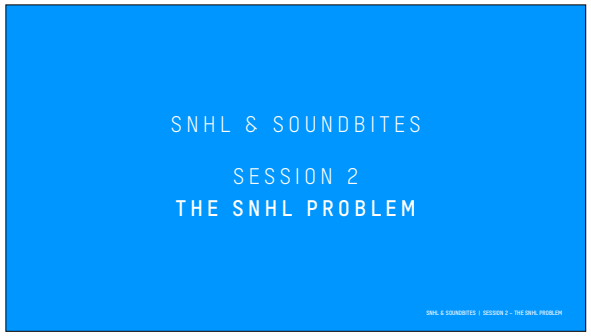
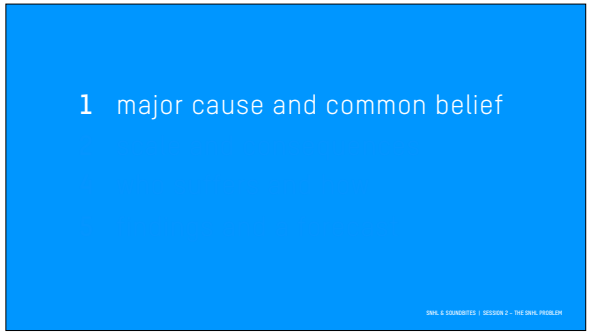


1

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

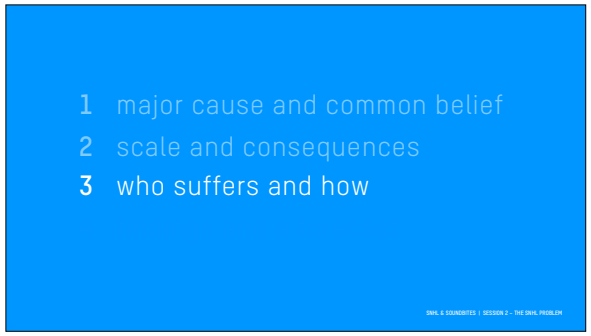


2

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

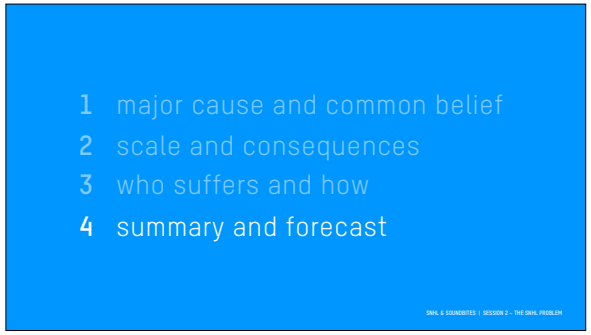
3

Then you'll learn about the scale and consequences



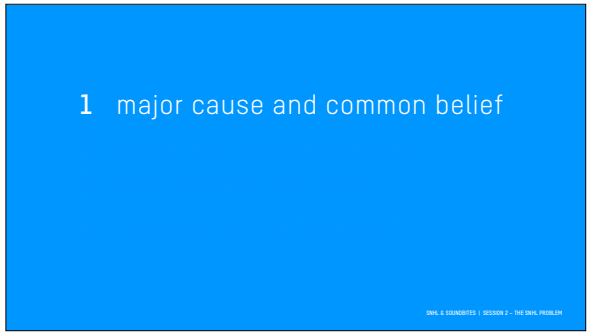
4

Then who suffers and how.



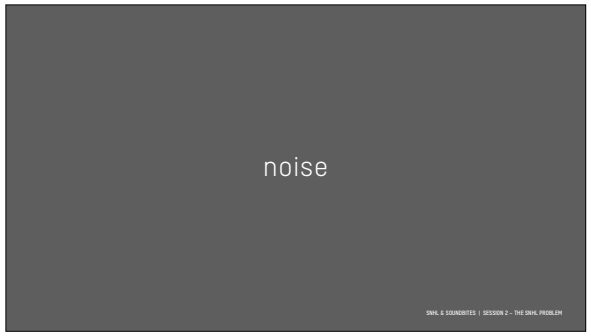
5

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.



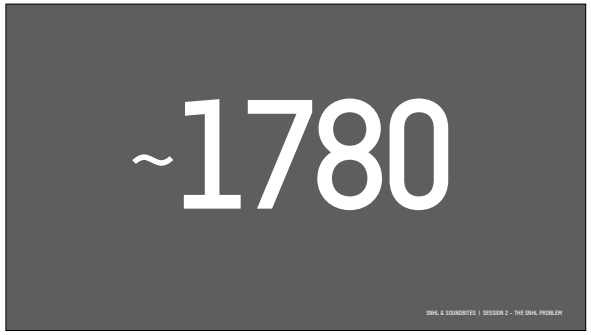
6

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



7

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



8

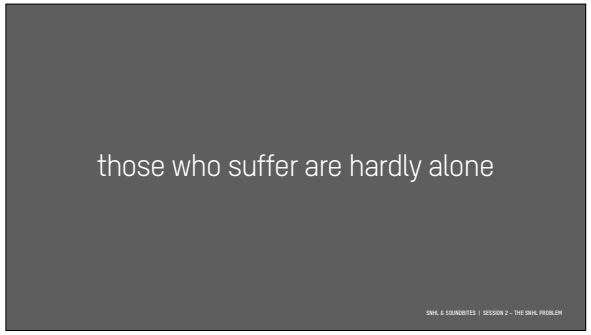
The hearing loss problem started escalating in the late eighteenth century with the invention of the steam engine and factories that burned fossil fuels, mainly coal and kerosene.

9

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.

10

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



11

Those who suffer are hardly alone.

12

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

13

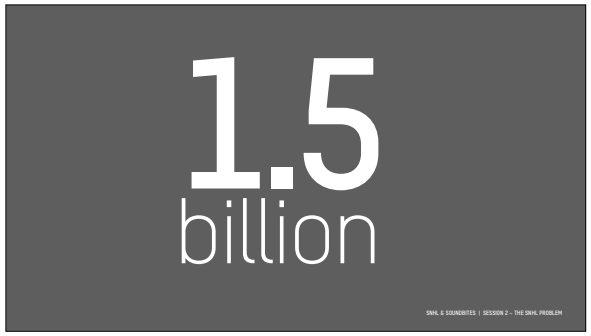
Now let's look at the scale and the consequences of hearing loss.

