

Leisure time noise - sources, exposure, and effects on hearing

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Presentation gives answers to following questions:

- Why this subject is important?
 - How much noise is too much noise?
 - What activities are the most noisy?
 - How noise effects on our health?
 - How to protect yourself from leisure time noise?
 - What should be done to handle this problem?
- 

Sound environments

Work

Hobbies

**Traffic
Nature**

Home

**Public buildings:
Schools
Offices
Shopping Centres
Restaurants
Concert halls
Sport stadiums**



We need hearing for..

- Communication
 - Sharing Information, learning
 - Social activity
- At work
 - Sound and noise professionals
 - Musicians, acousticians
 - Communication needed jobs
 - Health professionals (hearing tests)
- Recognising important sounds
 - Safety
- Enjoyment, entertainment
 - Listening and playing music
 - Experiences (films)
- Experience of silence



How sounds effects us?

- Orientation effect: fight or run away!

- Heart beat, blood circulation

Laugh varies!



- Effects on sleep

- Hearing works while sleeping!



- Same sound could evoke different kind of emotions



- Annoyance, disturbance, scaring, cheering, relaxing, katarsis



- Music effects us on many ways



Sounds and music are being used

- Part of atmosphere
- Paying attention
- Having special effects
- Influencing of our shopping behaviour
- Many places
 - Concerts, festivals, circus
 - Movies, theatres
 - Shops, Sports games
 - Church



<http://www.youtube.com/watch?v=1UrpQTl6HTo>

Noise increases continuously

- Reasons
 - Traffic growth, industrialisation
 - Technical development
- Contribution of:
 - Economical well being
 - More spare time
 - Variation of activities
 - Modern people eager to have experiences, hedonism



Examples of noise sources

Sound Pressure level, dB	Source, example
180	Canon, ear drum damages immediately
140-160	Shooting guns
130	Fireworks, jet plane
120	Pain in the ear
100	Rock-concert, saw
90	Lawn mover
85	Hearing damage occurs, *upper exposure level
80	*Lower exposure level
70	Traffic
60	Normal speech
40	Computer
20	Whisper
0	Hearing level of normal young people

http://www.youtube.com/watch?v=tf_QyFlbA8w



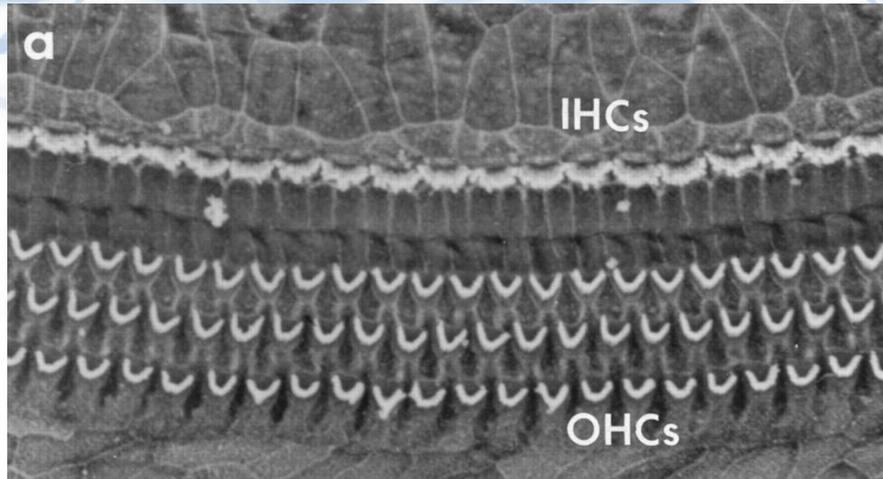
Noise and time 3 dB rule!

Sound level	Maximum exposure time
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85	8 hrs
88	4 hrs
91	2 hrs
94	1 hrs
97	30 min
100	15 min
103	7 min
106	4 min
109	2 min

