Noise Induced Hearing Loss in Metal Workers in Pokhara, Nepal

Student ID: 930040
(Josh Whittaker)
Supervisors: Mr Mike Smith (ENT consultant, Hereford), Mr Aanand Acharya (ENT SpR, UHB), Dr George Dowswell (Department of Primary Care, University of Birmingham), Eka Dev Devkota (INF camp co-ordinator, Pokhara, Nepal)

Keywords
Noise induced hearing loss, occupational noise, metal workers, Nepal.

Introduction
Sound is generated by changes in air pressure levels. Pressure is measured in Pascals (Pa). The loudness of the sound is determined by the amplitude of the pressure wave – the greater the amplitude the louder the sound. The human ear can detect pressure changes from 20μPa to 200Pa. The loudness of the sound is determined by converting pressure to a logarithmic scale called decibels (dB). A-weighted sound pressure level (L_a) is a measure of sound level as applied to the spectrum to which human ears are sensitive (units are dBA).¹

Hearing thresholds in humans are usually measured in Decibels Hearing Loss (dBHL) – this measurement is based upon the comparison of an individual’s hearing threshold with an agreed ‘normal’ hearing threshold. Hearing impairment is generally described in the literature as a biural average of >25dBHL over frequencies between 1 to 4 thousand hertz (kHz). The World Health Organisation (WHO) definition corresponding to a “quantifiable burden of disease” is set at >40dBHL averaged over 0.5, 1, 2 and 4 kHz.²

Noise is undesired sound. Prolonged exposure to loud noise can result in a permanent hearing loss. Noise can be produced during any activity of daily living although prolonged exposure to noise below 80dBA poses negligible risk to hearing in adults.³ However, certain occupations have a higher average noise exposure level. Occupational noise exposure is measured using an A-weighted equivalent level averaged over eight hours (L_Aeq).¹

The WHO defines a L_Aeq of 85-90 dBA as moderately high and greater than 90 dBA as high noise exposure.⁴ Studies have shown a strong association between the magnitude and duration of occupational noise and the risk of developing noise-induced hearing loss (NIHL).⁵,⁶,⁷,⁸ The WHO global assessment of occupational noise assumes that, because hearing conservation programmes (HCPs) are rare in developing countries, 5% of production workers are exposed to 85-90dBA while the remaining 95% are exposed to greater than 90dBA.⁹ Global estimates of excess risk for hearing impairment at a daily exposure level of 90dBA increases with age and years of exposure from 5.4% (aged <30; <10 years exposure) to 24.7% (aged 60; >10 years exposure).¹⁰

NIHL is permanent and progresses with continued exposure. The WHO correlates moderate impairment of >40dBHL as being “able to hear and repeat words using a raised voice at 1m”.¹¹ The personal consequences of NIHL include:

- Social isolation
- Impaired communication within the workplace and in the wider community
- A decreased ability to monitor surrounding and increased injury risk
- Anxiety, irritability and low self-esteem.

Consequences for employers include a loss of productivity and expenses for compensation and hearing aids.¹² Nepal has a population of approximately 30 million with 64% of these over the age of 15 (approximately 19.2 million).¹³ Previous audiometric surveillance of over 15,000 Nepali adults exposed to all variety of noise levels, found an age-standardised prevalence of hearing impairment (>25dBHL) of 15.3%, while 8.7% had a disabling hearing loss (>40dBHL). This was the third highest rate in the world at the turn of the century, and Nepal had the highest prevalence of hearing loss >60dBHL of any country surveyed.¹⁴ Although there is no specific data for Nepal on how much of this is NIHL, within the WHO sub-region South East Asia Region-D (SEAR-D)(in which Nepal is included), 16% of adult-onset hearing loss can be attributed to occupational noise exposure (24% in men, 9% in women).¹⁰ Compare this to the UK, where at the same time the prevalence of hearing impairment >25dBHL and >40dBHL was 11.8% and 4.0% respectively¹⁴ and the percentage attributable to occupational noise within the WHO sub-region was 9%.¹⁰

