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Epidemiology of tinnitus

Professor David Baguley

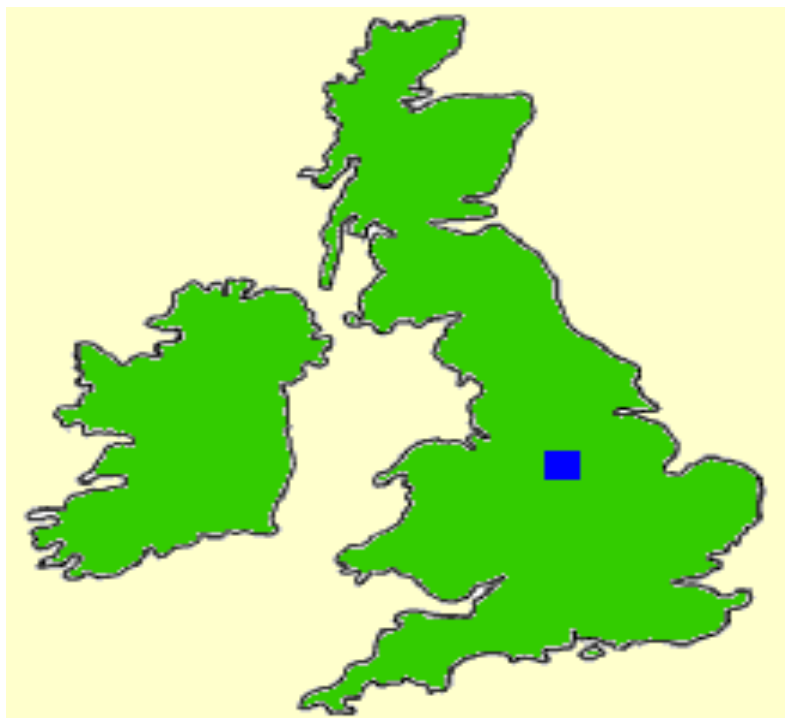
Clinical Hearing Sciences

Nottingham Biomedical Research Centre,
University of Nottingham

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TINNITUS SYMPOSIUM



Ciba Foundation, London, England, January, 1981

Front row, left to right, seated: Ellis Douek, Patricia House, Mary Meikle, Joan Box

Front row, standing: Abe Shulman, David Kemp, Harold Feldmann, Jonathan Hazell, Ron Goodey, Richard Tyler
Charles Berlin, Gloria Reich

Back Row, standing: William Burns, Don Brown, Jurgen Tonndorf, Ross Coles, John House, John Emmett, Jack
Vernon, Pat Wilson, Jean-Marie Aran, Ted Evans

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Overview



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- Introduction
- Prevalence, incidence, and natural history in adults
- Prevalence, incidence, and natural history in childhood
- Clinical questions
- Unanswered research questions



Introduction: definitions

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- CDCP
 - <https://www.cdc.gov/ophss/csels/dsepd/ss1978/lesson1/section1.html>
- Epidemiology
 - GK *epi* (*on*), *demos* (people), *logos* (study of)
 - the study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to the control of health problems

Introduction: definitions

- Prevalence
 - The number of cases of a particular symptom, condition, or disease in a specific population
- Point prevalence
 - The number of cases of a particular symptom, condition, or disease in a specific population at a specific time
- Incidence
 - The number of new cases arising of a particular symptom, condition, or disease in a specific population over a specific time period

Introduction: definitions



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- Natural History
 - the progression of a disease process in an individual over time, in the absence of treatment (CDCP, 2017)



Introduction: definitions

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- Tinnitus
 - ‘a sound in the ears or head that occurs in the absence of any external stimulus’ (Baguley et al., 2013)
- Hyperacusis
 - “unusual tolerance to ordinary environmental sounds” (Vernon, 1987)
 - “abnormal reduced tolerance to environmental sound” (Baguley, 2003)

Tinnitus prevalence in adults

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Tinnitus in adults

Tyler and Baker (1983)

Journal of Speech and Hearing Disorders, TYLER & BAKER, Volume 48, 150-154, May 1983

DIFFICULTIES EXPERIENCED BY TINNITUS SUFFERERS

RICHARD S. TYLER LESLEY J. BAKER
Institute of Hearing Research, General Hospital, Nottingham, United Kingdom

Ninety-seven members of a tinnitus self-help group were asked to list the difficulties that they had as a result of their tinnitus. Seventy-two replies were returned from 22 men and 48 women (sex not reported in two cases) whose average age was 61 years. Tinnitus was associated with hearing difficulties in 53%, effects on lifestyle in 93%, effects on general health in 56%, and emotional difficulties in 70% of the sample. Getting to sleep was the most frequently mentioned difficulty, and many respondents indicated that they experienced depression, annoyance, and insecurity. The clinical applications of this open-ended questionnaire are discussed.