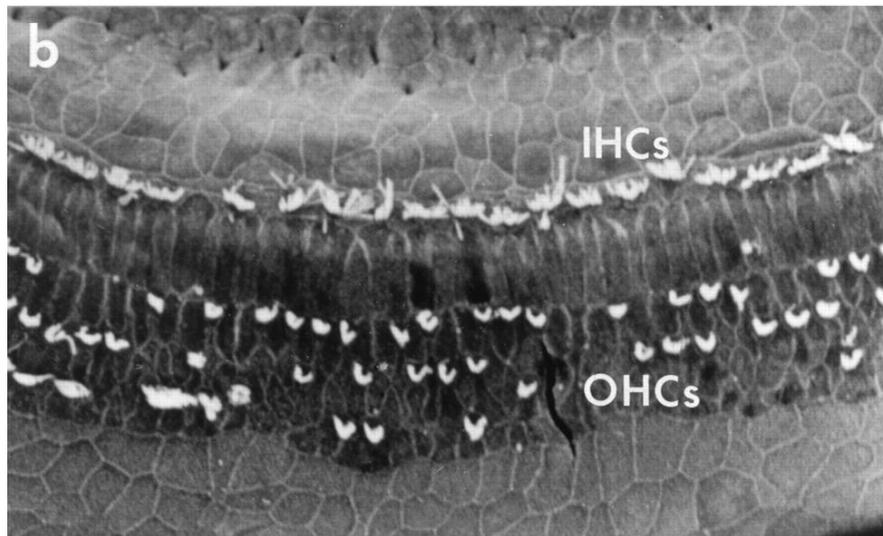


Scanning electron micrographs of the normal (a) and damaged (b) cochlear sensory epithelium.



Normal hair cells

Temporary threshold shift, TTS
Permanent hearing loss, PTS



http://www.youtube.com/watch?v=ahCbGjasm_E

Damaged hair cells

Ryan A F PNAS 2000;97:6939-6940

<http://www.youtube.com/watch?v=Xo9bwQuYrRo>

First warnings being exposed too much noise:

- Ears feels blocked
- You hear ears ringing= tinnitus
- You speak louder than normal
- You have to ask you partner to rise his/her voice

Signs of permanent hearing loss

What?

WHAT did you say?

Sorry, I can not hear you?

Could you repeat?

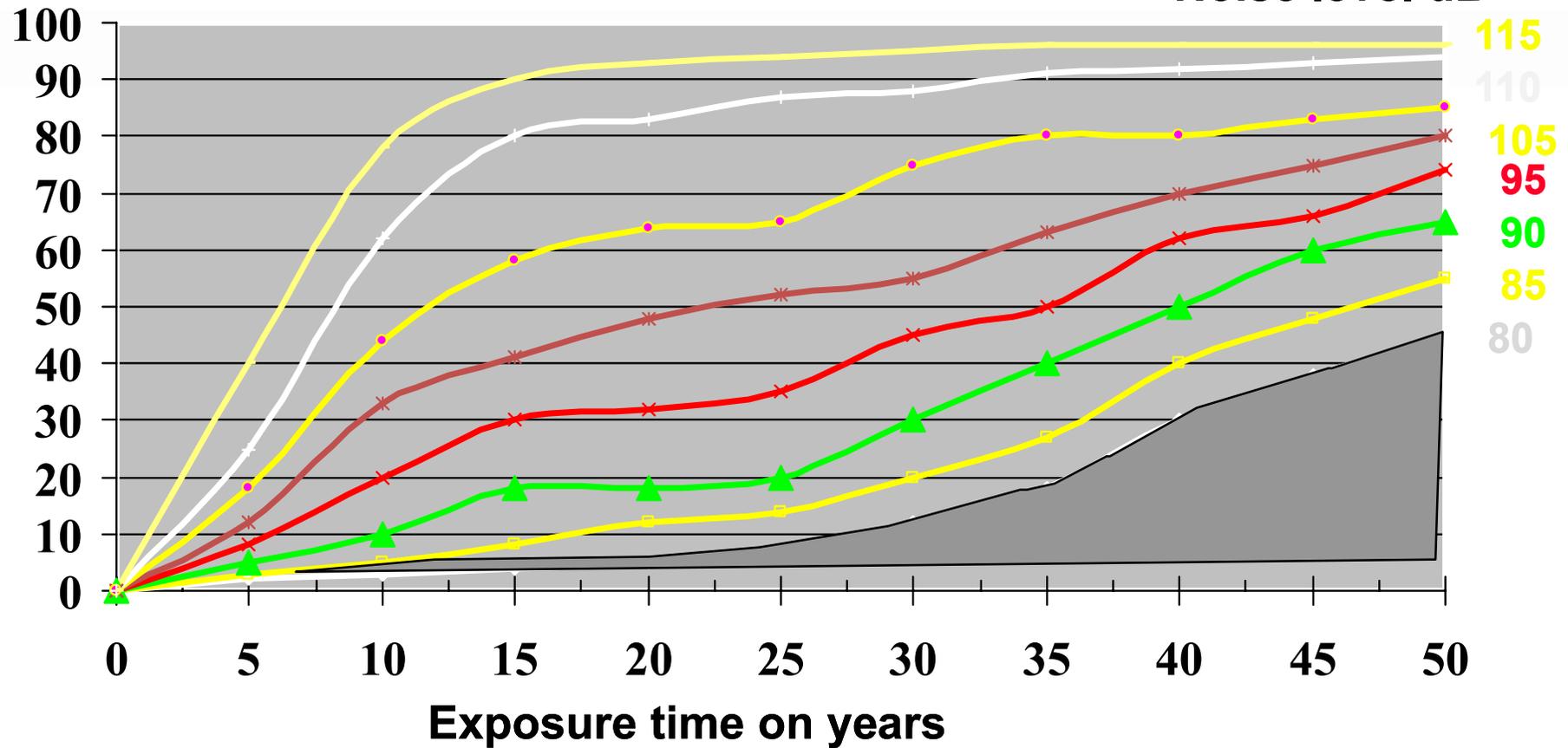
- You have to concentrate carefully that you could hear others
- You can not always hear speech at the first time
- Your friend & Family members says that you talk loud voice
- You listen tv & radio louder than others
- You can not hear doorbell, telephone
- Difficulty to follow what happens
 - E.g at school, cinema/theatre, meetings