14

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

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.

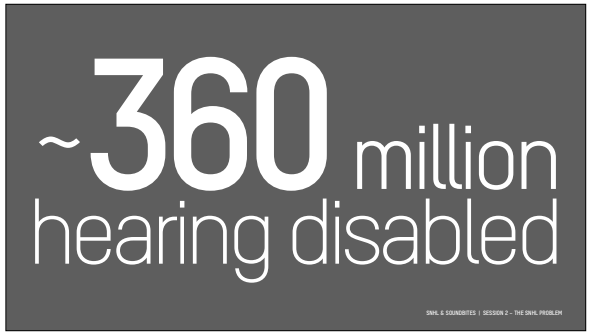


16

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

17

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



18

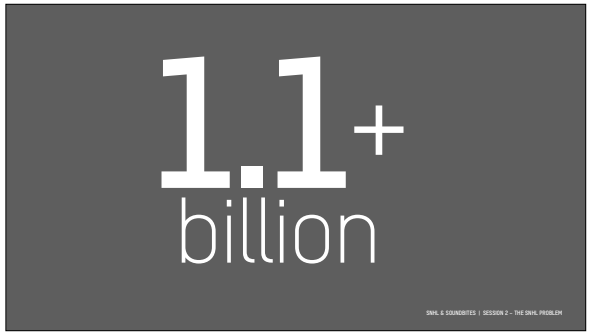
About a quarter of those with hearing loss, about 360 million people, are profoundly hearing disabled, meaning they’ve become functionally deaf.

19

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

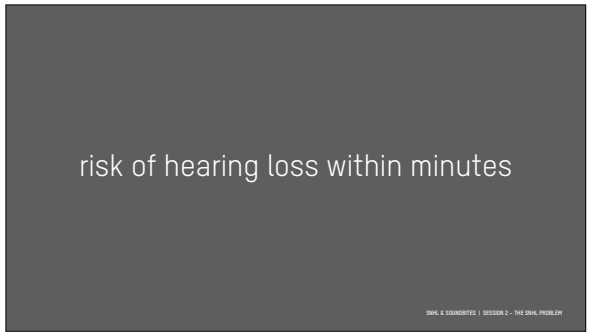
20

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%.



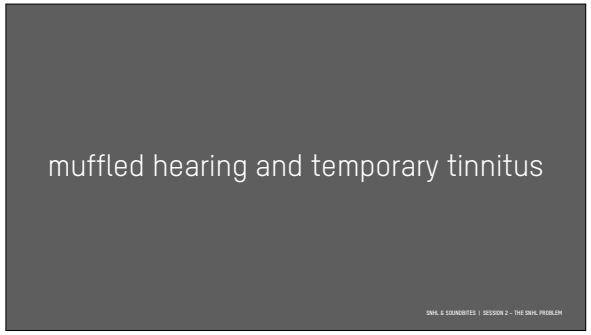
21

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.



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.

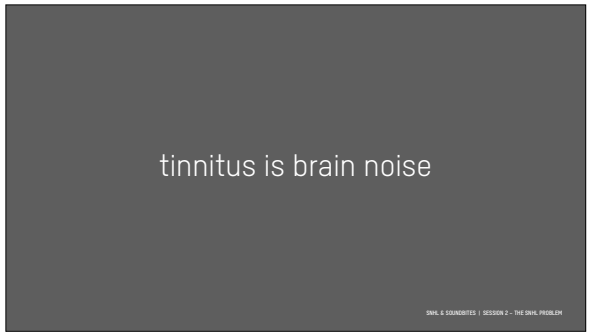


23

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.

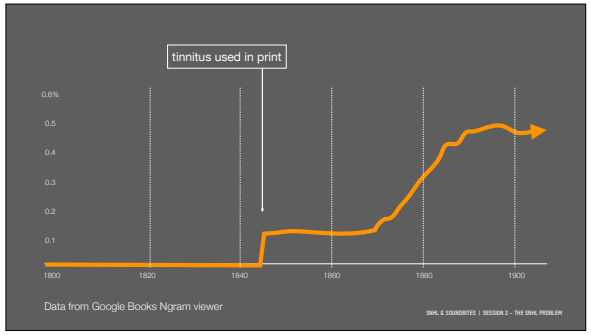
24

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



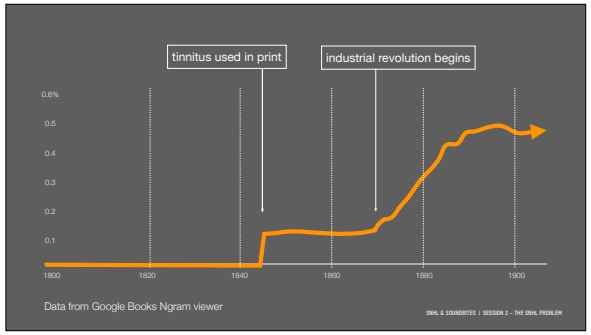
25

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



26

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

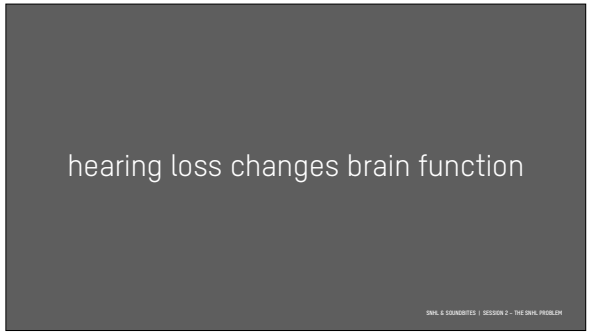


27

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.

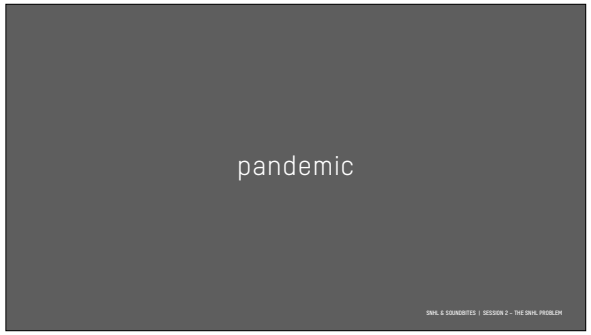
28

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.