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Davis and Refaie (2000)

CHAPTER I

Epidemiology of Tinnitus

Adrian Davis
El Amr Rafaie

Tyler and Baker (1983)

- n=97 self help group members, n=72 respondents
- M= 22, F 48, mean age 60.7 y (sd 13.1y)
- Open ended questions, mean 4.6 (sd 2.2)
- Association between >problems, >length of history
- Most issues with
 - Sleep
 - Persistence of T
 - Family problems

Davis and Razaie, 2000

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- National Study of Hearing, UK MRC
- n=34,050
- Have you ever had noises in your head or ears?
- Nowadays do you get noises in your head or ears?
- Do these noises usually last for longer than 5 minutes?
- PST =10.1%, 5.1% unilateral, 5% bilateral

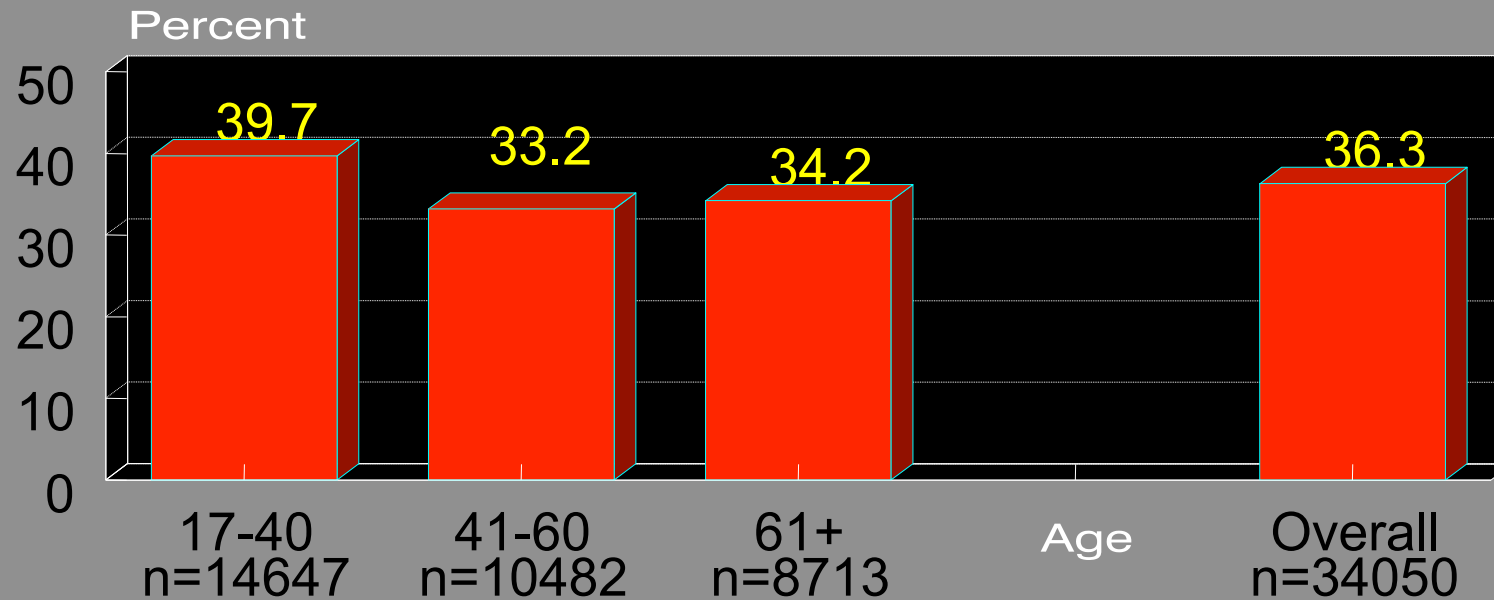
Davis and Rafaie, 2000

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- A third of all adults report some tinnitus
- About 10% of all adults report prolonged (> 5 mins) spontaneous tinnitus by questionnaire
- About 1 in 20 (5 %) adults report tinnitus that is moderately or severely annoying
- 2 – 4 % of adults have been referred to a hospital concerning tinnitus
- In 0.5% of adults tinnitus has a severe effect on QoL