Other research into NIHL in Nepal is rare. A literature search only identified one study. This was carried out in Kathmandu and included a questionnaire-based assessment of the health-related ill effects of environmental noise and a small retrospective cohort study (36 cases, 25 controls), comparing those exposed to environmental noise >70dBA with those exposed to <55dBA. The significant odds ratio was 4.2, demonstrating a substantial risk of developing NIHL in those exposed to higher noise levels in Nepal. When adjusted for occupational noise the study demonstrated a slightly lower significant odds ratio of 4.0. The difference between odds ratios may suggest that within the general population the clinical
effect of occupational noise on NIHL risk is minimal. However, this does not mean that within occupations with high noise exposure it is not a significant contributor to NIHL.\textsuperscript{3}

In western countries and certain industrialising Asian nations noise permissible exposure level (PEL) legislation has been implemented. This includes neighbouring India and China, for which both have set a $L_{Aeq,8h}$ of 90dBA.\textsuperscript{15} In the UK the “Control of Noise at Work Regulations 2005” set the PEL at 87dBA or a peak of 140dBA.\textsuperscript{16} In Nepal there are no such regulations in place to monitor and regulate occupational noise exposure or to dictate HCPs.\textsuperscript{15} As such there is a need for research into occupational noise exposure levels and the prevalence of NIHL in all subsectors of employment within Nepal. The proposed study will be the first to examine the audiometric effect of occupational noise on hearing within Nepal. The result of the study would provide objective evidence for the relative merits of developing a Hearing Conservation Programme and Occupational Health and Safety legislation regarding Permissible Exposure Levels in Nepal.

**Primary Aim and Objectives**

- To examine the effect of occupational noise exposure on hearing within the study population in Pokhara, Nepal.
  - To determine and compare prevalence of NIHL within metal workers and non-metal workers in Pokhara.
  - To determine the occupational noise exposure at the workplace in a variety of industries in Pokhara.

**Design**

This will be a quantitative cross sectional study. Depending upon participation numbers included and a complete assessment of confounding factors it may be possible to conduct post-hoc matching of participants however this will not become apparent until data collection is completed and can be accounted for during the analysis of the final write-up.

**Setting**

The study will be conducted in Pokhara, Nepal. Pokhara is the second largest city in Nepal with 300,000 inhabitants, made up of predominantly of Brahman, Gurung and Chhetri ethnicities. There are also two Tibetan refugee villages north and south of the city. Sitting at the base of the Annapurna Mountain range, tourism and trekking is the major industry here, receiving over 74,000 tourists annually\textsuperscript{17}.

**Population**

There are just over 31,000 valid registered cottage and small industries in manufacturing in Nepal, this includes workshop metal working.\textsuperscript{18} Within Nepal exact numbers employed within the industry sector are unknown, and it is hard to apply known figures from India and China due to the economic differences between the countries. In Pokhara itself, there are 2650 registered small to medium scale industries consisting of 87 types. These employ just over 21,000 of the cities inhabitants.\textsuperscript{17} Metal working here is conducted in small workshops consisting of 4-5 workers each.

**Sample and Recruitment**

Initial contact with workers and employers will be facilitated by the International Nepal Fellowship (INF) as well as via letter correspondence. Access to participants will either be done through the employer (which in some cases will be the worker themselves) or a trade organisation. All participants at each workplace will be invited to participate in the study in the same way. It is anticipated that a minimum of 40 metal workers working across 15 workshops in Pokhara city will be included in the study. This population will be compared with 80 workers from the same geographical area who are employed in industries where the workplace is associated with noise exposure levels below that deemed to be significant for a risk of NIHL by WHO standards (<80dBA).\textsuperscript{4}

Exclusion criteria include:

- Congenital Hearing loss (HL) (onset before exposure to occupational noise or <15 years old)
- Bilateral outer or middle ear inflammation on otoscopy (in cases of unilateral outer or middle ear inflammation data will only be included from the uninflammed ear)
- aged <15 years

Some of these may only be able to be applied after stage 1b of the participant assessment (see below).

**Method**

**Participant assessment.** This will be conducted in a quiet environment as convenient to the workplace as possible. If necessary the assessment will be done outside of the workplace or the participant will be invited to attend assessment at the INF head office in Pokhara. To limit the effect of Temporary Threshold Shift (TTS), a phenomenon that causes changes in hearing thresholds for minutes to hours after exposure to high amplitude noise, participants will be provided with 30 dBA...
ear protection to be worn while working for 48 hours prior to assessment, in accordance with the UK assessment regulations.  

