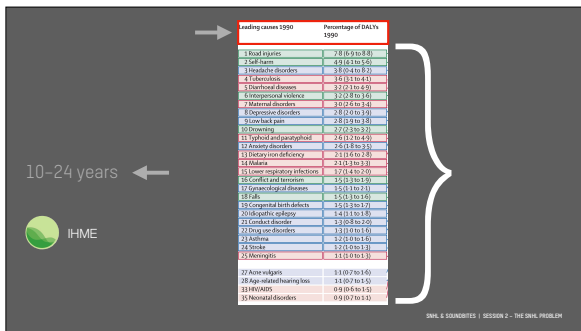
10-24 years ←





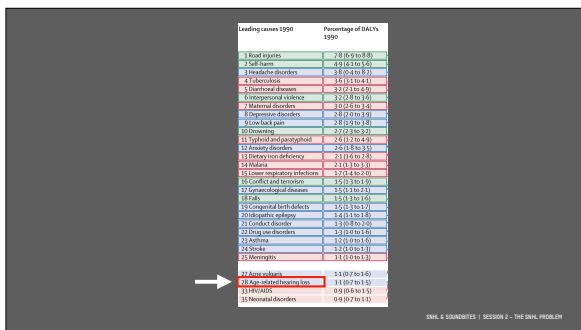
46

and DALY percentages...



47

...with the worst problems at the top. There are hundreds of health metrics in the data. I'm showing only the top thirty-five. You'll see why in a minute.



48

Since its first report, GBD data has used the term age-related hearing loss to report inner ear hearing loss, because it can happen at any age. Pathogenic causes of SNHL, like childhood meningitis, for example, are classified separately under those diseases, which are much further down the list.

Leading causes 1990	Percentage of DALYs 1990
1 Road injuries	7.8 (5.5 to 8.8)
2 Self-harm	4.9 (3.5 to 5.5)
3 Infective disorders	3.9 (3.4 to 4.7)
4 Cardiovascular	3.8 (3.1 to 4.4)
5 Diets-related disorders	3.2 (2.8 to 3.9)
6 Intentional violence	3.2 (2.8 to 3.6)
7 Mental disorders	3.2 (2.8 to 3.4)
8 Digestive disorders	2.9 (2.5 to 3.4)
9 Low back pain	2.8 (2.5 to 3.1)
10 Diabetes	2.7 (2.3 to 3.1)
11 Typical and atypical	2.6 (2.2 to 3.1)
12 Anxiety disorders	2.6 (2.3 to 3.1)
13 Bicyclic deficiency	2.1 (1.6 to 2.8)
14 Malaria	2.1 (1.9 to 3)
15 Lower respiratory infections	1.7 (1.4 to 2.0)
16 Conflict and terrorism	1.5 (1.3 to 1.9)
17 Gram-negative diseases	1.5 (1.3 to 1.7)
18 FAP	1.5 (1.3 to 1.6)
19 Congenital birth defects	1.5 (1.3 to 1.7)
20 Infectious pathology	1.4 (1.1 to 1.8)
21 Conduct disorders	1.3 (1.0 to 2.0)
22 Drug use disorders	1.3 (1.0 to 1.6)
23 Asthma	1.2 (1.0 to 1.5)
24 Stroke	1.2 (0.9 to 1.3)
25 Overweight	1.1 (0.9 to 1.3)
27 Arms injuries	1.1 (0.7 to 1.6)
28 Age-related hearing loss	1.1 (0.7 to 1.5)
29 HIV/AIDS	0.9 (0.7 to 1.1)
30 Neonatal disorders	0.9 (0.7 to 1.1)

$1.1 = 1.1\%$

49

Two side notes. First, GBD percentages are shown as superscript decimal points, so one point one equals 1 point 1%.

Leading causes 1990	Percentage of DALYs 1990
1 Road injuries	7.8 (5.5 to 8.8)
2 Self-harm	4.9 (3.5 to 5.5)
3 Infective disorders	3.9 (3.4 to 4.7)
4 Cardiovascular	3.8 (3.1 to 4.4)
5 Diets-related disorders	3.2 (2.8 to 3.9)
6 Intentional violence	3.2 (2.8 to 3.6)
7 Mental disorders	3.2 (2.8 to 3.4)
8 Digestive disorders	2.9 (2.5 to 3.4)
9 Low back pain	2.8 (2.5 to 3.1)
10 Diabetes	2.7 (2.3 to 3.1)
11 Typical and atypical	2.6 (2.2 to 3.1)
12 Anxiety disorders	2.6 (2.3 to 3.1)
13 Bicyclic deficiency	2.1 (1.6 to 2.8)
14 Malaria	2.1 (1.9 to 3)
15 Lower respiratory infections	1.7 (1.4 to 2.0)
16 Conflict and terrorism	1.5 (1.3 to 1.9)
17 Gram-negative diseases	1.5 (1.3 to 1.7)
18 FAP	1.5 (1.3 to 1.6)
19 Congenital birth defects	1.5 (1.3 to 1.7)
20 Infectious pathology	1.4 (1.1 to 1.8)
21 Conduct disorders	1.3 (1.0 to 2.0)
22 Drug use disorders	1.3 (1.0 to 1.6)
23 Asthma	1.2 (1.0 to 1.5)
24 Stroke	1.2 (0.9 to 1.3)
25 Overweight	1.1 (0.9 to 1.3)
27 Arms injuries	1.1 (0.7 to 1.6)
28 Age-related hearing loss	1.1 (0.7 to 1.5)
29 HIV/AIDS	0.9 (0.7 to 1.1)
30 Neonatal disorders	0.9 (0.7 to 1.1)

$1.1 [0.7 \text{ to } 1.5]$
 $=$
 $1.1\% [0.7\% \text{ to } 1.5\%]$

50

Second, public health data is useful for formulating public health policy, but it's imperfect. That fact is acknowledged by the averages of the numbers in brackets, called the uncertainty interval, the UI, and the confidence interval, the CI.