<http://www.youtube.com/watch?feature=endscreen&v=ar1Dq-M2ok4&NR=1>

How fast hearing will be damaged?

Hearing risk %

Noise level dB



Effects of Noise

Concentration, motivation,
learning, language development

Communication
difficulties,
social isolation

Effects on personality and
behavior

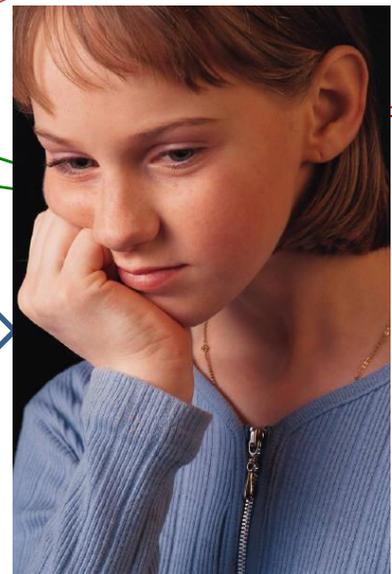
Voice problems

Irritation, annoyance,
effects on sleep,
headache,
stress responses

Hyperacusia

Effects on Hearing,
TTS, tinnitus,
Sound distortion

Increase of heart rate,
blood pressure,
hormone responses



Risk for accidents



Why evaluation of noise exposure is important?

- Development of NIHL is gradual
 - Longitudinal and non-reversible process
 - Harmful effects of noise is often too late noticed
 - Tinnitus effects more and more on quality of life
 - Effects on individuals life, social environment and activities
- Need for communication is important
 - Speaking the most significant way to communicate (fast, effectiveness)
 - Many jobs have changed to communication work
 - Good hearing capacity is needed for the communication and work
- On safety more and more important



Why evaluation of leisure time noise exposure is important?

- Noise exposure starts early at childhood
 - Change of society from 60 s (e.g toys)
 - Hearing protection of children and young people important->future adults!
- Ignorance of effects of noise is general
 - Some sources noise levels are overestimated, some underestimated





What are your main values of life?

Good health

Love

Interesting work

Economical welfare

Family

Good relationships

Nature

Hobbies





Evaluation of Leisure time noise is important

- Total noise exposure of all the leisure time activities combined less known issue
- Several activities, new comes available continuously
- The difficulty of control the all the activities combined
- NIHL is cumulative process, hearing does not distinct the activities and their noise



Leisure time noise?

- Any high sound level performed during the leisure time activities.

Sources:

- Music

- Discos, pubs, restaurants , concerts, festivals
- Listening: audio systems (car, home), portable equipment: Mp3, I-pod, mobile phones
- Playing: practising, performing, band/orchestra

- Home tools, and equipment indoors and outdoors

- Sports

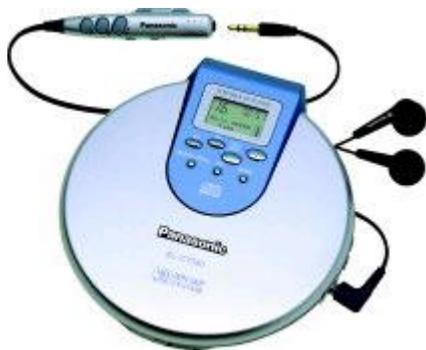
- Shooting, hunting
- Sports games, (often strong music included)
- Motor sports: driving, games, events

- Fireworks, toys, games, movies



Technical development has been fast

So are the dB levels!