Stage 1(a). All participants will be consented (see below). A questionnaire will be completed through a translator with the purpose of examining for the presence of any confounding factors and to establish further details relating to the subjects’ exposure to occupational noise (particularly frequency and duration). The questionnaire design is based on UK OHS guidelines for assessment. The questionnaire will be completed by the researcher to ensure consistency in data collection. The findings of the clinical examination (see below) will also be recorded on the questionnaire in order to minimise accidental loss of data.

(b). An otoscopic examination will be performed following the guidance of the British Society of Audiology (BSA), to exclude the presence of pathology prior to audiometric assessment. Exclusion criteria will be applied at this point.

(c). An air conduction pure tone audiogram (PTA) will be performed on every participant at 0.5, 1, 2 and 4 kHz. A portable sound level meter will be used to monitor ambient noise and if this should exceed 35dBA then the examination will stop until such time as the ambient noise level reduces to the satisfactory level as set by the BS EN ISO standards. If the average hearing threshold over the four frequencies for either ear is >25dBHL then the participant will be entered to stage 2. See analysis for the outcomes recorded.

Stage 2. Qualifying participants will have three further audiometric criteria applied.

1. Air-conduction audiometry at 3kHz, 6kHz and 8kHz to identify the profile of the hearing loss. A peak hearing threshold between 3 and 6 kHz will be used to define presence NIHL.
2. Bone-conduction audiometry will be performed at 1, 2 and 4 kHz to identify the presence of an air-bone gap. An air-bone gap >20dBHL indicates the presence of a conductive hearing loss and the participant’s ear will be excluded.
3. A participant with asymmetry between ears of >20dBHL without presence of other exclusion criteria will also be excluded for practicality issues.

Workplace assessment

The ambient noise level at the workplace of each participant will be assessed using a portable sound level meter which quantifies LNeo. The meter will be placed approximately one metre from the principle noise emission (hammer hitting metal) at head height in each working location. A measurement of the average and peak A-weighted sound level over a hour period will be taken. Data from the occupational history will provide the average working time of the participant during the week. From these measures the LNeo,8h of the participant will be calculated. In circumstances when there is no obvious principle noise emission location the noise levels will be taken at head height one metre from the worker in their working environment.

The audiometer (Ampilvox 260) will be calibrated by qualified technicians from the audiology department at Hereford hospital prior to their use and routine checks will be made on a daily and weekly basis in accordance with the BSA guidelines. The Sound level meter will also be calibrated by qualified technicians and routine checks will be made in accordance with UK ‘control of noise at work regulations’.

Sample size

The previous study of 61 subjects in Kathmandu, Nepal, within groups exposed and non-exposed to environmental noise >70 dBA found an overall prevalence of NIHL of 13.5%. This figure can be used as the expected prevalence in the non-metal worker group, as it is the best estimate of the rate of NIHL in the general population. There is no comparable data for those exposed to levels >85dBA (expected exposure level in metal workers). The prevalence of NIHL in the same study in the exposed group (>70dBA) of 39.3% can be used as a minimal estimate of prevalence likely in metal workers. The study expects access to only 40-50 metal workers so a 2:1 sample size ratio of metal workers to non-metal workers will increase the ability to detect the expected difference in prevalence. Minimum samples of 40 and 80 participants respectively will give the study a power of 0.82. It may be feasible to recruit more numbers than this, in which case the power of the study will increase further. For example, samples of 50 and 100 will give the study a power of 0.9.

Analysis

Data collected

- Demographic and occupational history variables from questionnaire (Appendix 1).
- NIHL status as defined by presence of a ‘notch’ configuration between 3 and 6 kHz on air-conduction audiometry.
- LNeo,8h and peak LNeo for participants from their respective workplace assessments
- Continuous audiometric data:
  - 1) Biaural average hearing threshold at 0.5, 1, 2 and 4 kHz calculated across both ears of all subjects.
  - 2) Biaural average peak hearing threshold between 3kHz and 6kHz if presence of NIHL is indicated.
Analysis Plan

Data gathered will be entered into a customised excel spreadsheet before using SPSS version 19 for conducting analysis. Where one ear is excluded for pathology or significant air-bone gap then the data from remaining ear will be used for that participant. If both ears are excluded (asymmetry or bilateral pathology) then the participant will be excluded.

