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# [Intervention Review]

# Interventions to prevent occupational noise-induced hearing loss

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# ABSTRACT

#### Background

This is the second update of a Cochrane Review originally published in 2009. Millions of workers worldwide are exposed to noise levels that increase their risk of hearing disorders. There is uncertainty about the effectiveness of hearing loss prevention interventions.

# Objectives

To assess the effectiveness of non-pharmaceutical interventions for preventing occupational noise exposure or occupational hearing loss compared to no intervention or alternative interventions.

#### Search methods

We searched the CENTRAL; PubMed; Embase; CINAHL; Web of Science; BIOSIS Previews; Cambridge Scientific Abstracts; and OSH UPDATE to 3 October 2016.

#### **Selection criteria**

We included randomised controlled trials (RCT), controlled before-after studies (CBA) and interrupted time-series (ITS) of non-clinical interventions under field conditions among workers to prevent or reduce noise exposure and hearing loss. We also collected uncontrolled case studies of engineering controls about the effect on noise exposure.

#### Data collection and analysis

Two authors independently assessed study eligibility and risk of bias and extracted data. We categorised interventions as engineering controls, administrative controls, personal hearing protection devices, and hearing surveillance.

# **Main results**

We included 29 studies. One study evaluated legislation to reduce noise exposure in a 12-year time-series analysis but there were no controlled studies on engineering controls for noise exposure. Eleven studies with 3725 participants evaluated effects of personal hearing protection devices and 17 studies with 84,028 participants evaluated effects of hearing loss prevention programmes (HLPPs).

#### Effects on noise exposure

Engineering interventions following legislation

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One ITS study found that new legislation in the mining industry reduced the median personal noise exposure dose in underground coal mining by 27.7 percentage points (95% confidence interval (CI) -36.1 to -19.3 percentage points) immediately after the implementation of stricter legislation. This roughly translates to a 4.5 dB(A) decrease in noise level. The intervention was associated with a favourable but statistically non-significant downward trend in time of the noise dose of -2.1 percentage points per year (95% CI -4.9 to 0.7, 4 year follow-up, very low-quality evidence).

# Engineering intervention case studies

We found 12 studies that described 107 uncontrolled case studies of immediate reductions in noise levels of machinery ranging from 11.1 to 19.7 dB(A) as a result of purchasing new equipment, segregating noise sources or installing panels or curtains around sources. However, the studies lacked long-term follow-up and dose measurements of workers, and we did not use these studies for our conclusions.

# Hearing protection devices

In general hearing protection devices reduced noise exposure on average by about 20 dB(A) in one RCT and three CBAs (57 participants, low-quality evidence). Two RCTs showed that, with instructions for insertion, the attenuation of noise by earplugs was 8.59 dB better (95% CI 6.92 dB to 10.25 dB) compared to no instruction (2 RCTs, 140 participants, moderate-quality evidence).

#### Administrative controls: information and noise exposure feedback

On-site training sessions did not have an effect on personal noise-exposure levels compared to information only in one cluster-RCT after four months' follow-up (mean difference (MD) 0.14 dB; 95% CI –2.66 to 2.38). Another arm of the same study found that personal noise exposure information had no effect on noise levels (MD 0.30 dB(A), 95% CI –2.31 to 2.91) compared to no such information (176 participants, low-quality evidence).

# **Effects on hearing loss**

# Hearing protection devices

In two studies the authors compared the effect of different devices on temporary threshold shifts at short-term follow-up but reported insufficient data for analysis. In two CBA studies the authors found no difference in hearing loss from noise exposure above 89 dB(A) between muffs and earplugs at long-term follow-up (OR 0.8, 95% CI 0.63 to 1.03), very low-quality evidence). Authors of another CBA study found that wearing hearing protection more often resulted in less hearing loss at very long-term follow-up (very low-quality evidence).

#### Combination of interventions: hearing loss prevention programmes

One cluster-RCT found no difference in hearing loss at three- or 16-year follow-up between an intensive HLPP for agricultural students and audiometry only. One CBA study found no reduction of the rate of hearing loss (MD –0.82 dB per year (95% CI –1.86 to 0.22) for a HLPP that provided regular personal noise exposure information compared to a programme without this information.

There was very-low-quality evidence in four very long-term studies, that better use of hearing protection devices as part of a HLPP decreased the risk of hearing loss compared to less well used hearing protection in HLPPs (OR 0.40, 95% CI 0.23 to 0.69). Other aspects of the HLPP such as training and education of workers or engineering controls did not show a similar effect.