Prevalence of any tinnitus nowadays as a function of age group

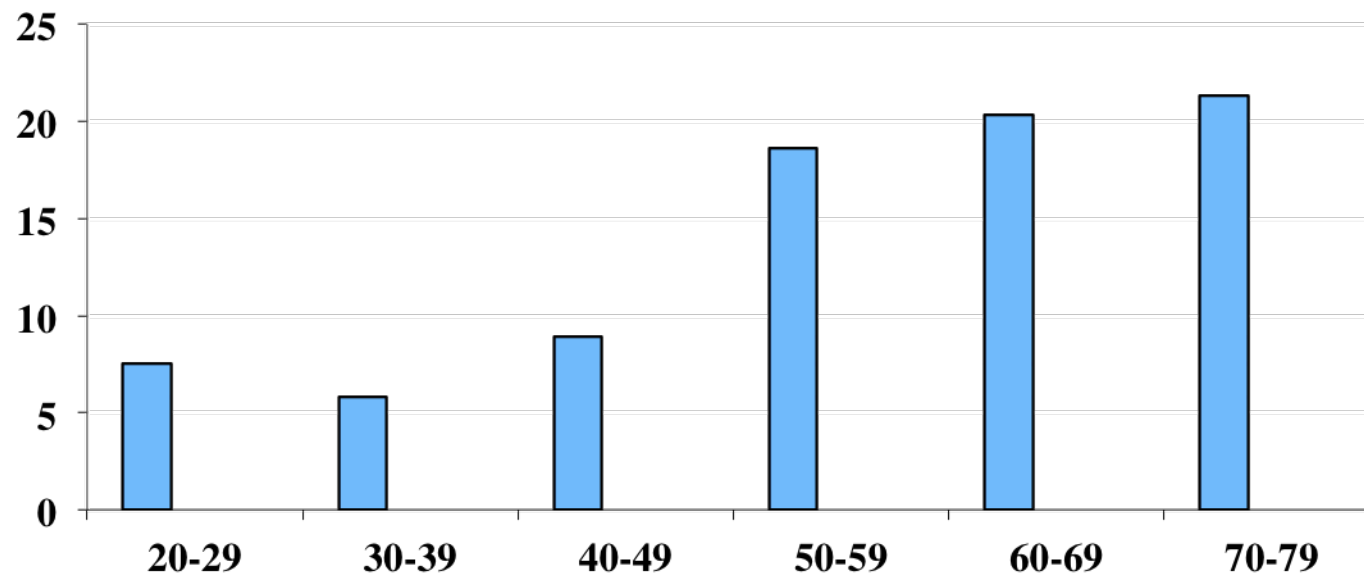


Nowadays, do you get noises in your head or ears ? Yes / No

Age and tinnitus



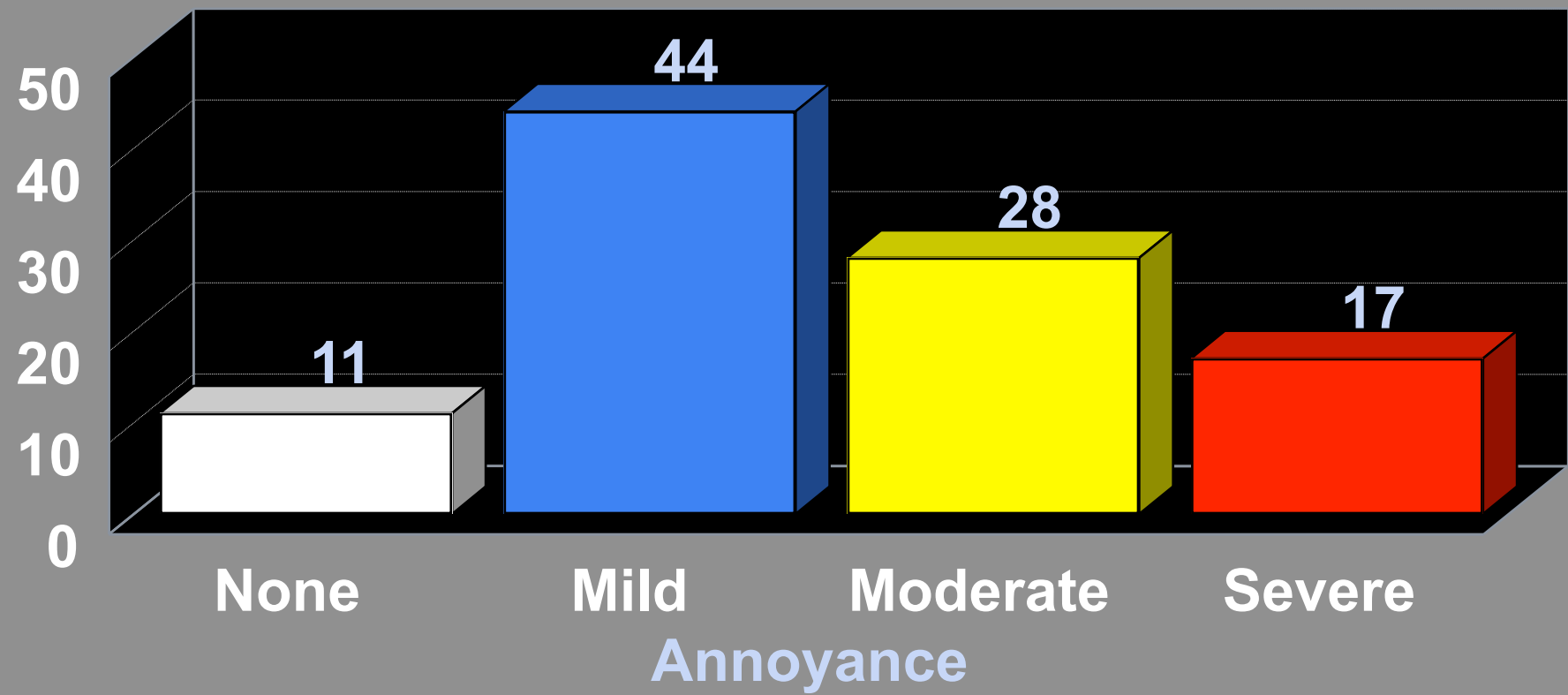
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Davis and Refaie, 2000

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Percentage of those with PST who report no, mild, moderate or severe annoyance, NSH (n=3476)



Population trends and tinnitus

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- Increasing age associated with increasing tinnitus annoyance
 - Davis and Razaie (2000)
- More women than men (ibid)
 - Not statistically significant
- Women have more complex tinnitus than men
 - Meikle and Greist (1989)
- Association with noise exposure and class
 - Davis and Razaie (2000)

Localisation of tinnitus

- Why is left tinnitus more common than right ?
 - Not explained by noise (Meikle and Greist, 1992)
 - Somatic symptoms in general are more common on the left
 - (Min and Lee, 1997)
 - No evidence that left ti is more annoying
 - Is there any such thing as unilateral/localised tinnitus ?
 - (Tyler, 1997)