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.



30

Hearing loss is a pandemic.

31

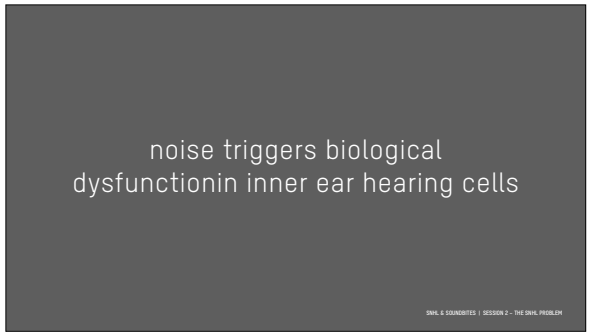
But we have to be careful using that word, because unlike pandemics caused by pathogens like the SARS virus that caused the Covid-19 pandemic, viruses and bacteria are relatively uncommon causes of hearing loss.

32

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

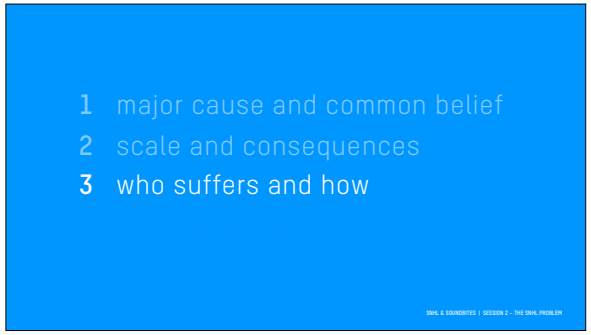
33

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



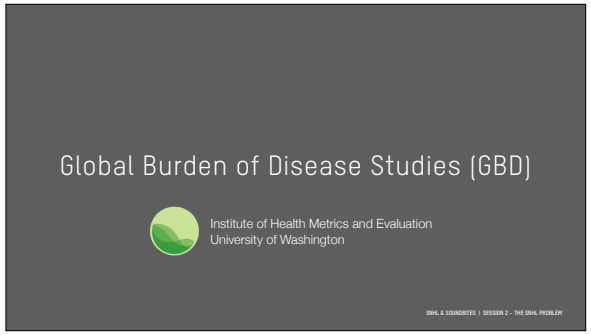
34

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



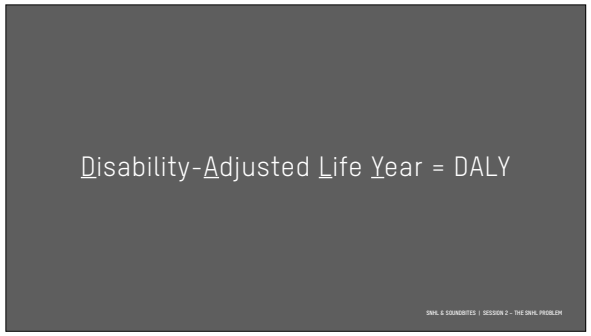
35

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



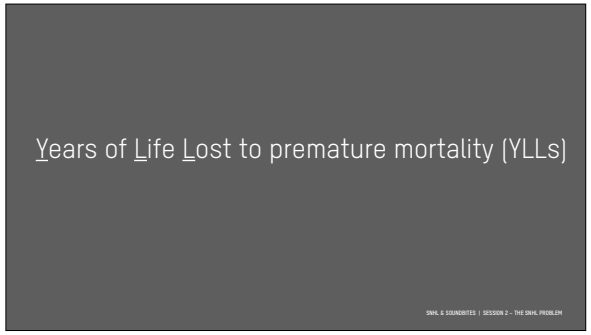
36

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.



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.

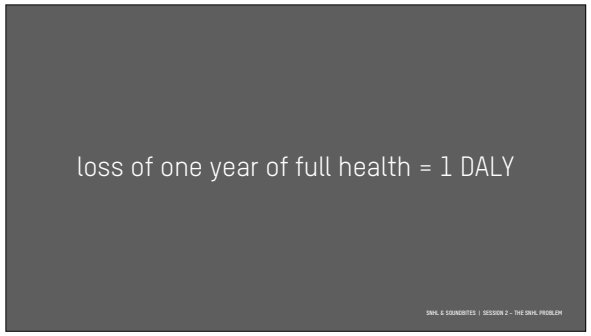


38

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…

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.



40

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

41

To be clear, one DALY…

42

is the same as one year of morbidity…

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

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43

…which is the same as one year of suffering.

---

the hearing loss disability
is included in GBD studies

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44

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

10–24 years

IHME

Leading causes 1990	Percentage of DALYs 1990
1 Road injuries	7·8 (6·9 to 8·8)
2 Self-harm	4·9 (4·1 to 5·6)
3 Headache disorders	3·8 (2·4 to 5·2)
4 Tuberculosis	3·6 (3·1 to 4·1)
5 Diarrhoeal diseases	3·2 (2·3 to 4·9)
6 Interpersonal violence	3·2 (2·8 to 3·6)
7 Maternal disorders	3·0 (2·6 to 3·4)
8 Depressive disorders	2·8 (2·0 to 3·9)
9 Low back pain	2·8 (1·9 to 3·8)
10 Drowning	2·7 (2·3 to 3·2)
11 Typhoid and paratyphoid	2·6 (1·7 to 4·9)
12 Anxiety disorders	2·6 (1·8 to 3·5)
13 Dietary iron deficiency	2·1 (1·6 to 2·8)
14 Malaria	2·1 (1·3 to 3·3)
15 Lower respiratory infections	1·7 (1·4 to 2·0)
16 Conflict and terrorism	1·5 (1·3 to 1·9)
17 Gynaecological diseases	1·5 (1·3 to 2·1)
18 Falls	1·5 (1·1 to 1·9)
19 Congenital birth defects	1·5 (1·3 to 1·7)
20 Idiopathic epilepsy	1·4 (1·1 to 1·8)
21 Conduct disorder	1·3 (0·8 to 2·0)
22 Drug use disorders	1·3 (1·0 to 1·6)
23 Asthma	1·2 (1·0 to 1·6)
24 Stroke	1·2 (1·0 to 1·3)
25 Meningitis	1·1 (1·0 to 1·3)
27 Acne vulgaris	1·1 (0·7 to 1·6)
28 Age-related hearing loss	1·1 (0·7 to 1·5)
33 HIV/AIDS	0·9 (0·6 to 1·5)
35 Neonatal disorders	0·9 (0·7 to 1·1)