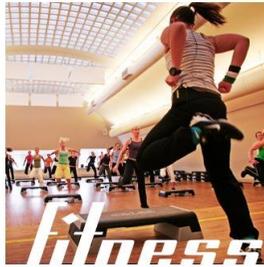


	LAeq, 1min			
MP3 Player	Headphones	Headphone 2	Ear buds	Ear insertec
Ipod	92	82	94	113
Nokia N91	98	94	99	123
Creative	85	75	95	112
Sony Sappin	80	70	85	107



Source: Institute of Occupational Health 2009

Noise levels of different activities , L_{Aeq} , dB



- Playing in a band/orchestra 75-135
- Singing 75-105
- Different musical instruments 60-120
- Listening to home stereos 70-100
- Listening via car audio systems 65-100
- Portable music equipment (Mp3) 50-115
- Concerts, festivals, music events 73-110
- Aerobics 78-106
- Movies 70-85
- Discos, music bars 60-110
- Motor sports 70-115
- Shooting (hunting) 120-165 L_{peak}
- Fireworks 120-165 L_{peak}
- Machines and equipment at home 60-100
- Tools, and machines outdoors 70-110
- Toys, games 70-112
- Toy weapons, 120-170 L_{peak}



Different music instruments

	L _{Aeq} , dB
Band playing	90-135
Bass	75-83
Bass guitar	85-100
Flute	85-111
Clarinet	92-103
Cembalo/clavichord	62-65
Oboe	80-94
Piano /Grand piano	75-110
Piccolo	95-112
Drums (maximum)	86-122
Saxofone	99
Cello	80-92
Trumpet	80-124
Trombone	85-114
Organs (church organs)	75-88
Violin	84-103



Concerts, LAeq-levels

Sting	2h 18min	94
Deep Purple	1h 47min	110
Jethro Tull	1h 53 min	100
Tom Jones	1h 15 min	99
Bob Dylan	1h 59 min	102
Bon Jovi	1h 45 min	105
Tina Turner	1h 52 min-2h 14 min	98-107
3 Lady´s on stage	2h 22 min	95
Karita Mattila	1h 16 min-1h 19 min	82
Kirka	2h 4 min	96
Smashing Pumpkins	2h 20 min	101
AC/DC	1h 48min -2h 3 min	108-110
Savage Garden	1h 21 min	101
Mötörhead	1h 28 min	107

Year of 2005 inFinland



Famous musicians suffering tinnitus

Neil Young

Pete Townsend (WHO)

Sting

Lars Ulrich & James Hetfield (Metallica)

Eric Clapton

Bono & The Edge (U2)

Anthony Kiedis (Red Hot Chili Peppers)

Phil Collins

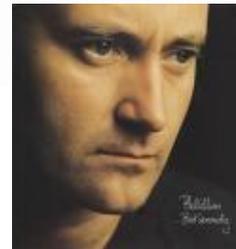
John Densmore (Doors)

Steve Lukather (Toto)

Ozzy Osborne

Huey Lewis

Ville Valo (HIM) <http://www.youtube.com/watch?feature=endscreen&v=QN2yQHJ0uWY&NR=1>



"Tinnitus, man, you can't...You know, there's nothing you can do about it. It doesn't get better. It can only get worse-that's the hell of that thing.

I always have to say "WHAT???", hahaha.
Be careful guys, this could happen to you!