Hearing loss and tinnitus

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- Hearing impairment is the dominant factor in predicting PST
 - (Davis and Razaie, 2000)
- Conductive loss
 - Bigger the air-bone gap, higher possibility of tinnitus
 - (Davis, 1995)

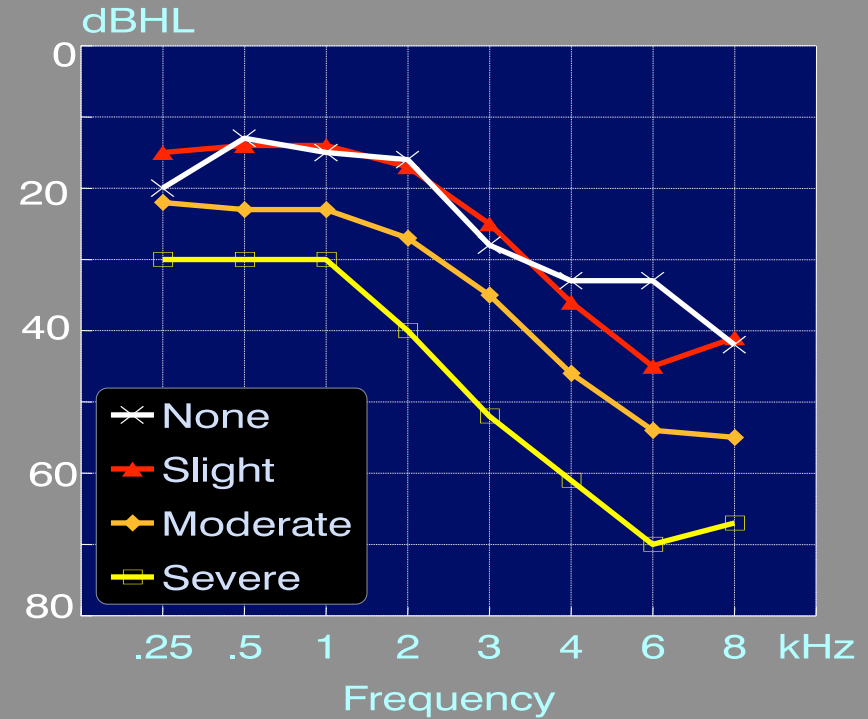
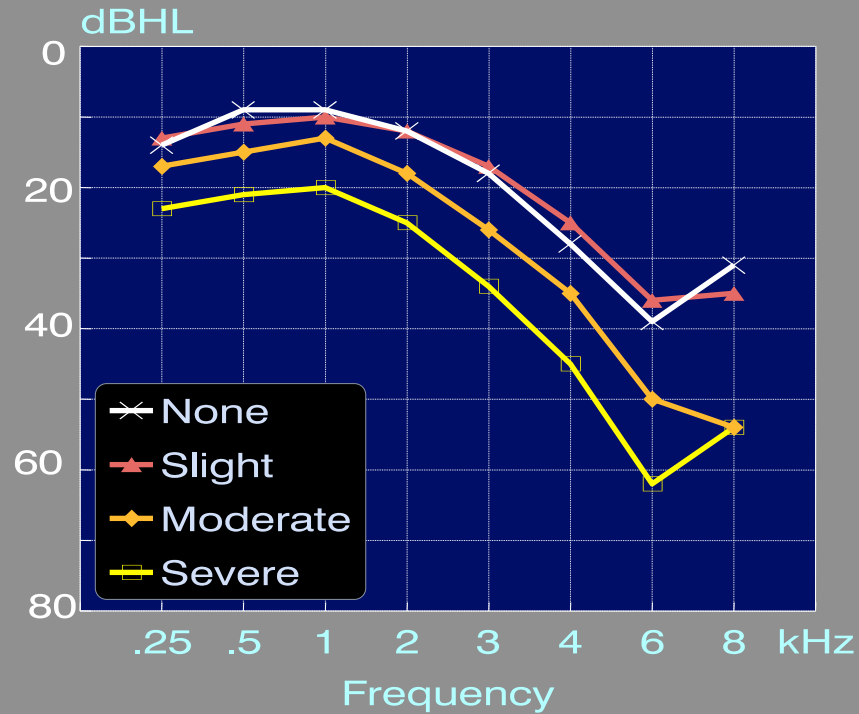
Median HTL as a function of PST annoyance



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Better ear

Worse ear



Median ages: None=56, Slight=51, Moderate=57, Severe=58

Systematic review

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- McCormack et al. (2016)
- 39 studies reviewed, 16 countries
 - Major bias towards developed world
 - ‘Lack of reliable prevalence data’
 - ‘high risk of bias’
 - ‘Available prevalence data is heterogeneous’

Is tinnitus ubiquitous ?

