The prevalence of noise-induced hearing loss among Tanzanian miners

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Background
Tanzania has a young mining history with several operating open pit and underground mines. No prevalence studies of noise-induced hearing loss (NIHL) have been conducted among mine workers to provide an impetus for the development of comprehensive hearing protection programmes.

Aims
To determine the prevalence of NIHL and associated factors among miners in a major gold mining company operating in Tanzania. Associated risk factors such as age, sex and duration of exposure were examined.

Methods
Audiograms obtained from periodic medical examinations were categorized using the UK Health & Safety Executive system.

Results
A total of 246 audiograms were studied. The prevalence of NIHL was 47%, with 12% with poor hearing and 35% with mild hearing impairment. The proportion of NIHL increased with total years of exposure to noise. Underground miners were more affected (71%) than open pit miners (28%). These findings were statistically significant. The highest proportion of miners with NIHL (60%) was among the youngest age group (20–29 years).

Conclusions
There was a high prevalence of NIHL in the company under study. There was a strong correlation with type of mining, age and years of exposure. The findings have been used to develop comprehensive hearing conservation programmes.

Key words
Exposure duration; HSE categorization; noise-induced hearing loss; mining; presbycusis.

Introduction

The mining industry contributes significantly to Tanzania’s foreign exports, direct foreign investment and the country’s gross domestic product [1]. Within this industry the greatest risks to health are from silica and noise exposure. The Tanzania Mining Act 2010 set an occupational exposure limit for noise at 85 dB(A) [2]. The Tanzania Occupational Health and Safety Act require employers in all industries to conduct periodic occupational medical examinations but there are no government data on miners’ exposure to hazardous noise [3].

A few African countries have prevalence studies of noise-induced hearing loss (NIHL) to draw from. In a Ghanaian gold mine study, 23% had a ‘notch’ in the audiogram at 4kHz [4], while in a South African mining workforce, 22% had NIHL [5]. Data suggest that males are most affected by the condition [6] and that age is an important confounder for hearing loss. An in-depth analysis showed that the prevalence of NIHL varied according to diagnostic criteria applied and the age group tested [7]. A South African study showed no cases in the youngest age group but a prevalence of 22% in workers aged 58 and over [5]. A similar study in Zimbabwe with a prevalence of 27% found 60% of cases in the oldest group (50 and over) and the lowest prevalence (5%) among the youngest (age 20–29) [8]. Another South African study found the highest degree of hearing deterioration among miners aged over 50 [9].

The Zimbabwean study showed that those most affected had >20 years’ service [8]. The South African study also showed an increase in hearing deterioration with longer service [9]. In a Nigerian study miners with prior exposure had a higher prevalence of hearing loss [10].
Among Zambian miners with >20 years’ experience 23% suffered total hearing loss [11].

To date no studies have investigated NIHL in Tanzanian miners. This study therefore sought to ascertain the prevalence of NIHL and evaluate associated factors such as age, sex and duration of exposure.

Methods

This was a cross-sectional study examining existing periodic audiograms of employees of a Tanzanian mining company to determine the prevalence of NIHL. Half the sample was drawn from an open pit mine and the other from an underground mine using a stratified random sampling technique. There are significant differences in noise exposure between open pit and underground mines. Industrial hygiene data from the company concerned show significant exposures to noise in some similar exposure groups (Table 1).

Tanzanian legislation offers no guidance on categorization of workers’ audiograms and there are no normative data on hearing for the Tanzanian population. Cases were therefore identified and categorized using the UK Health & Safety Executive (HSE) system for categorizing audiograms in noise-exposed populations (Table 2) [12]. This does so according to the sum of hearing at 1, 2, 3, 4 and 6 kHz. Although criticized, the HSE system also allows for the identification of other forms of hearing loss [13].

All audiograms were produced by Interacoustics model AS216 audiometers calibrated to the British standard BS EN 60445-1. The audiometry booths were calibrated according to the South African standard SANS 10182 and the audiometry testing procedures were based on the South African Standard SANS 10083:2004, which requires the use of a soundproof booth and no exposure to noise for 24 h prior to the test.

### Table 1. Company industrial hygiene data on workplace noise exposures

<table>
<thead>
<tr>
<th>Task designation</th>
<th>Underground 8-h TWA exposure in dB(A)</th>
<th>Open pit 8-h TWA exposure in dB(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jumbo operator</td>
<td>101</td>
<td>Dozer operator</td>
</tr>
<tr>
<td>Jumbo helper/offsider</td>
<td>97</td>
<td>Drill operator</td>
</tr>
<tr>
<td>Jack leg operator</td>
<td>105</td>
<td>Grader operator</td>
</tr>
<tr>
<td>Alimak driller</td>
<td>108</td>
<td>Haul truck operator</td>
</tr>
<tr>
<td>Truck operator</td>
<td>101</td>
<td>Excavator operator</td>
</tr>
<tr>
<td>Long hole driller</td>
<td>95</td>
<td>Water truck operator</td>
</tr>
</tbody>
</table>