Leading causes 1990	Percentage of DALYs 1990	Leading causes 2019	Percentage of DALYs 2019
1 Road injuries	7.8 (5.5 to 8.8)	1	2.8 (2.5 to 3.1)
2 Self-harm	4.9 (3.5 to 5.5)	2	1.5 (1.3 to 1.7)
3 Infective disorders	3.9 (3.4 to 4.7)	3	1.4 (1.1 to 1.8)
4 Cardiovascular	3.8 (3.1 to 4.4)	4	1.3 (1.0 to 1.6)
5 Diets-related disorders	3.2 (2.8 to 3.9)	5	1.2 (1.0 to 1.5)
6 Intentional violence	3.2 (2.8 to 3.6)	6	1.2 (1.0 to 1.5)
7 Mental disorders	3.2 (2.8 to 3.4)	7	1.2 (1.0 to 1.5)
8 Digestive disorders	2.9 (2.5 to 3.4)	8	1.2 (1.0 to 1.5)
9 Low back pain	2.8 (2.5 to 3.1)	9	1.2 (1.0 to 1.5)
10 Diabetes	2.7 (2.3 to 3.1)	10	1.2 (1.0 to 1.5)
11 Typical and atypical	2.6 (2.2 to 3.1)	11	1.2 (1.0 to 1.5)
12 Anxiety disorders	2.6 (2.3 to 3.1)	12	1.2 (1.0 to 1.5)
13 Bicyclic deficiency	2.1 (1.6 to 2.8)	13	1.2 (1.0 to 1.5)
14 Malaria	2.1 (1.9 to 3)	14	1.2 (1.0 to 1.5)
15 Lower respiratory infections	1.7 (1.4 to 2.0)	15	1.2 (1.0 to 1.5)
16 Conflict and terrorism	1.5 (1.3 to 1.9)	16	1.2 (1.0 to 1.5)
17 Gram-negative diseases	1.5 (1.3 to 1.7)	17	1.2 (1.0 to 1.5)
18 FAP	1.5 (1.3 to 1.6)	18	1.2 (1.0 to 1.5)
19 Congenital birth defects	1.5 (1.3 to 1.7)	19	1.2 (1.0 to 1.5)
20 Infectious pathology	1.4 (1.1 to 1.8)	20	1.2 (1.0 to 1.5)
21 Conduct disorders	1.3 (1.0 to 2.0)	21	1.2 (1.0 to 1.5)
22 Drug use disorders	1.3 (1.0 to 1.6)	22	1.2 (1.0 to 1.5)
23 Asthma	1.2 (1.0 to 1.5)	23	1.2 (1.0 to 1.5)
24 Stroke	1.2 (0.9 to 1.3)	24	1.2 (1.0 to 1.5)
25 Overweight	1.1 (0.9 to 1.3)	25	1.2 (1.0 to 1.5)
27 Arms injuries	1.1 (0.7 to 1.6)	26	1.2 (1.0 to 1.5)
28 Age-related hearing loss	1.1 (0.7 to 1.5)	27	1.2 (1.0 to 1.5)
29 HIV/AIDS	0.9 (0.7 to 1.1)	28	1.2 (1.0 to 1.5)
30 Neonatal disorders	0.9 (0.7 to 1.1)	29	1.2 (1.0 to 1.5)

51

The charts I'll show you compare the ranking for leading worldwide health problems in 1990 with their ranking in 2019, along with the percentage of DALYs.

what happened to hearing loss in the roughly three decades 1990 - 2019?

52

Ready? Let's see what happened to hearing loss in the twenty-nine years from 1990 to 2019.