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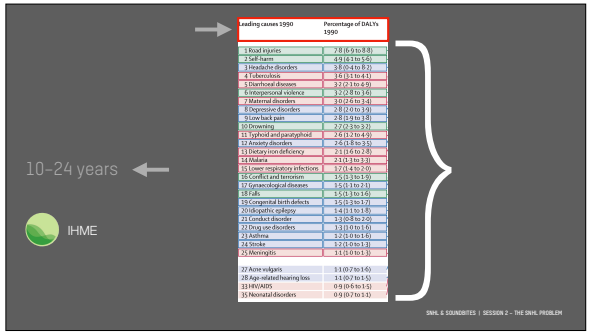
45

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

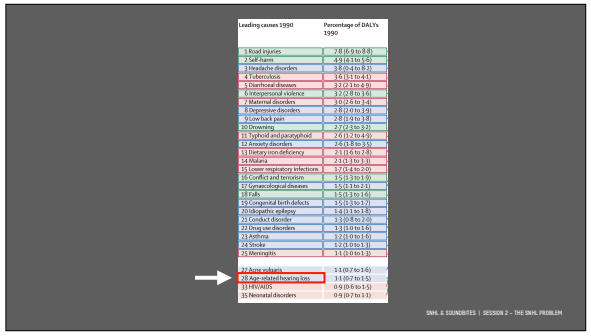
46

and DALY percentages…



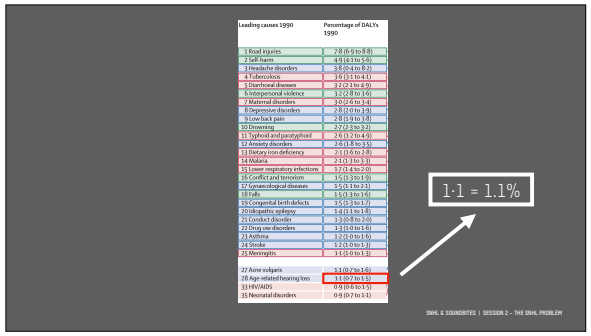
47

…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.



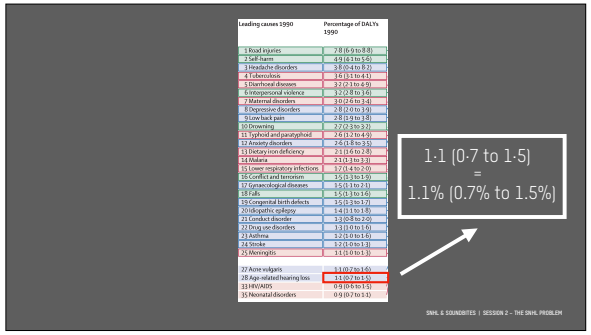
48

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.



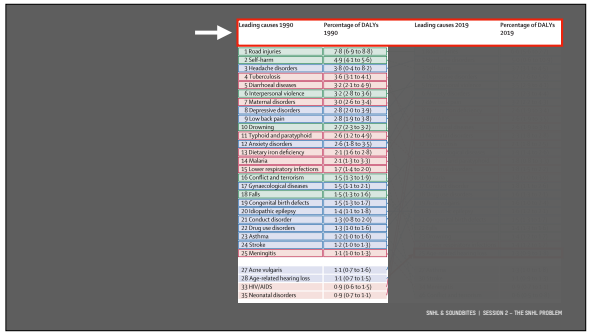
49

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



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.



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?

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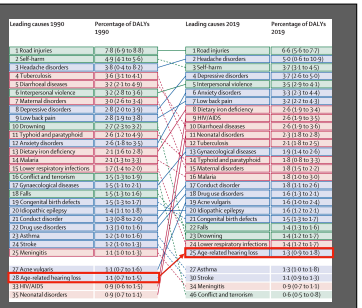
52

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

10–24 years



Leading causes 1990	Percentage of DALYs 1990	Leading causes 2019	Percentage of DALYs 2019
1 Road injuries	7.8 (6.6 to 8.8)	1 Road injuries	6.6 (5.6 to 7.7)
2 Self-harm	4.9 (4.3 to 5.6)	2 Headache disorders	5.0 (0.6 to 10.9)
3 Headache disorders	3.8 (0.4 to 8.2)	3 Self-harm	3.7 (3.1 to 4.5)
4 Tuberculosis	3.6 (3.1 to 4.1)	4 Depressive disorders	3.7 (2.6 to 5.0)
5 Diarrhoeal diseases	3.2 (2.1 to 4.9)	5 Interpersonal violence	3.5 (2.9 to 4.3)
6 Interpersonal violence	3.2 (2.8 to 3.6)	6 Anxiety disorders	3.3 (2.3 to 4.4)
7 Maternal disorders	3.0 (2.6 to 3.4)	7 Low back pain	3.2 (2.2 to 4.3)
8 Depressive disorders	2.8 (2.0 to 3.9)	8 Dietary iron deficiency	2.6 (1.9 to 3.4)
9 Low back pain	2.8 (1.9 to 3.8)	9 HIV/AIDS	2.6 (1.9 to 3.5)
10 Drowning	2.7 (2.3 to 3.2)	10 Diarrhoeal diseases	2.6 (1.9 to 3.6)
11 Typhoid and paratyphoid	2.6 (1.2 to 4.9)	11 Neonatal disorders	2.3 (1.8 to 2.8)
12 Anxiety disorders	2.6 (1.8 to 3.5)	12 Tuberculosis	2.1 (1.8 to 2.5)
13 Dietary iron deficiency	2.1 (1.6 to 2.8)	13 Gynaecological diseases	1.9 (1.4 to 2.6)
14 Malaria	2.1 (1.3 to 3.3)	14 Typhoid and paratyphoid	1.8 (0.8 to 3.3)
15 Lower respiratory infections	1.7 (1.4 to 2.0)	15 Maternal disorders	1.8 (1.5 to 2.2)
16 Conflict and terrorism	1.5 (1.3 to 1.9)	16 Malaria	1.8 (1.0 to 3.0)
17 Gynaecological diseases	1.5 (1.1 to 2.1)	17 Conduct disorder	1.8 (1.1 to 2.6)
18 Falls	1.5 (1.1 to 1.6)	18 Drug use disorders	1.6 (1.3 to 2.1)
19 Congenital birth defects	1.5 (1.3 to 1.7)	19 Acne vulgaris	1.6 (1.0 to 2.4)
20 Idiopathic epilepsy	1.4 (1.1 to 1.8)	20 Idiopathic epilepsy	1.6 (1.2 to 2.1)
21 Conduct disorder	1.3 (0.8 to 2.0)	21 Congenital birth defects	1.5 (1.3 to 1.7)
22 Drug use disorders	1.3 (1.0 to 1.6)	22 Falls	1.4 (1.1 to 1.6)
23 Asthma	1.2 (1.0 to 1.6)	23 Drowning	1.4 (1.2 to 1.7)
24 Stroke	1.2 (1.0 to 1.3)	24 Lower respiratory infections	1.4 (1.2 to 1.7)
25 Meningitis	1.1 (1.0 to 1.3)	25 Age-related hearing loss	1.3 (0.9 to 1.8)
27 Acne vulgaris	1.1 (0.7 to 1.6)	27 Asthma	1.3 (1.0 to 1.8)
28 Age-related hearing loss	1.1 (0.7 to 1.5)	30 Stroke	1.1 (0.9 to 1.3)
33 HIV/AIDS	0.9 (0.6 to 1.5)	34 Meningitis	0.9 (0.7 to 1.1)
35 Neonatal disorders	0.9 (0.7 to 1.1)	46 Conflict and terrorism	0.6 (0.5 to 0.8)