- Presence of “tinnitus” in silence in normal hearing
 - Heller and Bergman (1953) n=80
 - 94%
 - Graham and Newby (1962)
 - 40%
 - Levine (2001) n=unstated
 - 55%
 - Tucker et al. (2005) n=120
 - 64%
 - Del Bo et al. (2008) n=53
 - 83%

Tinnitus incidence in adults



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- Martinez et al. (2014)
- Anonymised patient-based primary care data from UK
- 4.7 million patients <85 years old
- Clinically significant tinnitus
 - Discharge from hospital with T as primary diagnosis
 - Primary care recording with follow-up within 28 days
- 5.4 new cases within 10,000 person years
- No gender difference
- Increase with age (11.4 incident cases age 60-69 years)
- 324,00 new cases in UK 2012 -2021

Studies of referral

- Economic evaluation in Netherlands (Maes et al., 2013)
 - 21 visits per patient, 15 days pa absent from work
 - Average cost of tinnitus care: Euro 1544
 - Healthcare cost pa: Euro 1.9 billion
 - Societal cost pa: Euro 6.8 billion
- Economic evaluation in UK (Stockdale et al., 2017)
 - 1.05 million Primary Care consultations pa
 - Average cost of tinnitus care: £717
 - Healthcare cost pa: £750 million
 - Societal cost pa: £2.7 billion

Updated prevalence data



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- Bhatt et al., 2017
- National Health Interview Survey data, collected 2014
- N= 75,764 respondents
- Tinnitus in last 12/12: 9.6%
- Greater prevalence, severity with age
- Greater prevalence with noise
- Of those with tinnitus, only half had discussed with GP (49.4%)
- Most had never tried any remedy (84.8%)

From: **Prevalence, Severity, Exposures, and Treatment Patterns of Tinnitus in the United States**

JAMA Otolaryngol Head Neck Surg. 2016;142(10):959-965. doi:10.1001/jamaoto.2016.1700

Table 1. Sex Stratification of Tinnitus Symptoms

Tinnitus Symptom	Population in Millions (%) ^a		P Value ^b
	Men	Women	
During past year	11.3 (10.5)	10.1 (8.8)	<.001
Extent of problem			
None	3.6 (31.7)	3.0 (30.2)	.11
Small or moderate	6.9 (61.1)	6.3 (62.5)	
Big or very big	0.8 (7.2)	0.7 (7.2)	
Discussed with physician	6.0 (52.8)	4.8 (48.0)	.04

^a Numbers of respondents represent a weighted national sample of adults who reported tinnitus in the 2007 National Health Interview Survey (raw sample, 75 764 respondents).

^b Calculated using χ^2 tests.

Table Title:
Sex Stratification of Tinnitus Symptoms

From: **Prevalence, Severity, Exposures, and Treatment Patterns of Tinnitus in the United States**

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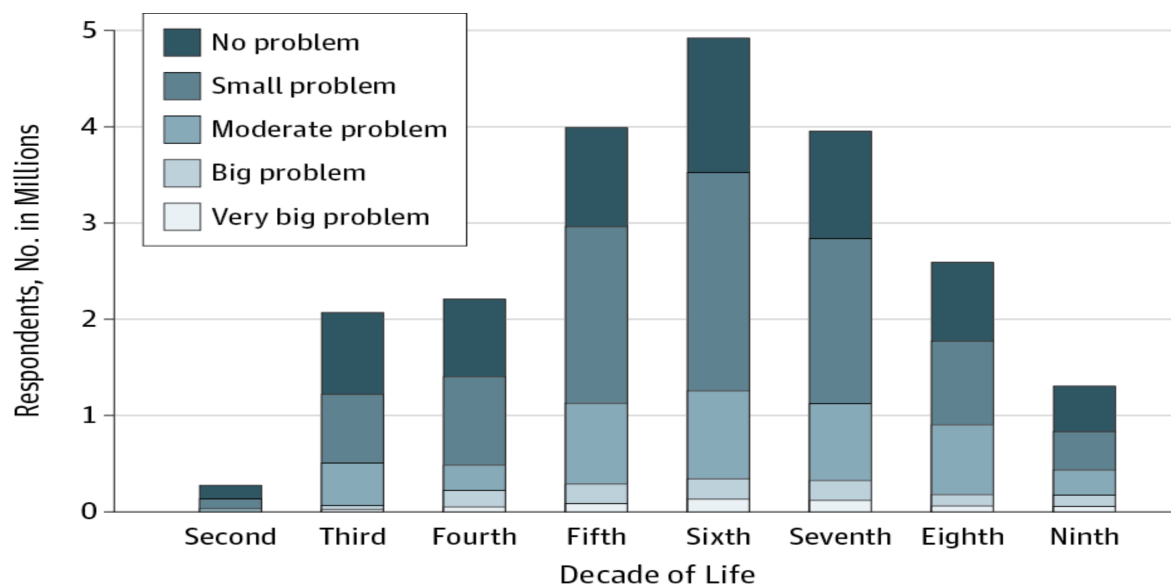


Figure Legend:

Subjective Severity of Tinnitus Symptoms by Age Numbers of respondents represent a weighted national sample of adults who reported tinnitus in the 2007 National Health Interview Survey (raw sample, 75 764 respondents). A direct correlation is seen between subjective perception of increased tinnitus severity and increased age ($r=0.083$; 95% CI, 0.042-0.125).