SNL & SOUNDWITTS | SESSION 2 - THE SNAK PROBLEM

10-24 years

Leading causes 1990	Percentage of DALYs 1990	Leading causes 2019	Percentage of DALYs 2019
1 Road injuries	7.0 (6.5 to 7.6)	1 Road injuries	6.6 (6.0 to 7.2)
2 Self-harm	4.0 (3.5 to 4.6)	2 Musculoskeletal disorders	5.2 (4.6 to 5.9)
3 Ischaemic heart disease	3.9 (3.4 to 4.4)	3 Self-harm	3.7 (3.1 to 4.4)
4 Tuberculosis	1.9 (1.3 to 2.4)	4 Depression disorders	3.7 (3.0 to 4.5)
5 Diarrhoeal diseases	2.2 (1.7 to 2.7)	5 Intergenerational violence	3.6 (3.0 to 4.3)
6 Intergenerational violence	1.9 (1.3 to 2.6)	6 Anxiety disorders	3.1 (2.5 to 3.8)
7 Maternal disorders	2.2 (1.7 to 2.7)	7 Low back pain	3.2 (2.6 to 3.7)
8 Depression disorders	2.2 (1.7 to 2.7)	8 Other musculoskeletal	3.1 (2.5 to 3.6)
9 Low back pain	2.4 (1.9 to 2.9)	9 HIV/AIDS	2.4 (1.8 to 3.1)
10 Tuberculosis	2.1 (1.6 to 2.7)	10 Tuberculosis	2.4 (1.8 to 3.1)
11 Typhoid and paratyphoid	2.4 (1.9 to 2.9)	11 Neurological disorders	2.1 (1.5 to 2.8)
12 Anxiety disorders	2.4 (1.9 to 2.9)	12 Tuberculosis	2.1 (1.5 to 2.8)
13 Dietary iron deficiency	2.1 (1.6 to 2.7)	13 Gastroenterology disorders	1.9 (1.4 to 2.5)
14 Asthma	2.1 (1.6 to 2.7)	14 Typhoid and paratyphoid	1.9 (1.4 to 2.5)
15 Lower respiratory infections	1.7 (1.2 to 2.3)	15 Asthma	1.9 (1.4 to 2.5)
16 Conflict and terrorism	1.4 (1.0 to 1.9)	16 Malaria	1.8 (1.3 to 2.4)
17 Gonorrhoeal diseases	1.5 (1.1 to 2.0)	17 Conflict and terrorism	1.5 (1.1 to 2.0)
18 Falls	1.4 (1.0 to 1.9)	18 Conflict and terrorism	1.5 (1.1 to 2.0)
19 Congenital birth defects	1.4 (1.0 to 1.9)	19 Congenital birth defects	1.4 (1.0 to 1.9)
20 Ischaemic stroke	1.4 (1.0 to 1.9)	20 Ischaemic stroke	1.4 (1.0 to 1.9)
21 Drug use disorders	1.3 (0.9 to 1.6)	21 Drug use disorders	1.3 (0.9 to 1.6)
22 Violence	1.2 (0.8 to 1.6)	22 Violence	1.2 (0.8 to 1.6)
23 Stroke	1.2 (0.8 to 1.6)	23 Lower respiratory infections	1.1 (0.7 to 1.5)
24 Meningitis	1.1 (0.7 to 1.5)	24 Stroke	1.1 (0.7 to 1.5)
25 Alcohol use disorders	1.1 (0.7 to 1.5)	25 Alcohol use disorders	1.1 (0.7 to 1.5)
26 Age-related hearing loss	1.0 (0.7 to 1.4)	26 Age-related hearing loss	1.2 (0.8 to 1.6)
27 HIV/AIDS	0.9 (0.6 to 1.3)	27 Stroke	1.0 (0.6 to 1.4)
28 Neurological disorders	0.9 (0.6 to 1.3)	28 Meningitis	0.9 (0.6 to 1.3)
		29 Conflict and terrorism	0.8 (0.5 to 1.0)

53

Hearing loss in the 10 to 24 year age group ranked 28th in 1990, and 25th in 2019, an uptick of 1.3%.

SNL & SOUNDWITTS | SESSION 2 - THE SNAK PROBLEM

25 - 49 years

Leading causes 1990	Percentage of DALYs 1990	Leading causes 2019	Percentage of DALYs 2019
1 Road injuries	5.6 (5.1 to 6.1)	1 Road injuries	5.1 (4.6 to 5.7)
2 Tuberculosis	5.6 (5.1 to 6.1)	2 HIV/AIDS	4.8 (4.4 to 5.3)
3 Ischaemic heart disease	4.1 (3.6 to 4.6)	3 Ischaemic heart disease	4.1 (3.6 to 4.6)
4 Low back pain	3.9 (3.4 to 4.4)	4 Low back pain	3.9 (3.4 to 4.4)
5 Self-harm	3.8 (3.3 to 4.3)	5 Musculoskeletal disorders	3.9 (3.4 to 4.4)
6 Stroke	3.8 (3.3 to 4.3)	6 Depression disorders	3.8 (3.3 to 4.3)
7 Musculoskeletal disorders	3.8 (3.3 to 4.3)	7 Gastroenterology disorders	3.8 (3.3 to 4.3)
8 Depression disorders	3.8 (3.3 to 4.3)	8 Other musculoskeletal	3.7 (3.2 to 4.2)
9 Tuberculosis	3.8 (3.3 to 4.3)	9 Stroke	3.7 (3.2 to 4.2)
10 Gastroenterology disorders	3.7 (3.2 to 4.2)	10 Tuberculosis	3.6 (3.1 to 4.1)
11 Maternal disorders	2.9 (2.4 to 3.4)	11 Self-harm	2.9 (2.4 to 3.4)
12 HIV/AIDS	2.9 (2.4 to 3.4)	12 Cervical	2.8 (2.3 to 3.3)
13 Intergenerational violence	2.8 (2.3 to 3.3)	13 Intergenerational violence	2.8 (2.3 to 3.3)
14 HIV/AIDS	2.8 (2.3 to 3.3)	14 Neurological disorders	2.8 (2.3 to 3.3)
15 Other musculoskeletal	2.8 (2.3 to 3.3)	15 Neurological disorders	2.8 (2.3 to 3.3)
16 Diarrhoeal diseases	2.8 (2.3 to 3.3)	16 Anxiety disorders	2.8 (2.3 to 3.3)
17 Falls	2.8 (2.3 to 3.3)	17 Falls	2.8 (2.3 to 3.3)
18 Anxiety disorders	2.8 (2.3 to 3.3)	18 Drug use disorders	2.8 (2.3 to 3.3)
19 Alcohol use disorders	2.8 (2.3 to 3.3)	19 Tuberculosis	2.8 (2.3 to 3.3)
20 Neck pain	2.8 (2.3 to 3.3)	20 Cervical	2.8 (2.3 to 3.3)
21 Cervical	2.8 (2.3 to 3.3)	21 Neck pain	2.8 (2.3 to 3.3)
22 Diarrhoeal diseases	2.8 (2.3 to 3.3)	22 Musculoskeletal disorders	2.8 (2.3 to 3.3)
23 Diarrhoeal diseases	2.8 (2.3 to 3.3)	23 Age-related hearing loss	2.8 (2.3 to 3.3)
24 Age-related hearing loss	2.8 (2.3 to 3.3)	24 Intergenerational violence	2.8 (2.3 to 3.3)
25 Lower respiratory infections	2.7 (2.2 to 3.2)	25 Maternal disorders	2.7 (2.2 to 3.2)
		26 Tuberculosis	2.7 (2.2 to 3.2)
		27 Oral disorders	2.7 (2.2 to 3.2)