Continuous noise level data and audiometric data will be converted into ordinal categorical groups, for example average hearing threshold will be converted into hearing impairment >25dBHL and >40dBHL (both of these groups are widely recognised outcomes in NIHL research). Descriptive techniques will be employed to explore the population demographics and the prevalence of the outcomes with 95% confidence intervals (CIs). The proportions of categorical outcomes in the metal and non-metal worker groups can then be compared for significant differences using chi-squared testing. Simple odds ratios can estimate the strength of the association (with 95% CIs). The raw continuous data, such as average and peak hearing thresholds and L_{Aeq,8h} of the workplace, will be compared between the two groups after testing for normality using Shapiro-Wilks test (Kolmogorov-Smirnov if sample becomes large enough). If normally distributed then independent sample t-tests will be employed to determine a significant difference. If non-normally distribution then Man-Whitney testing will be employed. Multiple Regression analysis may be possible to examine whether independent variables collected in the questionnaire can predict hearing loss as a complication of occupational noise exposure.

Ethical Approval

The principal researcher has submitted an application for ethical approval to the Nepal Health Research Council, in addition to the INF Research Ethics Committee, who will be facilitating the research and liaising between the study and other parties in Nepal. Approval will also be sought from the University of Birmingham Internal Ethics Review Committee.

Poor literacy in Nepal has lead to concerns that written consent may not be valid. Where necessary the content of the consent form (appendix 2) will be explained via the translator and the participant will be asked if they wish to sign or verbally consent. The translator will be asked to sign to recognise that the participant has understood and consented in this way, having signed a confidentiality agreement prior to the start of data collection (appendix 3). Where necessary to refer participants on to further care, their consent will be sought for confidentiality breach of their personnel details only and arrangements will be made through the INF. It is anticipated that potential participants will attend a presentation that will discuss the aims of the study and the processes involved, and allow them the opportunity to ask questions of the researcher.

Permission will be sought from employers’ to access the workplace for the purpose of the workplace assessment. In this study the employers and the place of work will remain anonymised, thereby protecting individual employers from adverse consequences as a result of the study findings – only the type of industry and their ambient sound levels will be recorded on the data collection sheet. Employers’ will be provided written information on the study in advance by letter correspondence (appendix 4) and via contact by the INF.

Study data will be coded to a participant list. The study data and the participant list will be kept separately in secure locations at the INF head office in Pokhara. Data transferred to the laptop will be secured with password protection and a backup store will be made on a password protected USB drive.

Upon completion of the study the result will be summarised, translated into Nepali and disseminated amongst the local authorities in Nepal for the benefit of the local population. The results will be placed in the public domain via the BMedSci research website and through any potential publications in ENT or occupational health journals.

Feasibility

The INF has facilitated similar research projects over the last 3 years. They have an established network of contacts within the community in Pokhara that will facilitate access to the study groups. The INF in Nepal have confirmed access to a minimum of 40 metal workers, of which a number have already been contacted. Translators will be arranged through the INF. The audiometer and otoscopy equipment is provided by the INF. The INF will be able to provide one sound level meter suitable for monitoring the noise level during audiometric assessment. An additional sound level meter with suitable integrating functions will be sourced by the study for workplace assessment.

Participant assessment is estimated to take between 20 and 35 minutes depending on stages required. This equates to a maximum of 87 hours data collection which will be feasible within the period allocated (four weeks).

A resource costing and Gantt chart of the proposed timetable is provided in the Appendix.

Acknowledgements

All my supervisors for their continuing support. Dr Lesley Roberts and Julie Shore for their help throughout the initial stages of planning my research project. Richard Bagshaw for discussions relating the methodology and practicality. Dr
Steve Sadhra for assistance with measurement techniques. The audiology departments at Worcester Royal and UHB hospitals for ENT training. Finally, Tim Robinson for methodological discussions and future collaboration in data collection.