Date of download: 10/2/2017

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From: **Prevalence, Severity, Exposures, and Treatment Patterns of Tinnitus in the United States**

JAMA Otolaryngol Head Neck Surg. 2016;142(10):959-965. doi:10.1001/jamaoto.2016.1700

Table 3. Treatment Options Discussed With Physicians Among Respondents Reporting Tinnitus

Type of Therapy Discussed	Population in Millions (%)
Included in AAO-HNSF guidelines	
Medications	1.45 (45.4)
Hearing aids	0.30 (9.2)
Nutritional supplements	0.25 (7.8)
Stress reduction methods	0.21 (6.7)
Music treatment	0.13 (4.0)
Tinnitus retraining therapy	0.10 (3.0)
Biofeedback therapy	0.09 (2.8)
Wearable masking device	0.08 (2.6)
Nonwearable masking device	0.07 (2.3)
CBT	0.01 (0.2)
All	2.68 (83.8)
Not included in AAO-HNSF guidelines	
Psychiatric therapy	0.01 (0.3)
Surgical transection of auditory nerve	0.04 (1.2)
Alternative medicine	0.12 (3.9)
Other	0.94 (29.5)
All	1.11 (34.9)

Abbreviations: AAO-HNSF, Academy of Otolaryngology–Head and Neck Surgery Foundation; CBT, cognitive behavioral therapy.

^a Numbers of respondents represent a weighted national sample of adults who reported tinnitus in the 2007 National Health Interview Survey (raw sample, 75 764 respondents).

Table Title:

Treatment Options Discussed With Physicians Among Respondents Reporting Tinnitus

Natural history: adults



- Philips et al. (2017)
 - 21 studies with waiting list controls
 - no change in depression, QOL
 - Modest improvements in ‘global tinnitus’, impact, loudness
- Bogo et al. (2017)
 - Longitudinal twin study, n=1084
 - Overall prevalence: 13.5%
 - Prevalence at baseline (mean 50y): 13.5%, f/u (m67y): 34.4%
 - At follow up, 4.2% reported resolution

Tinnitus prevalence in childhood

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BMJ Open Prevalence of tinnitus and hyperacusis in children and adolescents: a systematic review

Susanne Nemholt Rosing,^{1,2,3} Jesper Hvass Schmidt,^{3,4} Niels Wedderkopp,^{5,6}
David M Baguley^{7,8}

Nemholt Rosing et al., 2016

Tinnitus prevalence in childhood



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- Nemholt Rosing et al., 2016
- 25 articles
- Prevalence in general population: 4.6 - 47%
- Prevalence in SNHL: 23.5 - 62.2%
- Very substantial challenges in
 - Population studied (age)
 - Definition of tinnitus
 - Reporting
- Coelho et al. (2007): sensation in 37.5%, 'suffering' in 19.6%

Tinnitus in childhood

- Hall et al. (2016)
 - 218/7092 (3.1%) 11 year old children experienced clinically significant tinnitus (present in 28.1%)
 - 21 of the 218 (9.6%) with tinnitus reported hyperacusis
- Humphriss et al. (2016)
 - 261/7093 (3.7%) 11 year old children reported hyperacusis
 - 109 (41.7%) of these reported (any) tinnitus
 - Risk factors: male, higher maternal education, readmission to hospital in first 4/52

Tinnitus incidence in childhood



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- Baguley et al., 2013
 - 88 cases per year in 4 major european centres
 - 3.9% of paediatric workload
 - 93% \geq 10y
 - Severe in 18%
 - Accompanied by hyperacusis in 39%
- Why so few referrals?

Ask every child?



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- British Tinnitus Association Good Practice Guide (2016)
- Kennedy et al., 2016, response to Hall et al., 2016

As the paper mentions, the Tinnitus in Children Practice Guidance document recommends that children attending an audiology service are routinely asked about noises in their ear, just as adults are. We disagree that the figures in the paper support the view that such would lead to over-reporting

Ask every child?



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- Humphriss, Hall, Baguley (2016)
Second, you argue for the case for all children attending an Audiology or ENT facility being asked about tinnitus, indicating that rather than over-reporting, this will facilitate the identification of children with troublesome tinnitus. This discussion has been ongoing, but was not illuminated by data until now: our paper indicates that 28.1% of 11-year-olds in the general population will answer that they do have tinnitus, but this will be clinically significant in 3.1%, thus 25% of children would have their attention drawn to their non-significant tinnitus. It is up to the individual clinician to come to his/her own view on this matter.

Has this caused my tinnitus?

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- I had ear problems as a child
- I am a musician
- Is my diet involved?
- I am a dentist
- My sleep is poor
- I have headaches
- I had chemotherapy

I had ear problems as a child



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- Dawes et al. (2010)
 - New Zealand , n=970
 - Those with OME and CHL, increased likelihood of adult tinnitus
- Aarhus et al., (2015)
 - Cross sectional study, childhood hearing and adult tinnitus
 - If childhood HL, more likelihood of adult tinnitus
 - Effect reduced if adult noise accounted for

I am a rock musician

- Stormer et al. (2015)
- n=111, 'active musicians' in Norway, 102 M, 15 F
- Tinnitus: "have you experienced tinnitus?"
 - n= 19.6%
 - None 'severe'
- Stormer et al., (2017)
 - Greater T in musicians than controls
 - More anxiety in musicians than controls
 - 'drug abuse was not more prevalent in musicians than controls'!

Is my diet involved?

- McCormack et al. (2014)
 - UK BioBank Data, 40-69y, n=171,722
 - Persistent tinnitus associated with
 - Bread
 - Dairy avoidance
 - Past and never smokers
 - Decreased tinnitus with
 - Fish
 - Egg avoidance
 - Caffeinated coffee

Is my diet involved?