54

The ranking is similarly low among 25-49 year-olds in 1990, and the percentage change of 1.5% a decade later is also quite small.

SNL & SOUNDWITTS | SESSION 2 - THE SNAK PROBLEM

50-74 years

Leading causes 1990	Percentage of DALYs 1990	Leading causes 2019	Percentage of DALYs 2019	Percentage change in number of DALYs 1990-2019
1 Ischaemic heart disease	13.5 (11.6 to 13.4)	1 Ischaemic heart disease	11.8 (10.7 to 12.9)	-46.1 (56.6 to 36.4)
2 Stroke	10.9 (10.0 to 11.0)	2 Stroke	9.9 (9.5 to 10.3)	-31.1 (45.0 to 47.8)
3 COPD	6.5 (5.9 to 7.0)	3 Diabetes	5.1 (4.6 to 5.7)	154.1 (143.4 to 167.9)
4 Tuberculosis	4.0 (3.6 to 4.4)	4 COPD	4.7 (4.2 to 5.2)	12.0 (9.9 to 28.3)
5 Lung cancer	3.6 (3.2 to 3.9)	5 Lung cancer	3.9 (3.4 to 4.3)	63.7 (48.8 to 92.1)
6 Diabetes	3.1 (2.8 to 3.4)	6 Low back pain	3.1 (2.8 to 4.0)	72.1 (50.0 to 74.2)
7 Cirrhosis	2.8 (2.6 to 3.1)	7 Cirrhosis	2.7 (2.4 to 2.9)	44.8 (31.7 to 57.2)
8 Chronic kidney disease	2.8 (2.5 to 3.2)	8 Chronic kidney disease	2.8 (2.5 to 3.2)	139.2 (119.9 to 168.6)
9 Age-related hearing loss	2.5 (1.6 to 4.0)	9 Age-related hearing loss	2.2 (1.4 to 3.0)	100.8 (92.0 to 104.0)
10 Stomach cancer	2.4 (2.1 to 3.0)	10 Stomach cancer	2.4 (2.1 to 2.8)	7.0 (5.9 to 8.2)
11 Road injuries	1.9 (1.8 to 2.0)	11 Other musculoskeletal	1.9 (1.4 to 2.6)	17.0 (16.6 to 387.4)
12 Lower respiratory infections	1.8 (1.6 to 2.0)	12 Tuberculosis	1.9 (1.7 to 2.1)	-21.1 (29.2 to 18.9)
13 Age-related hearing loss	1.7 (1.2 to 2.3)	13 Lower respiratory infections	1.8 (1.6 to 1.9)	-24.0 (19.0 to 54.4)
14 Chronic kidney disease	1.6 (1.4 to 1.7)	14 Depressive disorders	1.7 (1.3 to 2.3)	100.1 (104.9 to 110.3)
15 Alzheimer's disease	1.5 (1.2 to 1.9)	15 Colorectal cancer	1.7 (1.6 to 1.9)	65.1 (60.0 to 108.3)
16 Hypertensive heart disease	1.5 (1.2 to 1.7)	16 Falls	1.7 (1.5 to 2.0)	88.7 (65.0 to 100.0)
17 Falls	1.4 (1.3 to 1.6)	17 Stomach cancer	1.7 (1.5 to 1.9)	5.1 (4.0 to 18.4)
18 Colorectal cancer	1.4 (1.3 to 1.5)	18 Osteoarthritis	1.6 (1.5 to 1.9)	114.6 (109.9 to 118.4)
19 Depressive disorders	1.3 (0.9 to 1.2)	19 Blindness and vision loss	1.4 (1.1 to 2.0)	88.8 (81.9 to 95.8)
20 Blindness and vision loss	1.2 (0.9 to 1.3)	20 Breast cancer	1.4 (1.3 to 1.5)	85.0 (69.9 to 99.4)
21 Liver cancer	1.2 (1.0 to 1.3)	21 Dementia disorders	1.4 (0.9 to 2.3)	-31.0 (-42.4 to 31.0)
22 Breast cancer	1.2 (1.1 to 1.2)	22 Hypertensive heart disease	1.3 (1.0 to 1.5)	36.7 (20.8 to 58.8)
23 Oesophageal cancer	1.1 (0.9 to 1.3)	23 Headache disorders	1.2 (0.4 to 2.5)	100.5 (88.7 to 108.0)
24 Osteoarthritis	1.1 (0.6 to 2.2)	24 Oral disorders	1.2 (0.8 to 1.8)	90.5 (86.9 to 94.2)
25 Self-harm	1.1 (1.0 to 1.2)	25 Neck pain	1.1 (0.7 to 1.7)	115.9 (110.5 to 122.2)

SMA & SQUADNETS | SESSION 2 - THE DALY PROBLEM

55

The ranking changes dramatically among ages 50 to 74 years, from #13 in 1990 to #9 in 2019, a 100% increase.