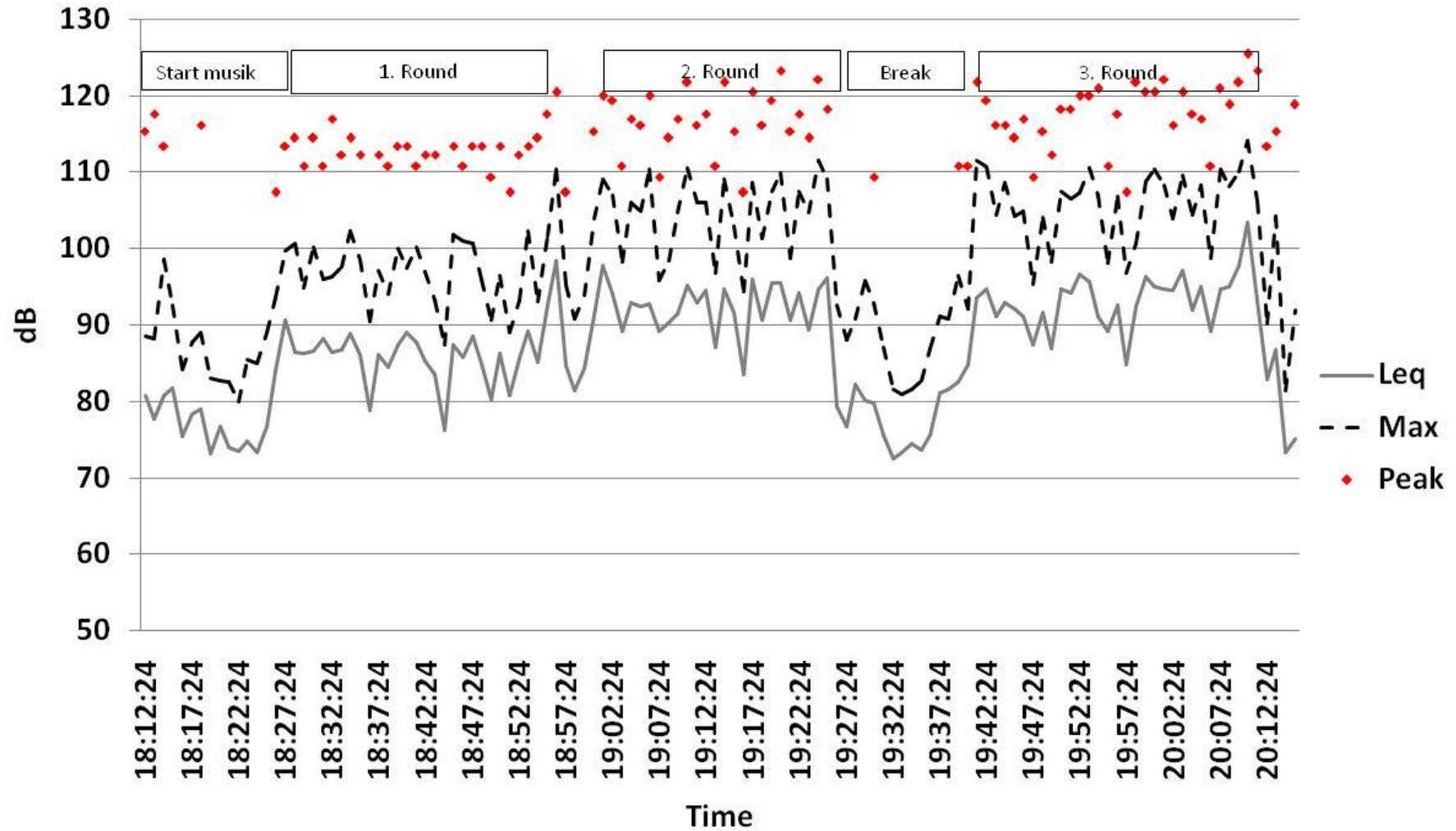
Noise levels of toys

Toy weapons (impulse noise)	132-170
Toy weapons (continuous noise)	82-99
Cars, etc. Moving vehicles	80-102
Tools	94-109
Simulators	81-100
Games	81-104
Soft toys	81-100
Bycycle horns	92-112
Key holders	73-80



Sun Volley- Raison Loimu Volley Ball game

7.4.2010 Oulu, $L_{Aeq}=92$ dB



Vuvuzela

- According to literature
 - Near horn opening L_{Amax} 131 dB
 - 2 m distance L_{Amax} 113 dB
 - $L_{Aeq,2h}$ during the game 96-107 dB
 - Those who had vuvuzela 100-107 dB
 - L_{Cpeak} -levels 133-144 dB



*EU 10/2003	In front of horn opening, dB		Next to ear, dB	
	Average	Variation	Average	Variation
L_{Amax} Hearing damage limit	129 100	119-133	105	95-110
L_{Aeq} Hearing damage limit*	121 85	108-126	96	86-100
L_{Cpeak} Hearing damage limit*	142 137	133-144	117	110-123

http://www.youtube.com/watch?v=YpXN8BvGp_o

JJokitulppo



Occupational noise exposure

- Continuously occupational problem
 - Occupational NIHL about 1000/year In Finland
- Noisy leisure time may have effect on total noise exposure
 - Appearance of Occupational NIHL faster
 - Hearing loss or tinnitus can interfere the work or or even prohibit to do the work (e.g. musicians, acousticians)
 - Also the vocational selection (need for good hearing capacity)



Background of PhD thesis

- Doctoral thesis of Jaana Jokitulppo ,
University of Kuopio, Department of Environmental Sciences 2009:
Non occupational noise - sources, exposure, and effects on hearing
- The Finnish Federation of Hard of Hearing (FFHOH)
 - Teenagers 12-16 years
- National Institute for Health and Welfare (THL) part of the EXPOLIS-study
 - Adults 25-55 years in Helsinki area
- The Finnish Defence Forces (Pori Brigade)
 - Conscripts 19-27 years, arrive and leaving examination



Puolustusvoimat
Försvarmakten | The Finnish Defence Forces



NATIONAL INSTITUTE
FOR HEALTH AND WELFARE

How leisure time noise exposure was calculated and evaluated?