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53

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

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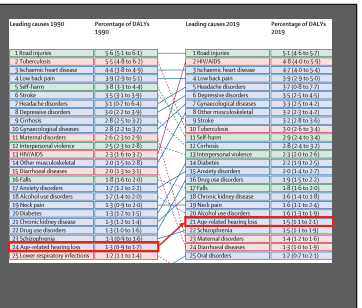
25 – 49 years

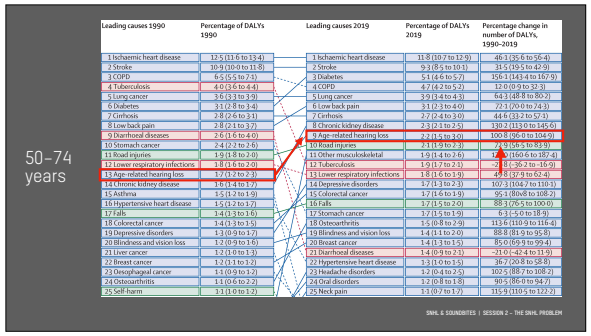


Leading causes 1990	Percentage of DALYs 1990	Leading causes 2019	Percentage of DALYs 2019
1 Road injuries	5.6 (5.1 to 6.1)	1 Road injuries	5.1 (4.6 to 5.7)
2 Tuberculosis	5.5 (4.8 to 6.2)	2 HIV/AIDS	4.8 (4.0 to 5.9)
3 Ischaemic heart disease	4.4 (3.8 to 4.9)	3 Ischaemic heart disease	4.7 (4.0 to 5.4)
4 Low back pain	3.9 (2.9 to 5.1)	4 Low back pain	3.9 (2.9 to 5.0)
5 Self-harm	3.8 (3.1 to 4.4)	5 Headache disorders	3.7 (0.8 to 7.7)
6 Stroke	3.5 (3.1 to 3.9)	6 Depressive disorders	3.5 (2.5 to 4.5)
7 Headache disorders	3.1 (0.7 to 6.4)	7 Gynaecological diseases	3.3 (2.5 to 4.2)
8 Depressive disorders	3.0 (2.2 to 3.9)	8 Other musculoskeletal	3.2 (2.7 to 4.2)
9 Cirrhosis	2.8 (2.5 to 3.2)	9 Stroke	3.2 (2.8 to 3.6)
10 Gynaecological diseases	2.8 (2.2 to 3.7)	10 Tuberculosis	3.0 (2.6 to 3.4)
11 Maternal disorders	2.6 (2.3 to 2.9)	11 Self-harm	2.9 (2.4 to 3.4)
12 Interpersonal violence	2.5 (2.3 to 2.8)	12 Cirrhosis	2.8 (2.4 to 3.2)
13 HIV/AIDS	2.0 (1.6 to 2.2)	13 Interpersonal violence	2.3 (1.9 to 2.6)
14 Other musculoskeletal	2.0 (1.5 to 2.8)	14 Diabetes	2.2 (1.9 to 2.5)
15 Diarrhoeal diseases	2.0 (1.3 to 3.1)	15 Anxiety disorders	2.0 (1.4 to 2.7)
16 Falls	1.8 (1.6 to 2.0)	16 Drug use disorders	1.9 (1.5 to 2.2)
17 Anxiety disorders	1.7 (1.2 to 2.2)	17 Falls	1.8 (1.6 to 2.0)
18 Alcohol use disorders	1.7 (1.4 to 2.0)	18 Chronic kidney disease	1.6 (1.4 to 1.8)
19 Neck pain	1.5 (0.9 to 2.0)	19 Neck pain	1.6 (1.1 to 2.4)
20 Diabetes	1.5 (1.2 to 1.5)	20 Alcohol use disorders	1.6 (1.3 to 1.9)
21 Chronic kidney disease	1.5 (1.2 to 1.6)	21 Age-related hearing loss	1.5 (1.1 to 2.1)
22 Drug use disorders	1.5 (1.0 to 1.6)	22 Schizophrenia	1.5 (1.1 to 1.9)
23 Schizophrenia	1.5 (0.9 to 1.6)	23 Maternal disorders	1.4 (1.2 to 1.6)
24 Age-related hearing loss	1.5 (0.9 to 1.2)	24 Diarrhoeal diseases	1.3 (0.9 to 1.9)
25 Lower respiratory infections	1.2 (1.1 to 1.4)	25 Oral disorders	1.2 (0.7 to 2.1)

SNHL & SOUNDBITES | SESSION 2 – THE SNHL PROBLEM

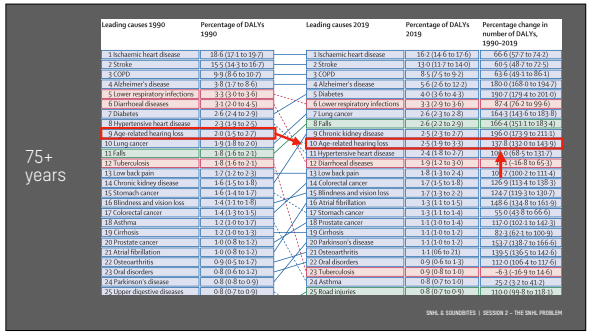
54

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.