75+ years

Leading causes 1990	Percentage of DALYs 1990	Leading causes 2019	Percentage of DALYs 2019	Percentage change in number of DALYs 1990-2019
1 Ischaemic heart disease	18.6 (17.1 to 19.7)	1 Ischaemic heart disease	16.2 (14.6 to 17.8)	66.5 (52.7 to 74.2)
2 Stroke	15.0 (14.0 to 16.7)	2 Stroke	15.0 (13.7 to 16.4)	60.5 (48.7 to 75.1)
3 COPD	9.9 (9.0 to 10.7)	3 COPD	9.5 (8.7 to 10.2)	63.4 (49.3 to 86.1)
4 Alzheimer's disease	8.8 (7.6 to 8.6)	4 Alzheimer's disease	6.5 (5.6 to 12.2)	180.0 (168.0 to 194.2)
5 Lower respiratory infections	3.1 (2.0 to 4.1)	5 Diabetes	6.0 (4.4 to 8.3)	292.1 (174.0 to 328.0)
6 Dementia disorders	3.1 (2.0 to 4.5)	6 Lower respiratory infections	3.3 (2.9 to 3.6)	87.4 (76.2 to 99.4)
7 Diabetes	2.6 (2.4 to 2.9)	7 Lung cancer	2.6 (2.3 to 2.8)	164.1 (143.6 to 183.8)
8 Hypertensive heart disease	2.4 (2.0 to 2.6)	8 Falls	2.6 (2.2 to 2.9)	166.4 (131.0 to 181.4)
9 Age-related hearing loss	2.0 (1.5 to 2.7)	9 Chronic kidney disease	2.5 (1.9 to 2.7)	126.0 (113.9 to 211.1)
10 Lung cancer	1.9 (1.8 to 2.0)	10 Age-related hearing loss	2.5 (1.9 to 3.1)	217.1 (172.0 to 244.0)
11 Falls	1.8 (1.6 to 2.1)	11 Hypertensive heart disease	2.4 (1.8 to 2.2)	159.0 (145.5 to 175.2)
12 Tuberculosis	1.8 (1.4 to 2.1)	12 Dementia disorders	1.9 (1.2 to 3.0)	41.2 (6.8 to 65.3)
13 Low back pain	1.7 (1.3 to 2.1)	13 Oral disorders	1.8 (1.3 to 2.4)	12.1 (10.0 to 13.4)
14 Chronic kidney disease	1.6 (1.5 to 1.8)	14 Colorectal cancer	1.7 (1.5 to 1.8)	128.9 (113.4 to 138.3)
15 Stomach cancer	1.6 (1.4 to 1.7)	15 Blindness and vision loss	1.7 (1.3 to 2.2)	122.7 (109.3 to 138.7)
16 Blindness and vision loss	1.4 (1.3 to 1.6)	16 Oral disorders	1.3 (1.1 to 1.5)	145.0 (141.8 to 150.9)
17 Colorectal cancer	1.4 (1.3 to 1.5)	17 Stomach cancer	1.3 (1.1 to 1.4)	55.0 (43.8 to 66.6)
18 Alzheimer's disease	1.3 (1.0 to 1.7)	18 Prostate cancer	1.3 (0.9 to 1.6)	141.0 (103.3 to 181.3)
19 Cirrhosis	1.2 (1.0 to 1.3)	19 Cirrhosis	1.2 (0.9 to 1.2)	60.3 (50.1 to 100.0)
20 Prostate cancer	1.0 (0.8 to 1.2)	20 Parkinson's disease	1.1 (0.9 to 1.2)	152.2 (148.7 to 166.6)
21 Atrial fibrillation	1.0 (0.8 to 1.2)	21 Osteoarthritis	1.1 (0.6 to 2.1)	139.0 (105.5 to 164.6)
22 Osteoarthritis	0.9 (0.5 to 1.7)	22 Oral disorders	0.9 (0.6 to 1.3)	112.0 (106.4 to 117.6)
23 Oral disorders	0.8 (0.6 to 1.2)	23 Tuberculosis	0.9 (0.8 to 1.0)	-4.1 (-25.9 to 14.6)
24 Parkinson's disease	0.8 (0.8 to 0.9)	24 Arthritis	0.8 (0.7 to 1.0)	-2.2 (-2.1 to 10.2)
25 Upper digestive diseases	0.8 (0.7 to 0.9)	25 Road injuries	0.8 (0.7 to 0.9)	110.0 (94.8 to 111.1)

SMA & SQUADNETS | SESSION 2 - THE DALY PROBLEM

56

Hearing loss among the oldest adults also falls to 9th place in 1990 to 10th place in 2019, but its prevalence increases 137%.