- Occupational noise exposure legislation
 - EU directive 10, 2003 (National legislation VnA 85,2006)
 - Lower and upper action levels 80 dB, 85 dB, (limit value 87 dB)
 - Was calculated with weekly noise exposure according to ($L_{Aeq,40h}$), ISO 1999
- With Questionnaire
 - Self reported duration of exposure of activity (hours)
 - Subjective estimation of loudness Scale 1-5 (60-100 dB)
 - Hearing Symptoms
 - Audiograms (conscripts)



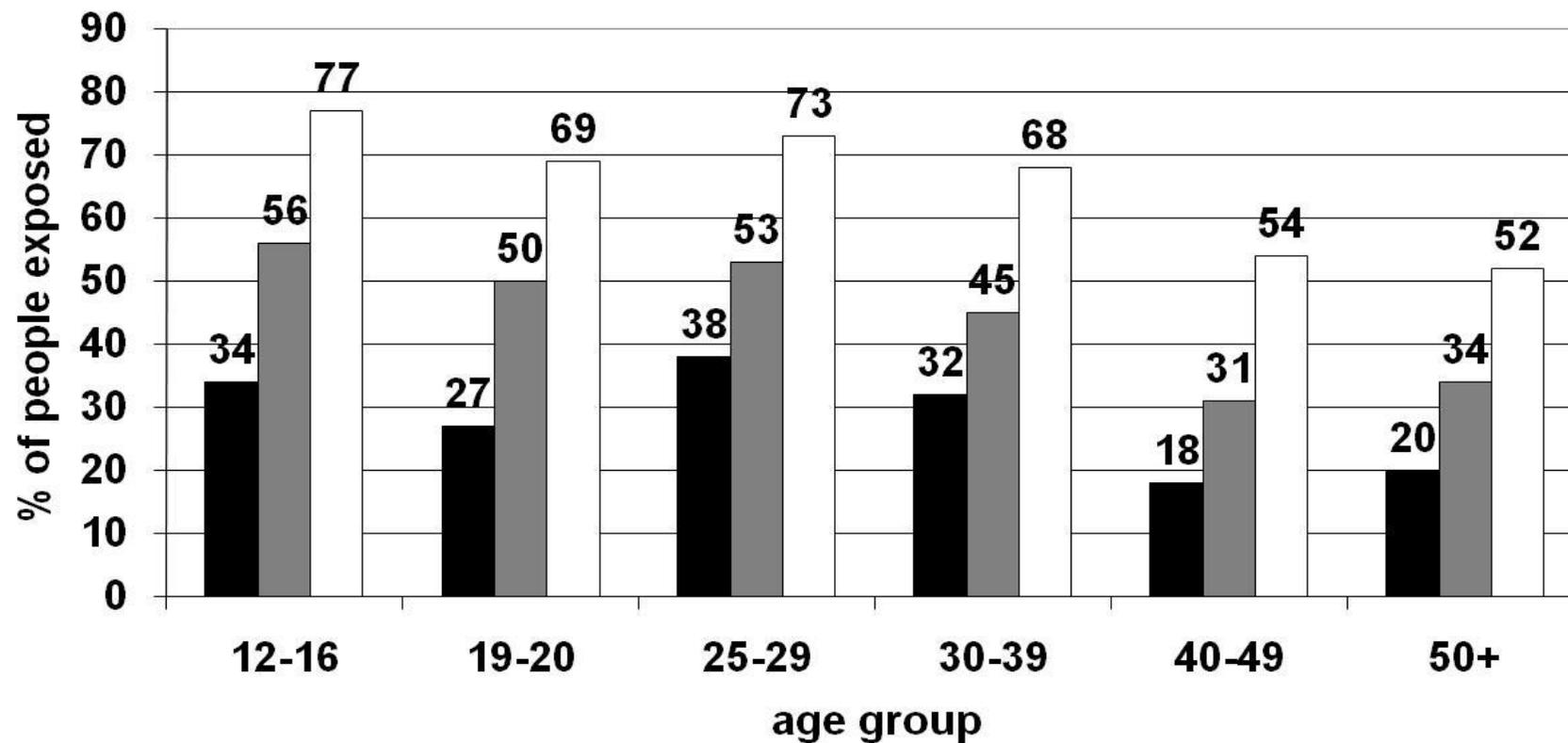
Results 1

- One of five was exposed over 85 dB leisure time noise at their life time
 - Teenagers and young adults used 40-hrs/week at their noisy leisure time, adults about n. 25-30 hrs/week
 - Weekly noise exposure was gathered many activities, the most significant were:
 - Music bars & discos, concerts, shooting, playing in a band, home tools and motor sports
- Safety level for ears, under 75 dB
 - 20% of teenagers
 - 30% of 19-40 years olds
 - About half of over 40- year olds