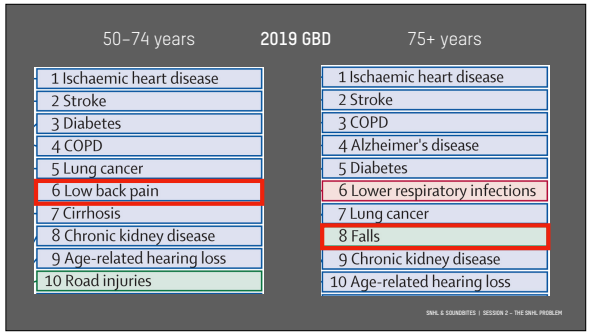
55

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



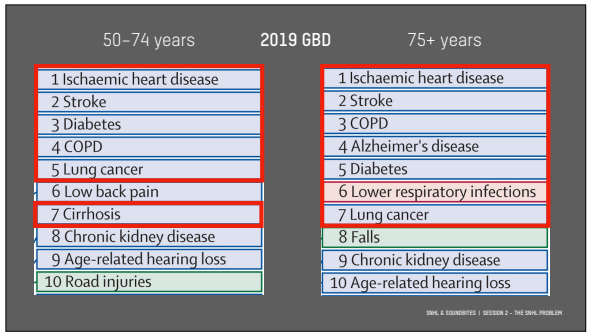
56

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



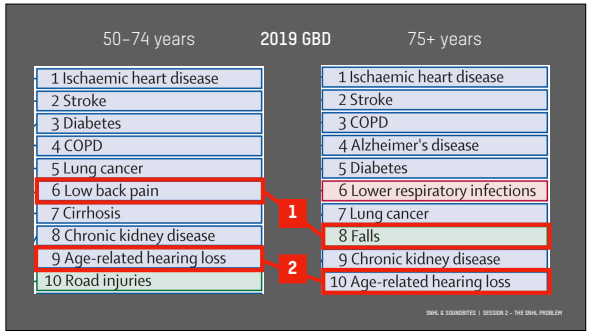
57

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



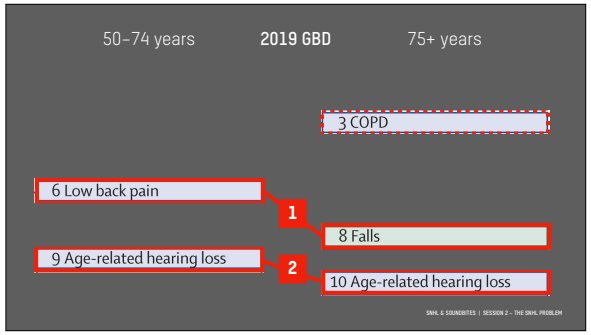
58

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



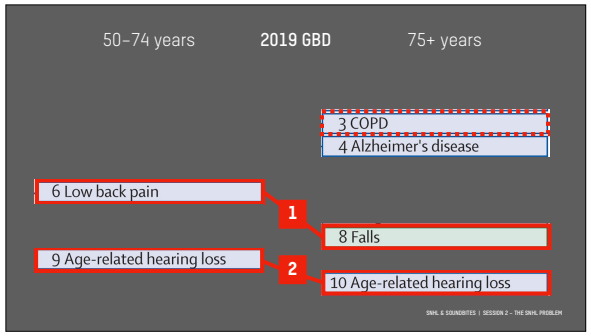
59

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



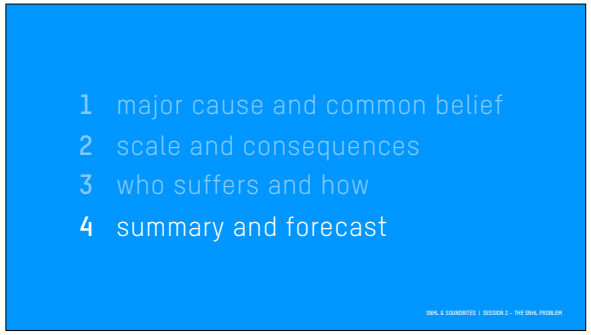
60

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



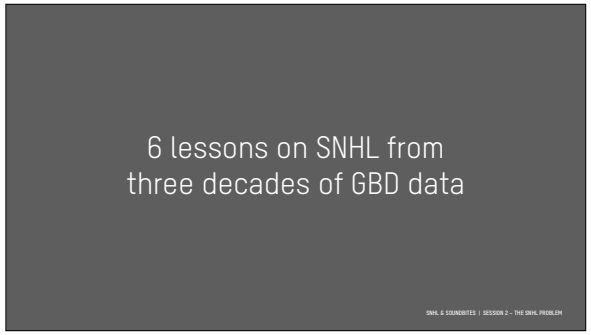
61

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



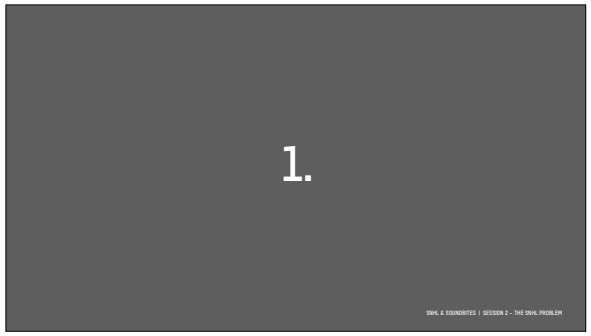
62

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.



63

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



64

First…

65

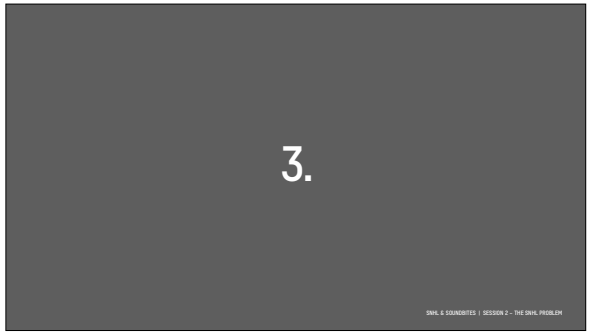
the estimated number of hearing loss patients worldwide increased 93%, from 751 million to 1.46 billion.

