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British Tinnitus Association

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NOISE AND THE EAR

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This leaflet has been written to help you understand more about the effect of noise on your ears and the connection with tinnitus.

Introduction

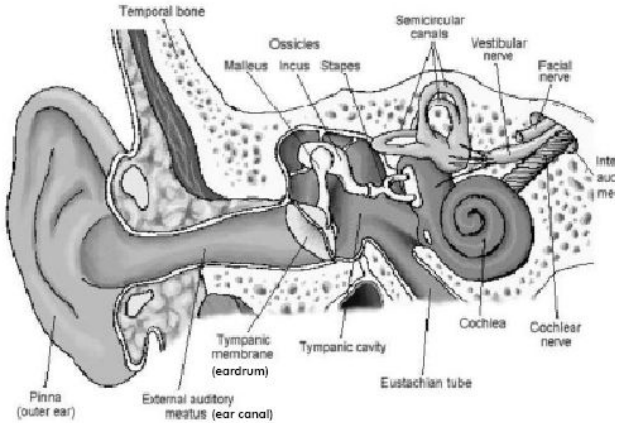
We only have one pair of ears, and they have to last us a lifetime. They are remarkable organs that allow us to hear, and we must take care that the sounds that we expose ourselves to will not cause them harm.

This leaflet will discuss sounds that could potentially damage our hearing as loud noise. Such noise can be unwanted (for example, noise from loud machinery at work) or it could be desired (like listening to music with the volume turned up). You can be exposed to noise at work, or with leisure pursuits (eg loud music, motorcycling, DIY, pubs/clubs). It is important to identify which noise can be damaging to hearing, and how to go about reducing the risk of damage.

The ears

The ear consists of three parts:

1. **The outer ear.** This is the visible part of the ear on the side of the head (called the *pinna*) and the external ear canal that goes inside the head, ending at the eardrum.



This part of the ear channels the sound vibrations into the ear and onto the eardrum.

2. **The middle ear.** This is composed of the eardrum and the three smallest bones in the human body (called the hammer or *malleus*, the anvil or *incus* and the stirrup or *stapes*), which are held in an air filled space in the head. The middle ear helps to boost the vibrations at the eardrum into stronger vibrations that can be better detected by the inner ear. The *stapedial reflex* causes one of the ligaments in the middle ear to tense which helps reduce the intensity of very loud sound.
3. **The inner ear.** The hearing part of the inner ear is called the *cochlea*. This is a fluid filled spiral structure that is pushed on by the stirrup or stapes of the middle ear. The vibrations that are delivered to it are turned into electrical signals by specialised cells called *hair cells*. These electrical signals are then sent along the cochlear nerve to the brain. One of the functions of the hair cells is to amplify quiet sounds. They also try to moderate the signal generated by loud sounds. However, if sounds are very loud, these hair cells can be overwhelmed and may

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end up permanently damaged. This can be by a single loud sound or by repeated exposure to loud sound.

These three parts enable the ear to hear a wide range of pitch of sound and a very wide range of 'loudness' of sound, from the gentle rustling of a leaf to the roaring jet engine of an aeroplane. However, as sounds get louder, there is a risk of these sounds damaging our ears. The risk of damage is associated with the 'dosage' of sound or noise received.

Noise dosage

The 'dosage' of noise exposure is dependent on two main things:

1. the 'volume' or intensity of the noise
2. the time or duration of the exposure to that noise.

The intensity of a noise can be measured by comparing its sound pressure (the change in air pressure caused by the sound) to that of the quietest sound that can be heard. The intensity of sound is measured in decibels (dB). Decibels are what's called a logarithmic unit, and this means that an increase of 3dB in a sound means that the sound intensity is doubled. So a sound of 88dB is twice as intense as a sound of 85dB.

Noise exposures are a combination of the intensity and the duration of the noise exposure. Most international regulations for noise exposure at work state that the loudest noise someone should be exposed to for an 8-hour working day is 85dB - roughly equivalent to a blender, or a milling machine. Now, as we saw before, a 88dB sound is twice as intense as a 85dB sound, so it follows that the maximum exposure duration should be half as much, so 4 hours. This rule of halving the maximum exposure duration for every 3dB increase (so doubling) in sound intensity is true for noises up to around 110-120dB. Above this, even a very short exposure time can be damaging.

Measuring the duration of exposure is quite easy. However, it is hard to measure noise intensity without specialist equipment, so how do you recognise whether noise is loud enough to be damaging?

A table of maximum exposure time for a range of noise intensities before damage may occur

Noise intensity (dB)	Maximum unprotected exposure*	Typical example
85	8 hours	blender, milling machine
88	4 hours	forklift truck
91	2 hours	Tube train
94	1 hour	lawnmower
97	30 minutes	industrial fire alarm
100	15 minutes	bulldozer, handheld drill
103	7½ minutes	mp3 player at full volume
106	3¾ minutes	motorbike
109	112 seconds	crying baby, jackhammer
112	66 seconds	live rock band
115	33 seconds	emergency vehicle siren

* before damage may occur

Identifying loud noise

There is no definitive method to identify whether a noise is loud enough to be damaging without taking a proper measurement, but below are a few 'rules of thumb' to help you identify what is too loud:

1. If you have to shout to be heard by somebody around a metre away, the background noise is loud enough to be potentially damaging. If you can only hear or be heard above the noise when shouting right next to the ear, the intensity is very loud indeed and is even more likely to be damaging your hearing.
2. If you find your hearing is dulled after exposing yourself to noise, then your hearing has been damaged. This may be temporary, but if you expose yourself repeatedly to these situations, the damage may become permanent. You should speak to your GP if concerned (and your human resources if the noise is work related) as you may need a hearing test. If this noise exposure will be repeated, ear protection should be used.
3. If you find a ringing or buzzing in your ears (tinnitus) after exposing yourself to noise, then the noise is likely to have been damagingly loud. Avoiding further exposure is strongly advised, as is speaking to your GP if you are concerned.
4. Use common sense! If a sound is painfully or uncomfortably loud, stop exposure immediately. If you find you are getting a headache, feel uncomfortable,

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or are at all concerned about the intensity of the noise, remove yourself from the situation and the noise exposure.