Total weekly leisure time noise exposure among all age groups

■ weekly noise exposure over 85 dB ■ weekly noise exposure over 80 dB
□ weekly noise exposure over 75 dB



Results 2

Tinnitus sometimes or often

- Over 70% of teenagers and conscripts
- 25 % of adults
- TTS sometimes or often
 - About 50 % of teenagers and conscripts
 - Over 10 % of adults
- Symptoms were experienced especially those with high personal weekly noise exposure

Weekly noise exposure and hearing symptoms – Conscripts, LAeq, dB

Symptom	Never 0	Sometimes 1	Often 2	Continuously 3	Difference
Tinnitus related to noise	78	80	86	82	All
Tinnitus for other reason	79	81	84	87	All
Pain in ear	79	80	85	-	-
Sound unpleasent	79	80	83	92	All
Sound distortion	79	81	85	93	All
TTS	78	81	84	95	All

Results 3 -Hearing loss

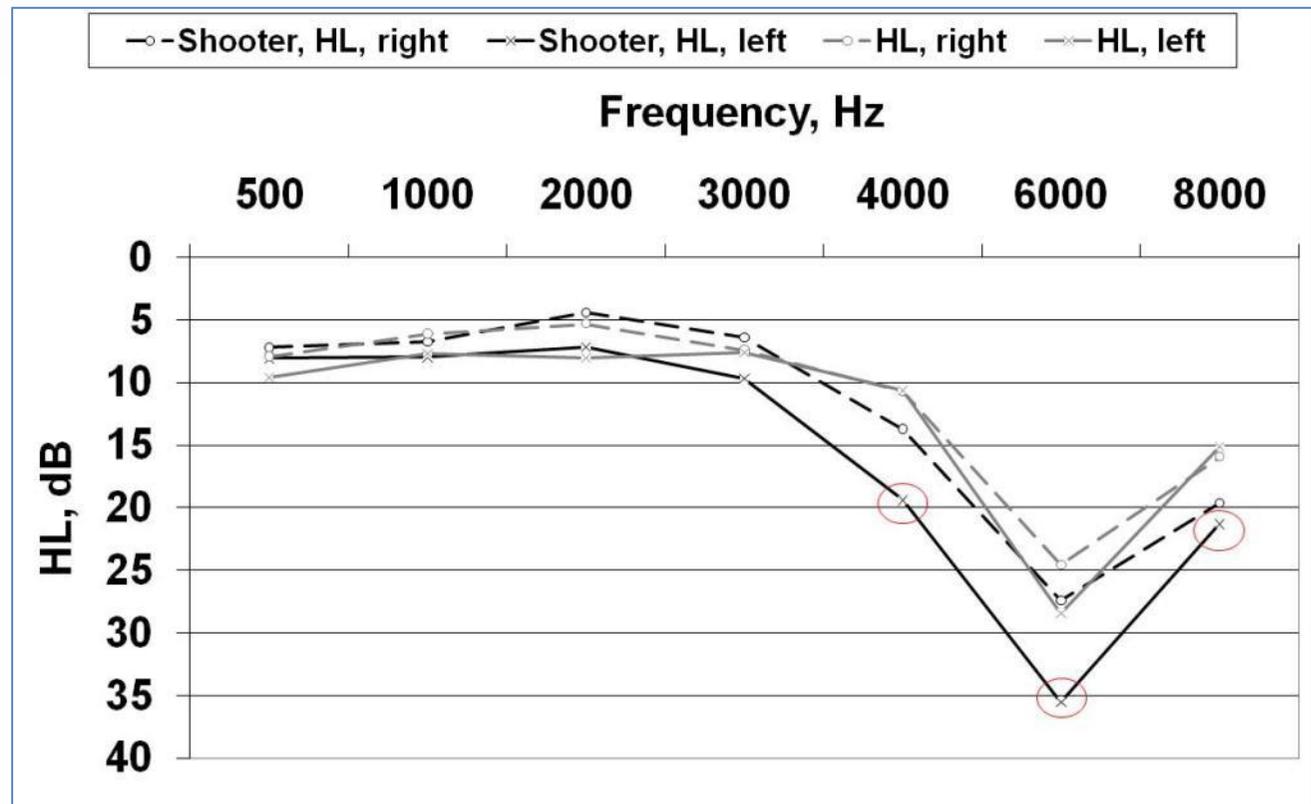
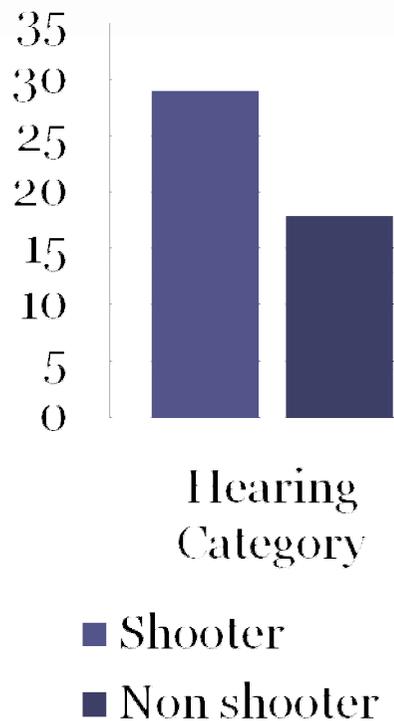
1/5 conscripts had hearing loss BEFORE the military service