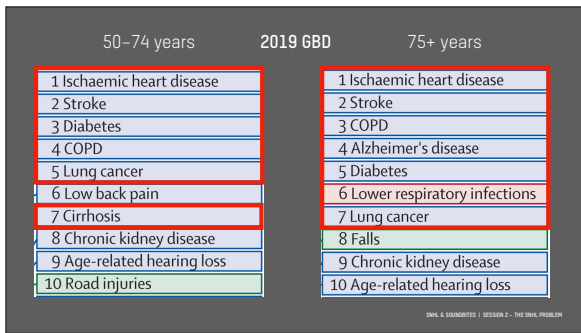
50-74 years 2019 68D 75+ years

1 Ischaemic heart disease	1 Ischaemic heart disease
2 Stroke	2 Stroke
3 Diabetes	3 COPD
4 COPD	4 Alzheimer's disease
5 Lung cancer	5 Diabetes
6 Low back pain	6 Lower respiratory infections
7 Cirrhosis	7 Lung cancer
8 Chronic kidney disease	8 Falls
9 Age-related hearing loss	9 Chronic kidney disease
10 Road injuries	10 Age-related hearing loss

SMA & SQUADNETS | SESSION 2 - THE DALY PROBLEM

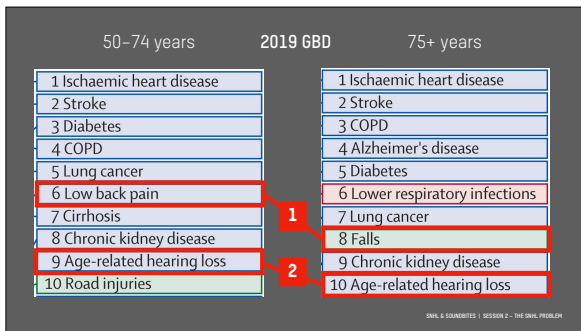
57

The key point is hearing loss is an outlier in the DALYs top-ten list. With the exception of low back pain and falls...



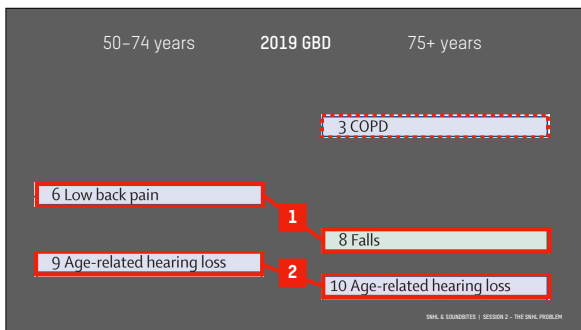
58

diseases cause all the other top-ten leading DALYs among adults over the age of 50 years...



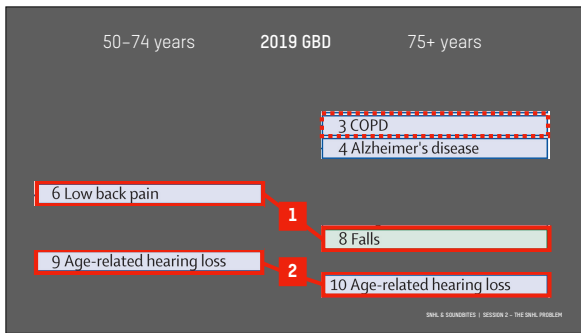
59

which makes hearing loss the world's second most common chronic disability after the age of 50.



60

If you're wondering, #3, COPD stands for chronic obstructive pulmonary disease, which causes airflow blockage and breathing problems like emphysema and chronic bronchitis.



61

#4, Alzheimer's disease, wasn't in the top ten in 1990. We'll get back to that in a moment.

- 1 major cause and common belief
 - 2 scale and consequences
 - 3 who suffers and how
 - 4 summary and forecast
- SNHL & SOUNDWITNESSES | SESSION 2 - THE SNHL PROBLEM

62

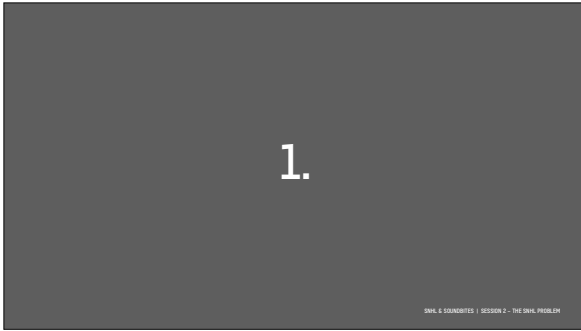
I'd like to end by summarizing the major lessons from the data, then share the World Health Organization forecast for hearing loss, and leave you with a thought about how the transition to renewable energy may eventually contribute to changing the forecast, but not anytime soon.

6 lessons on SNHL from three decades of GBD data

SNHL & SOUNDWITNESSES | SESSION 2 - THE SNHL PROBLEM

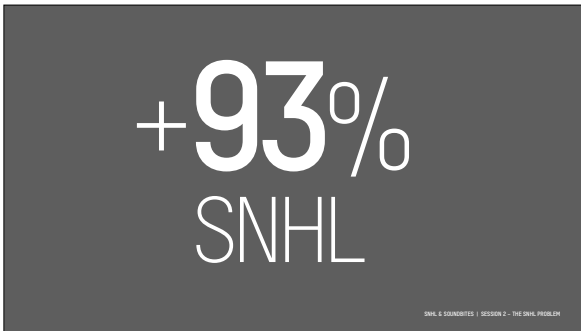
63

Three decades of GBD data teaches at least six lessons about hearing loss.