66

Second…

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.

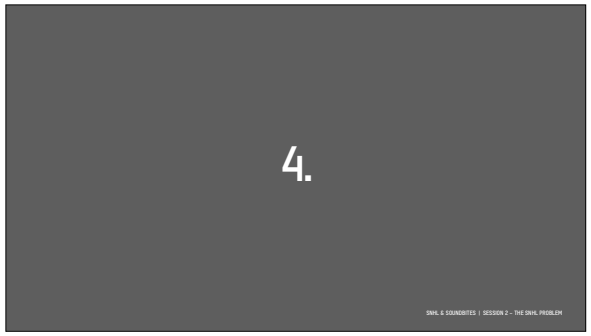


68

Third…

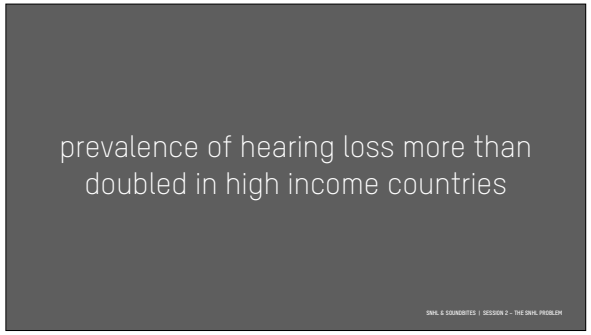
69

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



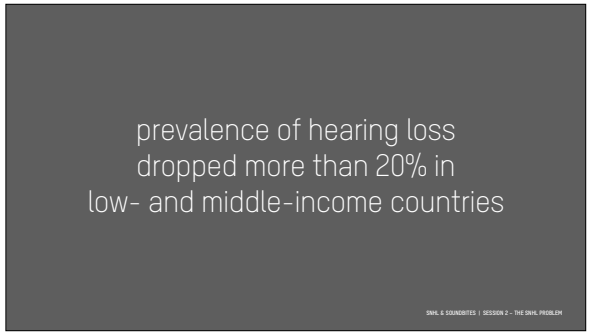
70

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



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.

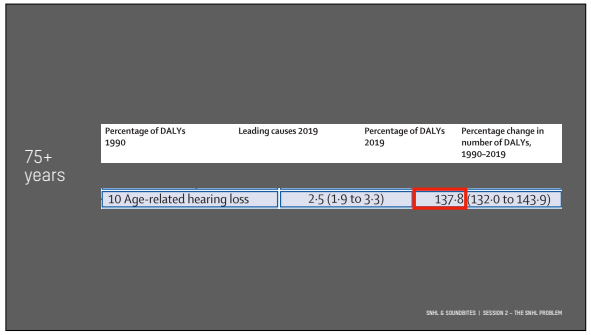


72

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

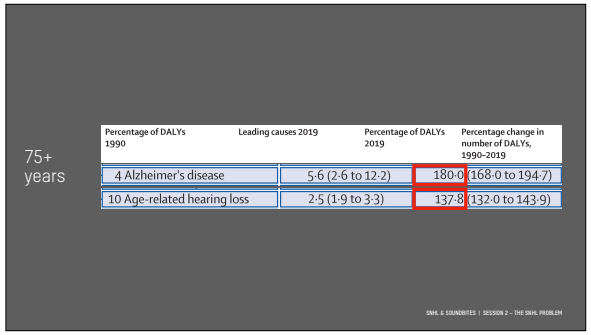
73

Fifth…



74

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

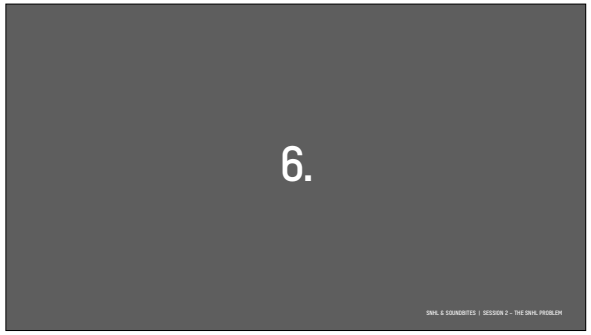


75

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

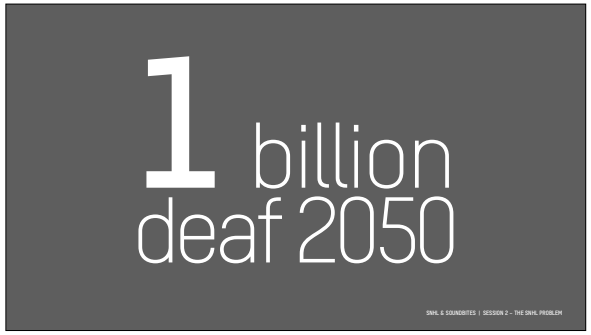
Sixth…

78

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

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.

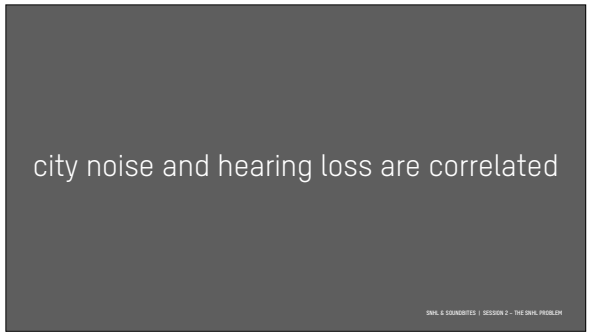


80

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

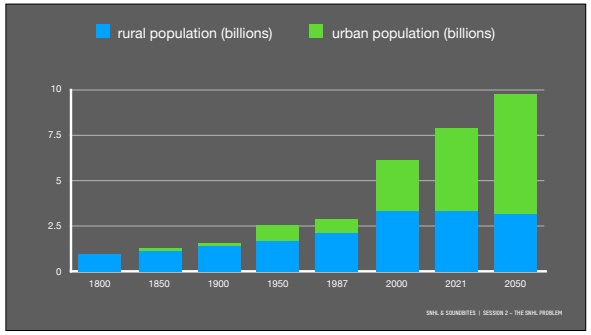
81

Global demographics and energy production data add a seventh lesson.