Most of them related to leisure time noise

1/3 had hearing loss at the END OF SERVICE of

The most effect was with less hearing protection usage rate of combat training in field

Hearing of Shooters -conscripts, before military service



Conclusion of Thesis

- Most sound exposure takes 15-20 years
 - At most at the age of 25-30 years, decrease after 40 years
- Risk of hearing loss
 - 1 of 3 of teenagers and young adults (under 40 years)
 - 1 of 5 adults (over 40 years)
- 1 of 5 hearing loss of Conscripts before military service
- 1 of 3 hearing loss of Conscripts after military service
- Shooters having hearing loss already before the military service
- Auditory symptoms general, especially tinnitus & TTS signals with high exposed noise levels
- Hearing protection hardly use



What should be done?

Noise levels must be reduced!!

- Legislation, especially with children hearing protection!
- Noise control (authorities, event arrangers)
 - Measurements, checking
 - Noise reduction
 - Technical opportunities (e.g. limiters)
 - Planning, design (acoustical & audio planning)
- Health examinations
 - Audiograms, hearing symptoms questionnaires
- Education
 - Into schools education systems
 - Key professionals: teachers, trainers, designers etc.
- General education
 - Hearing conservation programs, Campaigns
- Hearing protectors
 - Nice *looking*, -> *To trend..* **Losers do not use HPD!!!**

<http://www.youtube.com/watch?v=2G9Q-r2leyw>

How to protect your hearing?



- Avoid noisy environments
- Set the volume level lower if possible
- Decrease the time of the noise exposure
- Allow silence breaks to your ears
- Go further the noise source
- Do not by noisy tools and equipment, remember also toys!
- When buying a tool/machine, by the one with low noise level
- Listening to music:
 - Use high quality headphones and equipment
 - Poor headphones makes you set the volume level higher
 - Take care of others, they may not want hear as loud as you do
 - While moving in traffic, you should hear the sounds of traffic
- Use hearing protectors, and carry always them with you!
- Take care childrens hearing

Hearing protectors

– Ear muffs, Headband

- Electronic
- Helmet mounted
- Communication

– Ear plugs

- Semi-inserted plugs
- Musicians ear plugs
- Personal ear plugs



http://www.youtube.com/watch?v=vke_3G-dTT8

How to prevent noise indoors?

- Discussion & communication
 - Speak normal voice, One speaks at the time
 - Never shout to ear, even though it is fun idea!
- Rooms, halls, corridors
 - Do not run, shout, or slam doors
- Pay attention to noise
 - Is the room acoustically appropriate for hearing and speaking?
 - Is the sound insulation adequate?
 - Is there other noise sources, such as air ventilation, data projectors etc. ?
- Less people in the same room
- Tools to register the noise levels



THE MOST IMPORTANT THINGS ARE SAID WITH LOW VOLUME LEVEL!



Thank you!