Appendix 1. Questionnaire/Data Collection Sheet

**Data Collection Format**

<table>
<thead>
<tr>
<th>Participant Study ID number</th>
<th>Participant Workplace ID number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.1 Age 

2.1 Gender 
- Male
- Female

3.1 Smoking Status 
- Yes
- No

3.2 Pack-years

4.1 Current occupation

4.2 Length of time in this occupation

4.3 Typical working time
- Days/week
- Hours/day

4.4 Typical start time
- Typical end time
- Typical break time

4.5 Ear Protection used 
- Yes
- No

4.6 Previous occupations
- 1
- 2
- 3
- 4
- 5

Ear protection? (Tick) Time in each – years, d/w, h/d.
5.1 Previous close exposure to any loud noise  
   eg gunfire/blasts/explosions | Yes  |  |  |  |  |  
   | No  |  |  |  |  |

5.2 Exposure frequency (circle) | Once | Occasional | Intermittent | Regular | Consistent |

6.1 Hearing loss prior to starting work | Yes  |  |  |  |  |  
   | No  |  |  |  |  |

6.2 Age of onset |  |  |  |  |  |  

6.2 Age of onset |  |  |  |  |  |  

7.1 Ear symptoms in the last six weeks – ear pain, discharge, temperature | Yes  |  |  |  |  |  
   | No  |  |  |  |  |

7.1 Ear symptoms in the last six weeks – ear pain, discharge, temperature | Yes  |  |  |  |  |  
   | No  |  |  |  |  |

8.1 Signs of pathology on Otoscopic examination and any exclusions for pathology
Including presence of: Perforation / Inflammation / Wax / Foreign bodies / Discharge / Middle ear fluid
Final Dataset of Participant

Average dBHL for participant:

NIHL: Yes / No

Peak dBHL of NIHL:

Workplace $L_{Aeq,8h}$:

Workplace Peak dBA:

Key:

Air conduction, masked if necessary
Bone conduction, not masked
Bone conduction masked
Uncomfortable loudness level

Right | Left
--- | ---
0 | X
△ | △
□ | □
▌ | ▌
Appendix 2. Participant Consent Form

Participation Consent Form

In many countries around the world, occupational noise has been shown to contribute significantly to hearing loss. This type of noise induced hearing loss has considerable effects on the standard of living of those that suffer from it. The World Health Organisation recognises hearing loss in the top 10 causes of disability around the world.

For this reason many countries have put in place guidelines to regulate the amount to noise people can be exposed to while at work. This study aims to establish whether workers in Nepal have the same risks of noise induced hearing loss in workplaces with a high noise level. In doing so we may be able to provide some evidence to support the generation of regulations that protect the hearing of those working in potentially noisy jobs.

The way we aim to do this is to assess the hearing of workers in various occupations in Pokhara, Nepal, and also assess the noise level within their workplaces. By agreeing to participate in this study we are asking you to give up half an hour of your time and undergo a hearing assessment. This assessment will involve answering some questions about your work and questions relating to any previous things that may have caused hearing loss. We will require looking into your ears using a small scope and then for you to undergo audiometric assessment. This is a non-invasive test that requires you to wear some headphones and listen to some noises, telling the assessor when you can hear the noise played into the headphones.

All results gathered during the assessment will be kept completely anonymous and secure in the INF head office in Pokhara. Your employers will not have any access to results. Anything told to the researchers or translator during the assessment is confidential and as such will not be disclosed to any third party unless permission is given to do so. If a hearing problem is discovered in yourself we will ask you if you want us to put you in contact with health services that may be able to provide you with further care.

If you agree to participate now, you may still withdraw your consent at any point in the future. If you have any further questions please direct them to the researchers.

Consent gained (tick): Written ☐ Verbal ☐

I understand the above passage and consent to assessment as part of this study.

Participant Study ID number.................................................................................................................................

Signed............................................................................................................................................................................. Date..............................
The above was explained to the participant, they understood what they were told and gave verbal consent to assessment as part of this study.

(Translator) Signed........................................................................................................... Date........................................
Translator Confidentiality Agreement

As part of this study the researchers will require a translator to facilitate the assessment of participants. For this an ability to translate from English to Nepali is required.

In agreeing to translate, we require you to maintain confidentiality of any information given by the participant during the assessment. We will require translation of all that is said by the participant during the assessment. If you are at any point uncomfortable with this role then please inform the researcher.

We also ask that when the participant is unable to read the consent form that you explain it to them in Nepali and ensure they understand what is stated within it. In such circumstances the participant will be asked if they then would like to sign the form themselves. Alternatively, if verbal consent is acquired we will require you, as a third party, to sign the consent form to acknowledge that the participant has given verbal consent.

I agree, in my role as translator, to maintain confidentiality of any information translated during the assessment. I also agree to provide acknowledgment that verbal consent acquired is valid by signing the participants’ consent form.

Translator name..............................................................................................................