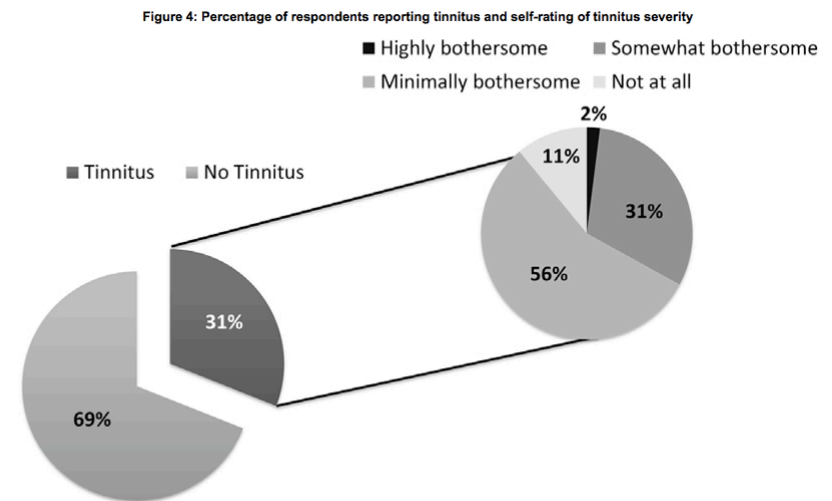


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- Spankovich et al., (2017)
 - National Health and Nutrition Examination Survey (NHANES), 1999-2002
 - n=2176
 - Any T in last year: 21.1%, persistent: 11.7%
 - Better diet associated with less tinnitus

I am a dentist

- Myers et al., (2016)
 - High levels of sound deriving from suction
 - T prevalence : 31% (n=144/395)



My sleep is poor

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- Long known that tinnitus associated with poor sleep
 - Tyler and Baker (1983)
 - Cronlein et al. (2016)
- Koo and Kwang (2017)
 - n=130,788, 21,798 with tinnitus
 - Higher incidence of tinnitus with
 - sleep disturbance
 - Sleep apnea

I have headaches



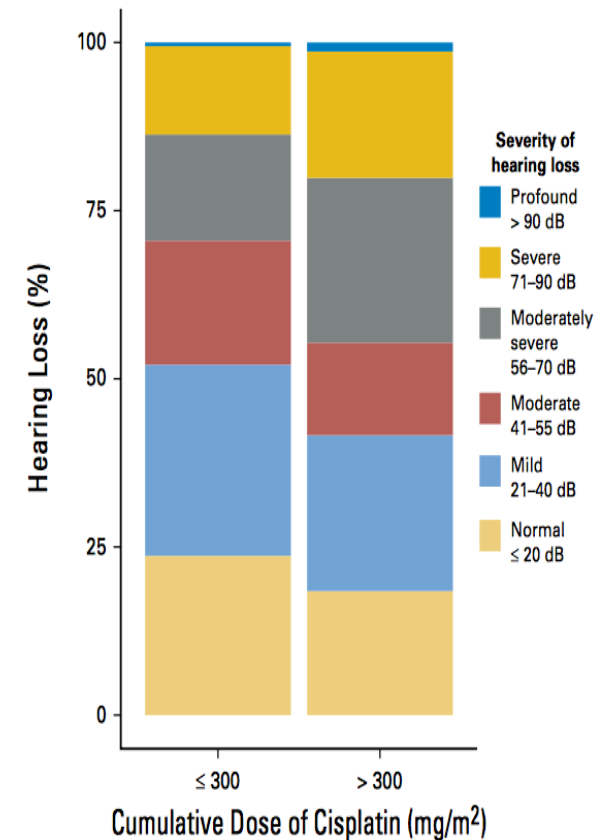
- Langguth et al. (2015)
 - TRI database, n=193 T + headache, 765 T no headache
 - T+ headache
 - Greater impact
 - Reduced QoL
 - Pain hyperacusis
 - Depression
 - Propose additive effect

I had chemotherapy

- Frisina et al., (2016)
- Bothersome tinnitus in 40%



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Ethnicity

- New Zealand
 - n= 69,976, random telephone survey, 2007-2013
 - T in last 12/12: 6.0%
 - M>F
 - Highest European, lowest Asian
- Adults from a Pacific Northwest Tribe
 - Gellert et al., 2017,
 - N= 217, tinnitus in 33%
 - M=F, risk factors >3 ear infections, noise

Tinnitus and hyperacusis

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- Seem to have become linked inextricably
- Explore the association

Relationship with tinnitus : adults



- 86% of hyperacusis patients report tinnitus
 - (Anari et al, 1999)
- 40% of tinnitus patients report hyperacusis
 - (Jastreboff et al, 1996)
- Scheckelman et al. (2014)
 - N=1713 patients with primary complaint of tinnitus
 - Do sounds cause you pain or physical discomfort?
 - 55% positive
 - Ti+H > Ti distress than Ti alone

Relationship with tinnitus – adults

- Yang et al. (2015)
 - N= 207 patients with a primary complaint of tinnitus
 - N=105 unilateral
 - N=102 bilateral
 - Hyperacusis
 - Unilateral t= 12.74%
 - Bilateral t= 4.76%
 - P=0.23 NS
- Degeest et al. (2015)
 - N=81 patients with a primary complaint of ti
 - N=26 (32%) with sound tolerance issues usually/ always
 - Hyperacusis Q score correlated with Tinnitus Handicap Inventory ($r=0.73$)