Consequences

Exposure to loud noise can have consequences for your ears, the most obvious of which is hearing loss. If noise is the suspected cause, this is termed *noise-induced hearing loss*. Exposure to loud noise can damage the hair cells in your cochlea, resulting in a hearing loss at certain frequencies.

The hearing loss can be temporary, and recover within a day or two, or permanent, and not recover at all. Even if the hearing loss is temporary, it should be taken as a warning that permanent damage is likely if this exposure is repeated. Such hearing loss makes it harder to hear the quieter sounds encountered in daily life, and can make it harder to understand speech, particularly in background noise. There is also evidence that noise exposure can damage the nerve fibres that go from the cochlea to the brain, and that this damage doesn't necessarily show up in hearing tests such as an audiogram.

In addition to hearing loss, there are other risks from loud noise exposure. Loud noise exposure can sometimes cause a ringing or buzzing in the ears called *tinnitus*. Sometimes tinnitus goes away after a few minutes or hours after a loud noise exposure. However, sometimes it can persist for weeks, years, or even indefinitely, especially if you have a noise-induced hearing loss.

To avoid such damage, simple steps can be taken to reduce the risk posed by loud noise exposure.

Prevention

There are several practical steps you can take to minimise your risk of damage to your ears caused by loud noise exposure.

1. If possible, remove yourself from the noise, reducing the time of exposure. Stopping your exposure to a noise that you think may be damaging is the best way to avoid problems.
2. If removing yourself from the source of noise isn't possible or practical, make sure you take frequent breaks from the loud noise. This gives your ears a chance to recuperate, and reduces the effect of the loud noise a little.
3. If you are going to be in a noisy environment (eg clubbing) wear hearing protection to reduce the intensity of the noise. Even if you are going to be exposed to a loud noise once (eg a concert), strongly consider wearing hearing protection because you will be exposed for a damaging amount of time. Buy ear plugs or ear defenders that are made for the task from a reputable seller. Cotton wool won't do anything to help! You must use proper hearing protection. For those who enjoy loud music, go clubbing or who are musicians, you can buy specially moulded earplugs that do not affect the balance of the sound. Sometimes audiology departments can arrange for these to be made for a reasonable price.
4. If you are going out, for example to a noisy pub or club, try to limit alcohol consumption and remain well hydrated. Both alcohol and dehydration can make your hair cells in the cochlea more vulnerable to damage.
5. Limit the time and volume when listening to music through earbuds or headphones. As earbuds are placed directly into the ear this can boost the audio signal by as many as 9dB. Larger earmuff-style headphones are to be preferred. Another protective measure is to adhere to the 60/60 rule, which simply put means never turn your volume up past 60%, and only listen to music with earbuds for a maximum of sixty minutes per day. You can also get noise-cancelling headphones which will allow you to listen to music for a longer extension of time, at a much lower decibel level.
6. If you are at work, your employer has a responsibility to protect your hearing and make sure you are not exposed to excessively loud noise. You should be issued with hearing protection if the noises you are exposed to are loud enough to be damaging. You must wear this hearing protection if it is issued.
7. If you are concerned in any way about the effect of noise exposure on your hearing, or about tinnitus, get medical advice. Normally this means speaking to your GP in the first instance. They should be able to help investigate any problems you may be experiencing. Cease loud noise exposure in the meantime if possible.

Summary

This has been only a brief explanation of what loud noise is, its effects on your ears, and how to minimise the risk posed by loud noise exposure. Prevention is much better than treatment. By mitigating the risks fewer people will experience noise-induced hearing loss and tinnitus.

You've only got one pair of ears – look after them!

References

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Alternative formats

This publication is available in large print on request.

For further information

Our helpline staff can answer your questions on any tinnitus related topics on **0800 018 0527.** You may also find our website **takeontinnitus.co.uk** helpful.

BTA publications

Our information leaflets are written by leading tinnitus professionals and provide accurate, reliable and authoritative information which is updated regularly. Please contact us if you would like to receive a copy of any of our information leaflets listed below, or they can be downloaded from our website. *available in Easy Read

- All about tinnitus*
- Balance and tinnitus
- Complementary therapy for tinnitus: an opinion
- Drugs and tinnitus
- Ear wax removal and tinnitus
- Flying and the ear
- Food, drink and tinnitus
- Hearing aids and tinnitus*
- Hyperacusis
- Ideas for relaxation without sound
- Information for musicians
- Musical hallucination (musical tinnitus)
- Noise and the ear
- Otosclerosis
- Pulsatile tinnitus
- Relaxation
- Self help for tinnitus*
- Sound therapy
- Sources of mutual support for tinnitus
- Supporting someone with tinnitus
- Taming tinnitus
- Tinnitus: a parent's guide
- Tinnitus: a teacher's guide
- Tinnitus and disorders of the temporo-mandibular joint (TMJ) and neck
- Tinnitus and sleep disturbance
- Tinnitus and stress
- Tinnitus services*

Leaflets for children:

- Ellie, Leila and Jack have tinnitus (for under 8s)
- Tinnitus (for 8-11 year olds)
- Tinnitus (for 11-16 year olds)
- Ellie, Leila and Jack have tinnitus activity book
- Tinnitus activity book (for 8-11 year olds)
- Tinnitus activity book (for 11-16 year olds)

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