64

First...



65

the estimated number of hearing loss patients worldwide increased 93%, from 751 million to 1.46 billion.



66

Second...

hearing loss is increasing more than twice as fast as population growth

SNHL & SOUNDWITNESSES | SESSION 2 - THE SNHL PROBLEM

67

Hearing loss is increasing more than twice as fast as population growth. Hearing loss doubled while the worldwide population increased 46%, from 5.3 billion to 7.7 billion.

3.

SNHL & SOUNDWITNESSES | SESSION 2 - THE SNHL PROBLEM

68

Third...

+83%
DALYs

SNHL & SOUNDWITNESSES | SESSION 2 - THE SNHL PROBLEM

69

hearing loss suffering increased 83%, from 22 million to 40.2 million DALYs.

4.

SNHL & SOUNDWITNESSES | SESSION 2 - THE SNHL PROBLEM

70

Fourth, the burden of hearing loss is shifting from low and middle-income countries to high-income countries.

prevalence of hearing loss more than doubled in high income countries

SNHL & SOUNDWITNESSES | SESSION 2 - THE SNHL PROBLEM

71

From 1990 to 2019, the prevalence of hearing loss more than doubled in high-income countries like the U.S., increasing to 43% from 20% of the total population.

prevalence of hearing loss dropped more than 20% in low- and middle-income countries

SNHL & SOUNDWITNESSES | SESSION 2 - THE SNHL PROBLEM

72

In the same time period, Hearing loss in low and middle-income countries dropped more than 20%, from 80% to 57%.



73

Fifth...

75+ years

Percentage of DALYs 1990	Leading causes 2019	Percentage of DALYs 2019	Percentage change in number of DALYs, 1990-2019
10	Age-related hearing loss	2.5 (1.9 to 3.3)	137.8 (132.0 to 143.9)

SMU & SCANDINAVIA | SESSION 2 - THE DALY PROBLEM

74

The GBD charts demonstrate that hearing loss among the oldest adults increased by 138%...

75+ years

Percentage of DALYs 1990	Leading causes 2019	Percentage of DALYs 2019	Percentage change in number of DALYs, 1990-2019
4	Alzheimer's disease	5.6 (2.6 to 12.2)	180.0 (168.0 to 194.7)
10	Age-related hearing loss	2.5 (1.9 to 3.3)	137.8 (132.0 to 143.9)

SMU & SCANDINAVIA | SESSION 2 - THE DALY PROBLEM

75

But the rate of Alzheimer's disease increased even more: 180%, jumping to 4th place on the DALYs list. Data analysts didn't miss the correlation.



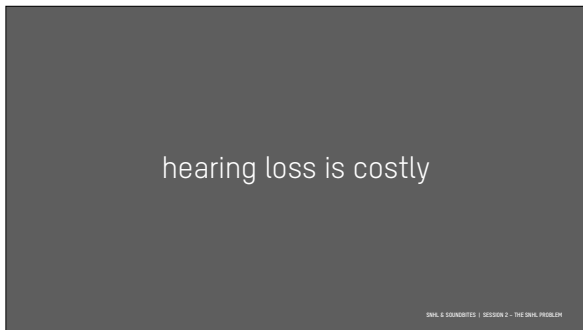
76

There's now significant scientific agreement that hearing loss in midlife is the single most significant risk factor for dementia, mainly Alzheimer's disease.



77

Sixth...



78

Hearing loss is costly – personally, socially, and economically.

\$1+
trillion

SNH & SOUNDWITTS | SESSION 2 - THE SNH PROBLEM

79

The World Health Organization estimates the annual worldwide cost of hearing loss to be about \$1 trillion. The costs include social isolation and stigma, health care, education, and lost productivity. These burdens impact people of all ages, starting in childhood.

1 billion
deaf 2050

SNH & SOUNDWITTS | SESSION 2 - THE SNH PROBLEM

80

If things continue at this rate, the W.H.O. forecasts 1 billion people will be deaf by 2050.

7.

SNH & SOUNDWITTS | SESSION 2 - THE SNH PROBLEM

81

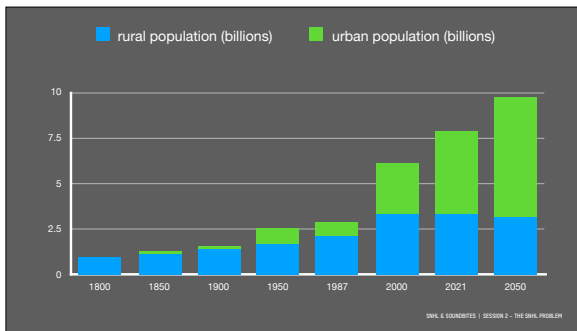
Global demographics and energy production data add a seventh lesson.

city noise and hearing loss are correlated

82

City noise and hearing loss are correlated. As I mentioned at the start, the hearing loss problem has escalated along with industrialization in the late 1800s, which also caused massive urban growth.