Convergence with tinnitus

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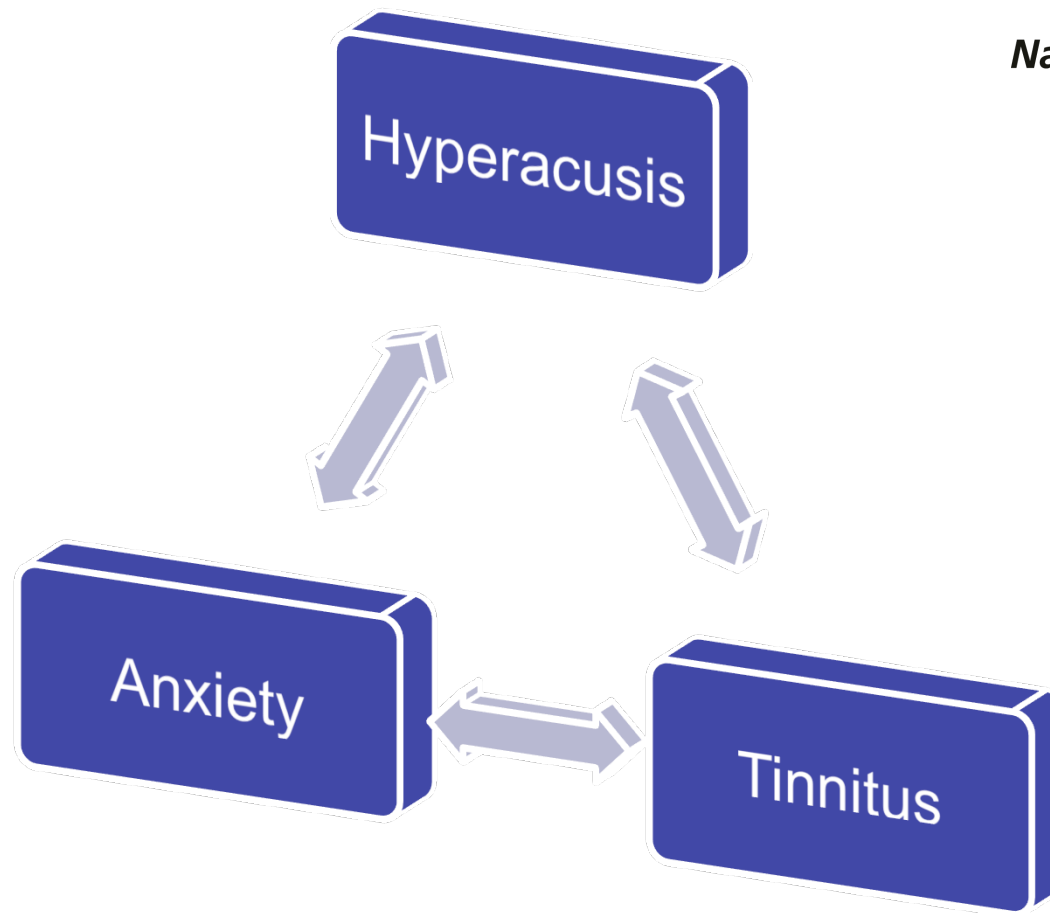
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- Co-occurrence
- Same referral pathway
- Same clinical skill set
- Relationship with anxiety

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Fear and anxiety



- Until recently, no quantitative data
- High levels of anxiety states
 - Juris et al., 2012
 - 47% anxiety disorder
- “emotional exhaustion”
 - Wallen et al., 2012
 - N=348 with EE, n=4 (1.1%) with hyperacusis
- Acute stress changes loudness tolerance in women with EE (Hasson et al., 2013)

Divergence with tinnitus

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- Unilateral and strongly lateralised hyperacusis is very rare, unlike tinnitus
 - Specific event/trigger
 - Acoustic Shock
 - Specific lesion
 - Insular cortex, Boucher et al., 2015

Divergence with tinnitus

- Hyperacusis is less labile than tinnitus
- Little traction for self help in severe hyperacusis
 - Hyperacusis.net
- Possible themes of
 - Self inflicted
 - Shame
 - Social isolation
- Perceptual salience rather than formless
 - (Auerbach et al., 2014)

Divergence with tinnitus

A horizontal bar composed of several colored segments: green, dark green, orange, purple, red, dark purple, and blue.

- Somatic modulation of hyperacusis is rare
- Intermittent hyperacusis is rare

- Some associations with hyperacusis have no relation to tinnitus
 - Misophonia
 - Autistic Spectrum Disorder

Tinnitus and hyperacusis

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- Cousins, not siblings, nor twins
- Some neurobiological overlap
- Some behavioural overlap

- Implications for treatment
 - Which is the primary problem?
 - Explore the topography of the individual problem

Unanswered research questions



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- Reliable tinnitus prevalence
 - Young children, adolescence, young adults, middle age, elderly
- Particular communities
 - Non-first world
 - Ethnicity
 - Behaviours
- Risk factors
 - Combination, multi-factorial

Unanswered research questions

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- Natural history
 - Habituation?
 - Barriers
- Help seeking behaviour
 - Patient perceived needs
 - Self help
 - Internet delivered (Beukes et al. 2016, 2017)

Unanswered research questions

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- On the increase?



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Looking ahead

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- Opportunities for robust research
- Many crucial questions remain unanswered
- Build upon collaborations

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