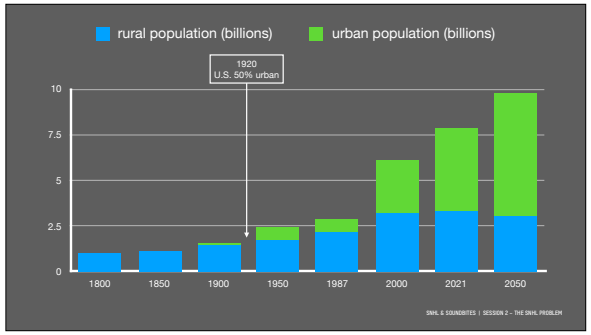
82

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.



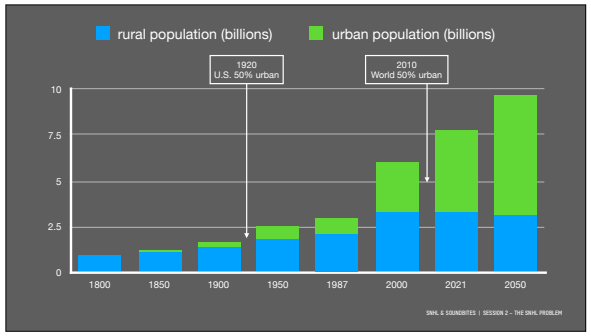
83

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.



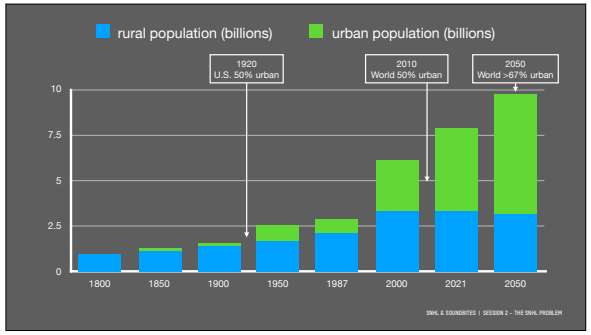
84

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



85

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

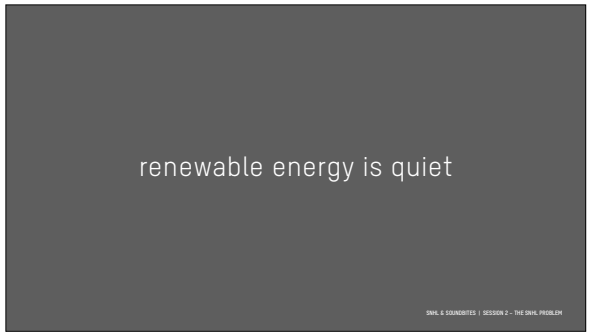


86

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

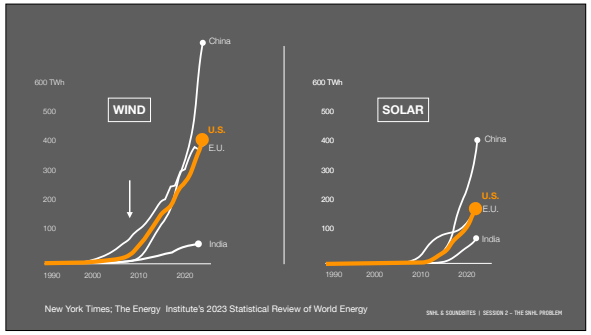
87

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



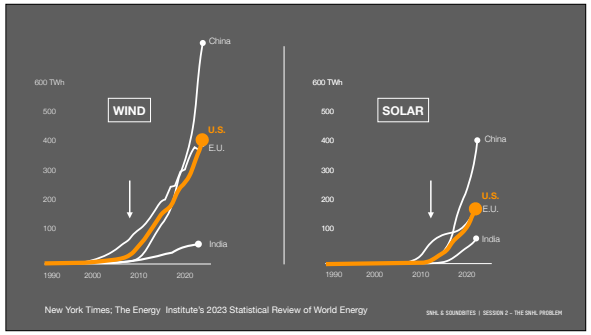
88

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



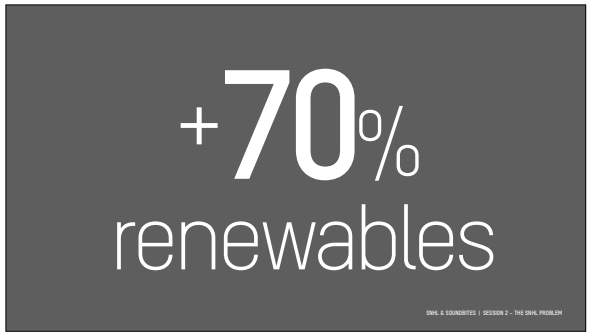
89

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.

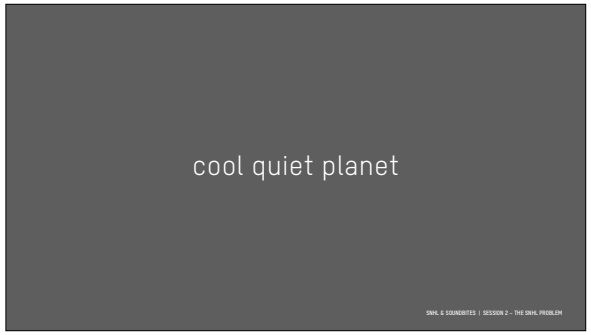


91

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

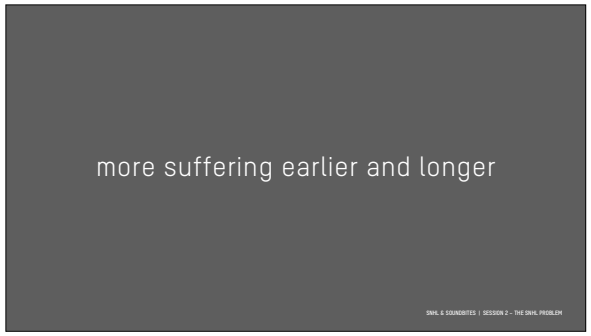
92

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



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.



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.

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.