Signed...............................................................................................................  Date............................................
Appendix 4. Letter to Employers

Dear Sir/Madam

Nameste

As you may or may not be aware between January and April 2012, students from the University of Birmingham, England, are travelling to Pokhara, Nepal, to conduct a small study in conjunction with the International Nepal Fellowship (INF). In previous years this partnership has conducted very successful and well run studies in the schools in the area. This year the researchers are interested in the adult population within Pokhara.

The research to be conducted this year will investigate the effects of noise in the workplace on hearing ability of the workers. As such the research team will be conducting hearing assessments of workers in a wide variety of jobs within Pokhara. Noise induced hearing loss has been shown by research in other countries to be linked to an increase in work related injuries, decreased productivity and increase costs through compensation payments and hearing aid provision.

As the employer we are writing to you to request that we may enter the workplace which you are responsible for and from which some of your employee may be invited to participate in the study. The purpose of this would be to measure the ambient sound levels of the working environment of the participants. This is an important measurement in the study and we would be very grateful for your co-operation. As part of the study we will also be providing your employees with ear protection for use during prior to assessment but that they will be able to keep for use after if they wish to.

All data collected about the participant’s workplace will be anonymised. The only data connected to the individual employee will be the type in occupation and the ambient noise level in which they work. In such a way there will be no negative consequences for yourselves from the findings of the study.

If you have any queries please do not hesitate to contact the research team directly or the INF.

We hope to meet you in person in February

Thank you for your time

Yours sincerely

Joshua Whittaker and Tim Robinson
Principal Researchers, University of Birmingham
E-mail: JDW840@bham.ac.uk
Appendix 5. Gantt Chart

<table>
<thead>
<tr>
<th>Task</th>
<th>Weeks (commencing week beginning Monday 16th January 2011)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Final ENT training</td>
<td></td>
</tr>
<tr>
<td>Familiarisation</td>
<td></td>
</tr>
<tr>
<td>Recruitment</td>
<td></td>
</tr>
<tr>
<td>Data Gathering</td>
<td></td>
</tr>
<tr>
<td>Data Entry</td>
<td></td>
</tr>
<tr>
<td>Analysis and Write up</td>
<td></td>
</tr>
<tr>
<td>Poster Presentation</td>
<td></td>
</tr>
</tbody>
</table>

Appendix 6. Resources and Costing

<table>
<thead>
<tr>
<th>Resource</th>
<th>Approximate Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flights</td>
<td>£560</td>
</tr>
<tr>
<td>Accommodation</td>
<td>£250</td>
</tr>
<tr>
<td>Data sheet printing</td>
<td>£50</td>
</tr>
<tr>
<td>Ethical approval fee</td>
<td>£63 (US$100)</td>
</tr>
<tr>
<td>Visa (2x 30 day)</td>
<td>£50 (US$80)</td>
</tr>
<tr>
<td>Translator</td>
<td>£126 (US$200)</td>
</tr>
<tr>
<td>Sound level meter hire</td>
<td>£100</td>
</tr>
<tr>
<td>Ear protectors</td>
<td>£8</td>
</tr>
<tr>
<td>Total</td>
<td>£1207 (US$1915)</td>
</tr>
</tbody>
</table>
References


4 Concha-Barrientos, M; Campbell-Lendrum, D; Steenland, K. p10.

5 Arndt, V; Rothenbacher, D; Brenner, H; Fraisse, E; Zschenderlein, B; Daniel, U; et al. Older workers in the construction industry: results of a routine health examination and five-year follow up (1996). In Concha-Barrientos, M; Campbell-Lendrum, D; Steenland, K. p6.


7 Hessel, P. Hearing loss among construction workers in Edmonton, Alberta, Canada (2000). In Concha-Barrientos, M; Campbell-Lendrum, D; Steenland, K. p6.

8 Palmer, K; Pannett, B; Griffin, M. Occupational exposure to noise and hearing difficulties in Great Britain (2001). In Concha-Barrientos, M; Campbell-Lendrum, D; Steenland, K. p6.

9 Concha-Barrientos, M; Campbell-Lendrum, D; Steenland, K. p13.


12 Concha-Barrientos, M; Campbell-Lendrum, D; Steenland, K. p4.

13 World Bank: Development indicators and global development finance (accessed 10/11/11)


26 Concha-Barrientos, M; Campbell-Lendrum, D; Steenland, K. p21.