### Table 2. HSE categorization scheme based on sum of hearing at 1, 2, 3, 4 and 6 kHz [12]

<table>
<thead>
<tr>
<th>Category</th>
<th>Calculation</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Acceptable hearing ability. Hearing within normal limits.</td>
<td>Sum of hearing levels at 1, 2, 3, 4 and 6 kHz. Compare value with figure given for appropriate age band and gender in standardized tables.</td>
<td>None</td>
</tr>
<tr>
<td>2. Mild hearing impairment. Hearing within 20th percentile, i.e. hearing level normally experienced by one person in five. May indicate developing NIHL.</td>
<td>Sum of hearing levels at 1, 2, 3, 4 and 6 kHz. Compare value with figure given for appropriate age band and gender in standardized tables.</td>
<td>Warning. This means the employee has mild hearing impairment and needs training and counselling on how best to prevent further deterioration. No referral is warranted.</td>
</tr>
<tr>
<td>3. Poor hearing. Hearing within 5th percentile, i.e. hearing level normally experienced by 1 person in 20. Suggests significant NIHL.</td>
<td>Sum of hearing levels at 1, 2, 3, 4 and 6 kHz. Compare value with figure given for appropriate age band and gender in standardized tables.</td>
<td>Referral. This means that the employee has hearing worse than would be expected for their age and referral to an occupational physician, audiologist or an ENT specialist for further evaluation is indicated.</td>
</tr>
<tr>
<td>4. Rapid hearing loss. Reduction in hearing level of 30 dB or more, within 3 years or less. Such a change could be caused by noise exposure or disease.</td>
<td>Sum of hearing levels at 3, 4 and 6 kHz.</td>
<td>Referral. This means that the employee has hearing worse than would be expected for their age and referral to an occupational physician, audiologist or an ENT specialist for further evaluation is indicated. This type of deterioration could be due to noise or disease.</td>
</tr>
</tbody>
</table>
OCCUPATIONAL MEDICINE

Ethical approval was granted by the University of Manchester Centre for Occupational and Environmental Health ethics committee.

**Results**

A total of 246 audiograms were studied. The study population was almost entirely male (98%). The prevalence of NIHL was 47%, with 35% exhibiting mild hearing impairment and 12% poor hearing. The largest proportion of study participants (56%) were in the 30–39 age group (**Table 3**). The largest proportion of participants (41%) had 6–10 years’ exposure and the smallest (18%) had >10 years’ exposure.

Approximately 70% of participants had a history of prior occupational noise exposure and 51% of these had NIHL. This group also had a higher proportion (17%) of individuals categorized as having poor hearing ($\chi^2 = 12$, $P < 0.05$). Only 2 (1%) of the 246 study participants were aware of having had a hearing problem in the past. Among underground miners, 72% had NIHL, 52% with mild hearing impairment and 20% with ‘poor hearing’. Among open pit miners, 22% had NIHL, with 17% having mild hearing impairment and 5% ‘poor hearing’, a statistically significant difference between these two occupational groups ($\chi^2 = 61$, $P < 0.01$ (**Figure 1**)).

The youngest age group (20–29) had the highest proportion with NIHL (60%), followed by those aged 50 and above (50%). The group with the smallest proportion affected was aged 40–49 (32%), although these differences were not statistically significant. The group with >10 years’ exposure was most affected (72%) and also had the highest proportion of individuals with poor hearing (37%) ($\chi^2 = 36$, $P < 0.05$). Eighty per cent of subjects operated mobile equipment as a core duty. Of this group, 41% had NIHL. In the group that did not operate mobile equipment 70% were affected, with 20% exhibiting poor hearing ($\chi^2 = 14$, $P < 0.05$).

**Discussion**

There was a high prevalence (47%) of NIHL among miners in this study with mild hearing impairment in 35% and poor hearing in 12%. A higher proportion of underground workers were affected and the youngest age group had the highest proportion of miners with NIHL.

Among the strengths of the study is that audiograms were taken by qualified technicians using recognized protocols on calibrated equipment. Its limitations, however,
The findings suggest that the Health & Safety Executive audiogram classification system may include hearing loss due to other causes as it ignores the notch.

There was a NIHL prevalence of 51% among those with history of work in a noisy industry compared to 36% among those without. This was similar to the findings of the Ghanaian study by Amedofu et al. [4]. The age distribution was similar to the Zimbabwean study with the greatest number of individuals in the 30–39 age group (56%). There were very few individuals in the over 50 age group, demonstrating that mining in Tanzania is in its infancy. The inference from other data that men are more affected by NIHL may be a result of population bias in an almost all male industry (Table 3).

The finding of a 1% prevalence of a history of pre-existing hearing problems is within the range of external ear infection prevalence found in Berger’s analysis [14], which implied that infections and other disease processes do not contribute significantly to hearing loss in occupationally noise-exposed populations.