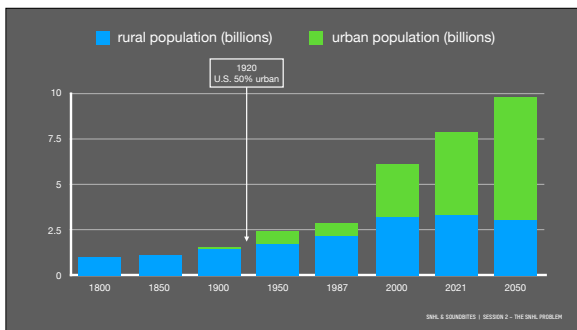
SNL & SOUNDWITNESSES | SESSION 2 - THE SNAIL PROBLEM



83

The green bars in the chart show the percentage of the world population living in cities from 1800 through 2050. World population at the start of industrialization was about 1 billion. It's about 8 billion today, forecast to reach nearly 10 billion by 2050.

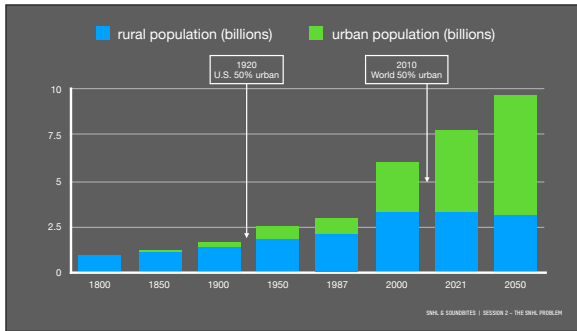
SNL & SOUNDWITNESSES | SESSION 2 - THE SNAIL PROBLEM



84

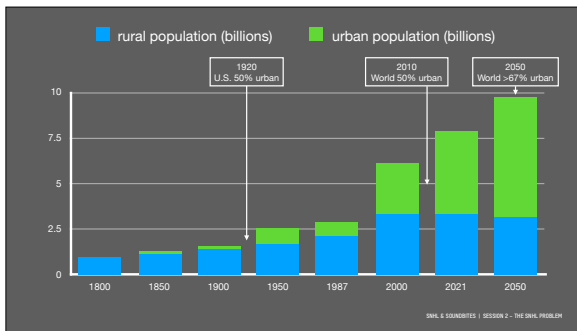
The US crossed the 50% urban population threshold in 1920 with a total population of 106 million.

SNL & SOUNDWITNESSES | SESSION 2 - THE SNAIL PROBLEM



85

The world crossed it in 2010. Today, 55% of the world's population lives in cities.



86

By 2050, more than two-thirds of the world's population, about 6.5 billion people, will live in cities.

noise and energy sources are correlated

87

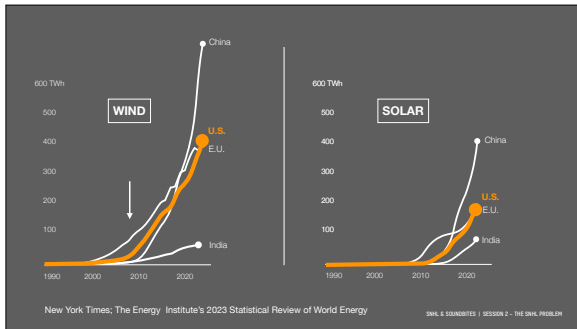
Noise and energy sources are correlated. Burning fossil fuels contributes to making cities noisy.

renewable energy is quiet

SMU & SANDRITES | SESSION 2 - THE OIL PROBLEM

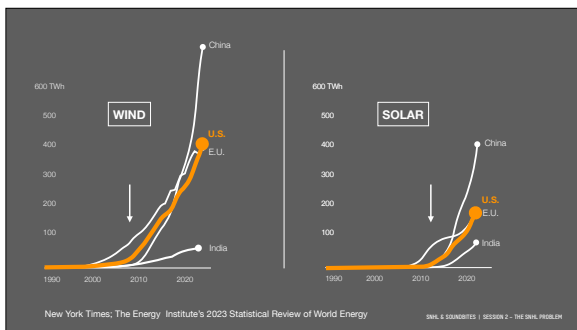
88

Renewables are quiet. Investment data suggest we may be reaching the beginning of the end of dependence on fossil fuels.



89

These charts track aggregated global investment in wind and solar. Wind investment started scaling exponentially in 2008.



90

Solar investment started scaling exponentially about four year later in 2012.

+70%
renewables

SMU, © COURTESY | SESSION 2 - THE OVAL PROBLEM

91

Annual investment in renewable energy production is now 70% higher than investment in fossil fuel production...

\$1.7
trillion

SMU, © COURTESY | SESSION 2 - THE OVAL PROBLEM

92

\$1.7 trillion compared with \$1 trillion for fossil fuels.

cool quiet planet

SMU, © COURTESY | SESSION 2 - THE OVAL PROBLEM

93

We may be on the way to a cooler planet, which will help make cities quieter. The transition won't solve the hearing loss problem directly, but it can be expected to help. No one knows when or by how much.

more suffering earlier and longer

SNHL & SOUNDWITNESSES | SESSION 2 - THE SNHL PROBLEM

94

In the meantime, millions more people will start suffering hearing loss earlier in life, and will suffer longer. It gives me no joy to leave you with that sobering thought.

THANK YOU

Keep Hearing initiative

SNHL & SOUNDWITNESSES | Q&A LEARNING | SESSION 1 - THE SNHL PROBLEM

95

Thank you. I hope you'll join me for the next two sessions to learn about the research to find a biomedical solution to the problem.