# Real-Time Personal Noise Measurements Contribution to Hearing Deterioration for Mineworkers in South Africa

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## ABSTRACT

*Occupational noise is a health hazard that leads to permanent hearing loss and the cumulative nature of the noise exposure requires active and preventive surveillance programmes. This type of hearing loss, commonly known as occupational noise-induced hearing loss is associated with a gradual hearing deterioration, affecting the high frequencies and has been well documented as the leading cause of a disabling hearing impairment by the South African mining industry. The author highlights the usefulness of real-time noise dosimetry which uses modern technology and enables the active and ongoing integration of audiometry medical surveillance big data to be accessed and analysed. In addition, to advance the preventive goal for hearing loss, the author recommends further investigations into electronic health systems employed by the mining houses as intervention tools that enable deep machine learning and could be used to identify trends and predict early signs of hearing deterioration for mineworkers.*

## INTRODUCTION

Complexities around irreversible hearing deterioration and the associated adverse effects caused by excessive occupational noise exposure that impact mineworkers globally have been well documented in the literature (WHO, 2021). Evidence-based studies have cited the cumulative nature over a period of time of excessive noise exposure, the type of noise exposure, and other non-modifiable factors such as age, sex, genetics, etc., and modifiable exposures such as dust, ototoxic chemicals, recreational noise, etc., which all increase mineworkers' susceptibility to permanent occupational-related hearing loss (Grobler et al., 2020; Ntlhakana et al., 2021; Pillay, 2020). Other previous studies in South Africa have shown the association between hearing loss and respiratory health conditions, associated risks from ototoxic drugs used for the treatment of pulmonary tuberculosis (PTB) and human immunodeficien-

cy virus (HIV) infection also increase the risk of noise-induced hearing loss (NIHL) in mineworkers (Khoza-Shangase, 2019; Rathipe & Raphela, 2023). In addition, various other occupational exposures and medical conditions have been reported as risk factors for occupation-related hearing loss, specifically occupational noise-induced hearing loss (ONIHL). Increased susceptibility to sleep disturbances, psychological stress, and fatigue have been associated with the frustration of losing hearing function, thus recommendations to consider mineworkers' mental health were made (Malatji & Stewart, 2013). The widely used definition of ONIHL is an occupational disease caused by overexposure to noise in the workplace, as a measure of time (in hours per shift) and intensity of noise (of $\geq$ 85 dBA) (Feuerstein & Chasin, 2009; South & Africa). In South Africa, all the mining commodities have reported ONIHL as one of the top three most common occupational diseases (1. pulmonary TB; 2. ONIHL and 3. silicosis) (Balfour, 2024), which leads to disabling permanent hearing loss (WHO, 2021). To attend to the complex interactions of risk factors which inevitably lead to permanent hearing loss, the mining houses require health-based regulations supported by the government.

The South African regulatory bodies that govern the mining industry have identified excessive noise exposure levels as the main risk factor associated with ONIHL. Excessive noise exposure levels continue to persist even after the numerous revisions of the Mine Health and Safety Council milestones for the prevention of ONIHL. These milestones have mainly been based on reducing noise emitted by mining equipment, for example, investing in solutions to quietening equipment that emits high noise and reducing the total occupational noise exposure levels to $\leq$ 107 dBA by December 2024 (Mine et al., 2015). To understand occupational noise exposure levels of various occupational groups of mineworkers, some researchers conducted studies that profiled jobs, and noise exposure levels and tracked the prevalence rates of ONIHL among mineworkers (Edwards et al., 2011; Grobler et al., 2020; Ntlhakana, Nelson, et al., 2020). However, research findings indicated the complexities around the mine depth, types of equipment used, and mineworker behaviours as some of the limitations which restrict the implementation of noise reduction interventions. Thus, noise detectors as early signals for noise exposure could be explored as artificial intelligence (AI) based solutions suitable for the mining industry and this technology requires the South African regulatory bodies' buy-in.

Recent advances in measuring personal noise exposures already exist, however, a dearth of evidence-based findings drawn from these technologies was imperative. Sound level meters (SLMs) and dosimeters are common sound pressure instruments used by most industries to measure occupational noise exposure levels. The various recent types of SLMs have been cited as quick, simple, and easy to operate, as well as allowing in-depth collation of workplace noise exposure levels collected for all jobs. In addition, using a dosimeter has been recommended as the preferred method to accurately measure and access mineworkers' occupational noise exposure levels. (Grobler et al., 2020; Ntlhakana, Khoza-Shangase, et al., 2020) There are different types of dosimeters, with different technologies integrated for the sole purpose of personal noise measurements. A dosimeter is described as a device fitted on the individual's upper body, with a microphone placed as close as possible to the ear (Bonnet et al., 2020). However, the most common practice of monitoring noise exposure levels with dosimeters using traditional technology seemed to be preferred by the industry and was intended only for those South African mineworkers who were at risk according to the mines' risk-based medical surveillance descriptors (Franz & Phillips, 2001). Nevertheless, there is limited evidence-based research on the implemented personal sampling strategies and devices which could predict and/or detect early, increased noise exposure levels. Therefore, solutions for measuring noise exposures with sensitive devices that have AI-assisted functions to