Of those affected by NIHL 67% were from the underground mine. This is in keeping with literature documenting greater noise exposure in underground mines. Significantly, more underground miners (71%) had NIHL than open pit miners (22%).

The youngest age group (20–29) had the highest prevalence of hearing impairment (60%). These findings are not consistent with a review of previous literature, in which NIHL prevalence increased with age. However, in the study of South African gold miners, the youngest age group (aged under 29) had a mean pure tone threshold of hearing 2 dB higher than the older 30–39 age group at the frequencies examined [9]. This could be due to the less mechanized mining methods used to induct new and younger miners. Further studies are required to examine this finding as it conflicts with other studies, although the differences in prevalence between age groups were not statistically significant.

The largest proportion of workers had a total exposure of 6–10 years and the smallest (18%) >10 years. Subjects in the Zimbabwean and South African studies had longer durations of exposure [5,8]. There was a greater NIHL prevalence (72%) among those with >10 years’ exposure. There was little difference in NIHL prevalence between those with 1–5 and 6–10 years’ exposure (42 and 40%, respectively). The greatest proportion of those with poor hearing (37%) occurred in subjects with >10 years’ exposure. With the exception of the similar NIHL prevalence between 1–5 and 6–10 years’ exposure these results are consistent with all studies reviewed. The results show a higher NIHL prevalence (70%) among miners not operating mobile equipment, probably because miners who operate mobile equipment as their core duty are exposed to noise of lower intensity (Table 3).

Although the company provides an array of hearing protection devices the high prevalence may suggest poor compliance with their use. The study’s findings highlight the need for comprehensive hearing conservation programmes that involve systematically classifying audiograms leading to a well-defined process to assist workers affected by NIHL, coupled with effective primary prevention measures. If progressive NIHL is to be prevented, clinicians should at every opportunity classify and interpret audiograms so as to ensure appropriate intervention to prevent deteriorating NIHL.

Further studies to verify the finding of the highest prevalence of NIHL in the youngest age group and determine the reasons for this would provide valuable insight. Additional studies to assess miners’ knowledge of NIHL and attitudes to the use of hearing protection would also provide useful information.

**Key points**

- This study found a high prevalence of noise-induced hearing loss among Tanzanian miners, with underground miners affected more than open pit miners.
- The findings suggest that the Health & Safety Executive audiogram classification system can be used to identify noise-induced hearing loss and consequently guide appropriate intervention.
- In industries undertaking periodic audiometry to screen for developing noise-induced hearing loss there is a need to classify audiograms using a simple, practical tool with clear protocols for resulting actions.

**Conflicts of interest**

None declared.

**References**

2. The Mining (Safety Occupational Health and Environment) Regulations 2010, 211(2).
Fifty years ago: ‘Genesis of a New Society’

It was with some surprise that we recently found ourselves taken to task—privately, and in a most gentle and courteous fashion—for our last leading article. The tone of this was clearly favourable to the proposed new constitution, and our critic felt that we should have withheld editorial judgment until the matter had been voted upon; it was also suggested that we went too far in anticipating an affirmative decision. We are unrepentant. An explicit editorial bias on any important issue is surely to be preferred to one which is subtly concealed, and still more to an attempt to avoid polemics altogether which, in the words of a recent Private Member’s motion in Parliament, may result in ‘non-controversial pap’. Our views on such subjects as the war in Vietnam may well be influenced by the editorial attitude of our daily newspaper, because we rely on it for facts as well as opinions; it is improbable that we should accord equal weight to the view that health services at work were an instrument of capitalist exploitation, or a mere fringe benefit of affluent industries, because such statements would run counter to our personal experience.

Hence it can hardly be said either that the majority which voted for the new constitution at the March Special General Meeting of the Association was improperly influenced by our support, or that the minority which opposed the changes—perhaps not all for the same reasons—was hamstrung because of it. We respect the motives of this minority, as well as the force of some of their criticisms; but since no constitution in a dynamic body will ever be perfect, we must expect motions to amend parts of it from time to time, and these will no doubt be forthcoming from the critics—to whom also the correspondence columns of this journal are open.

And so from next October we are to become the Society of Occupational Medicine, a title which for a while will have a strange sound. Two of the Panels (Advisory and Educational) have already started their work, and produced important memoranda which would in the past either have been drawn up by the officers or necessitated the setting up of ad hoc subcommittees. ‘Undoubtedly an increasing number of similar tasks will come their way, and they have advisedly and deliberately been given powers to initiate study of policy problems without having to await formal instructions.

For this and many other provisions designed to enhance the influence of the Society on the contemporary national scene, we must pay tribute to the vision, draughtsmanship and industry of Dr Fisher and his colleagues, who have met in committee no fewer than twenty-six times to produce the constitution which has ‘now been approved’.

All in all this is an exciting and stimulating period in which to be alive; and it is good that we have equipped ourselves more adequately to meet its challenge.

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