In three long-term CBA studies, workers in a HLPP had a statistically non-significant 1.8 dB (95% CI –0.6 to 4.2) greater hearing loss at 4 kHz than non-exposed workers and the confidence interval includes the 4.2 dB which is the level of hearing loss resulting from 5 years of exposure to 85 dB(A). In addition, of three other CBA studies that could not be included in the meta-analysis, two showed an increased risk of hearing loss in spite of the protection of a HLPP compared to non-exposed workers and one CBA did not.

#### Authors' conclusions

There is very low-quality evidence that implementation of stricter legislation can reduce noise levels in workplaces. Controlled studies of other engineering control interventions in the field have not been conducted. There is moderate-quality evidence that training of proper insertion of earplugs significantly reduces noise exposure at short-term follow-up but long-term follow-up is still needed.

There is very low-quality evidence that the better use of hearing protection devices as part of HLPPs reduces the risk of hearing loss, whereas for other programme components of HLPPs we did not find such an effect. The absence of conclusive evidence should not be interpreted as evidence of lack of effectiveness. Rather, it means that further research is very likely to have an important impact.

# PLAIN LANGUAGE SUMMARY

#### Interventions to prevent hearing loss caused by noise at work

# What is the aim of this review?



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The aim of this Cochrane Review was to find out if hearing loss caused by noise at work can be prevented. Cochrane researchers collected and analysed all relevant studies to answer this question. They found 29 studies that studied the effect of preventive measures.

#### Key messages

Stricter legislation might reduce noise levels. At the personal level, earmuffs and earplugs can reduce noise exposure to safe levels. However, instruction on how to put plugs into the ears is needed. Without instruction earplugs probably do not protect enough. Providing feedback to workers on noise exposure probably does not decrease noise. Engineering solutions such as better maintenance might lead to similar noise reduction as hearing protection. Better evaluation of these engineering solutions is needed.

The effects of hearing loss prevention programmes (HLPP) are unclear. Better use of hearing protection as part of a programme probably helps but does not fully protect against hearing loss. Improved implementation might provide better protection.

#### What was studied in the review?

Millions of workers are exposed to noise that can lead to hearing loss. The review authors were interested in the effect of any intervention to reduce noise or hearing loss at workplaces, such as engineering solutions, hearing protection or hearing loss prevention programmes.

#### What are the results of the review?

# Effects on noise exposure

#### Engineering solutions

We found one study that showed that noise levels decreased by about 5 decibels (dB) after the implementation of stricter legislation in the mining industry. Even though many case studies show that technical improvements can reduce noise levels at workplaces by as much as 20 dB, there were no controlled studies outside the laboratory that would show this with more confidence.

#### Hearing protection

In eight studies with 358 workers, hearing protection reduced noise exposure of workers by about 20 dB(A). However, for earplugs there was moderate-quality evidence in two randomised studies that if workers lack proper instructions in the use of earplugs, the attenuation offered is reduced by on average 9 dB.

#### Feedback on noise exposure

Providing feedback on noise exposure did not change noise levels in the construction industry in one study.

#### Effects on hearing loss

We found 16 studies with 81,220 participants on the long-term effects of hearing protection on hearing loss.

#### Hearing protection

The use of hearing protection devices in a well-implemented HLPP was associated with less hearing loss. For other elements of programmes such as worker training, audiometry alone, noise monitoring, or providing feedback on personal noise exposure, there was no clear effect. Two studies with 3242 workers found that there was no difference in the long-term effect of earmuffs versus earplugs on hearing loss.

#### Hearing loss prevention programmes

Four studies provided very low-quality evidence that, compared to non-exposed workers, average HLPPs do not reduce the risk of hearing loss to below a level at least equivalent to that of workers who are exposed to 85 dB(A). Two comparable additional studies showed that the risk of hearing loss is still substantial despite being covered by a HLPP. However, one low-quality study showed that a stricter HLPP can protect workers from hearing loss.

The absence of conclusive evidence should not be interpreted as evidence of lack of effectiveness. Rather, it means that further research is very likely to affect the conclusions we reached. Higher-quality prevention programmes, better quality of studies, especially in the field of engineering controls, and better implementation of legislation are needed to prevent noise-induced hearing loss.

# How up to date is this review?

The review authors searched for studies that had been published up to October 2016