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SASOM
South African Society
of Occupational Medicine

South African Society of
Occupational Medicine (SASOM)



SAIOH

Southern African Institute for
Occupational Hygiene (SAIOH)



Mine Medical Professionals
Association (MMPA)

An accredited journal of the Department of Higher Education and Training (RSA)

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Volume 29, Issue 3, 2023

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RSVP:

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SOUTHERN AFRICA

Volume 29, Issue 3, 2023

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From the Assistant Editor . . .



Ntombizodwa Ndlovu,
Assistant Editor

There are at least two things worth celebrating in August in South Africa. Temperatures rise during this last month of winter in South Africa, and we celebrate National Women's Month. The 9th of August is National Women's Day – a day when we commemorate the fight for women, by women, for equality. On this day in 1956, 20 000 women of all races marched to the Union Buildings in Pretoria to protest the pass laws that controlled where non-white people could work, live, and travel.¹

During Women's Month, issues that

affect women, such as gender-based violence, sexual harassment in the workplace, and unequal pay are brought to the fore and discussed, and solutions are sought. This year's theme, *Accelerating Socio-Economic Opportunities for Women's Empowerment*, focuses on the creation of more employment opportunities for women.¹

Women's participation in the economy has increased, but there is still a gap in the labour force participation rate for women (54.3%) compared with that for men (64.9%).² As efforts to narrow this gap continue and more women enter the workplace, their wellbeing and health in relation to the workplace must be prioritised.

Women differ from men not just biologically, but also with respect to occupations, treatment in workplaces, and their social contexts and roles. These factors influence the occupational risks that women encounter. Women are more likely to work in low-paying jobs and in vulnerable conditions, which include self-employment and unpaid household work.² Due to their various roles in the society, women can work up to three shifts in a day: as homemakers, cleaning and cooking; as workers, employed or self-employed; and as caregivers, nursing sick family members.³ Much of this work is often unrecognised or invisible because it falls outside occupational regulations and legislation. As a result, despite the significant contributions of women to society and the economy, there is little occupational disease data available and the burden borne by women is underestimated because diseases are not diagnosed, reported, or compensated.

Due to the historic exclusion of women in many employment sectors, occupational standards and policies have been based on scientific evidence drawn from studies on men, and might not adequately protect the health of women. The occupational health and safety laws in many countries do not consider risks that are specific to women, and there is a growing consensus that the 'one-size-fits-all' approach to regulation might put women's health at risk. Recognition of the differences between women and men in the workplace is crucial for the protection of the health of all workers.

In a recent book chapter, Hiroaki Matsuura explains the concept of gender mainstreaming in occupational health and safety.⁴ The International Labour Organization (ILO) defines gender mainstreaming as "the process of assessing the implications for women and men of any planned action, including legislation, policies or programmes, in any area and at all levels. It is a strategy for making the concerns and experiences of women as well as of men an integral part of the design, implementation, monitoring and evaluation of policies and programmes in all political, economic and societal spheres, so that women and men benefit equally, and inequality is not perpetuated".⁵ The goal, therefore, is to promote

occupational health for all by implementing appropriate gender-specific interventions that target women exclusively, both men and women, or only men, as required.⁴ This means that all stakeholders, including policymakers and researchers, should consider the influence of sex-related differences in their work.

The reporting of data on women in research is an important methodological issue. In some studies, due to the small numbers of women, findings are not reported by sex or women are excluded. This practice is not unusual in male-dominated occupational settings.⁶ As researchers, we need to be intentional and ensure that data on women are reported, even if the numbers are small and cannot be analysed as a separate group. Reporting will contribute to knowledge on occupational exposures and diseases in women.

In this issue of the Journal, there are four papers on topics that affect both men and women – in and outside the workplace. Following the COVID-19 lockdowns, there has been an upsurge in travel globally. This has been coined as 'revenge travel', characterised by more frequent travel and longer stays,⁷ which increases the risk of diseases in travellers, including malaria. Ross and Freaan discuss another dimension of malaria – occupational malaria – that affects, amongst others, workers in crop farms, fisheries, border control, military, healthcare, boats, and research. Malaria contracted while at work is not officially recognised as an occupational disease because it is difficult to distinguish between occupational and non-occupational malaria. The authors highlight that medical practitioners should be able to recognise and diagnose malaria and encourage workers to take prophylaxis, as required.

The Department of Health has implemented an outpatient, decentralised care model for tuberculosis management. To test if ventilation in the homes of confined patients with tuberculosis could be improved, Mutava et al. investigated the effectiveness of an innovative intervention, using wind-driven turbines. The intervention shows promise as the turbines improved ventilation, which may significantly reduce the risk of tuberculosis infection of household members.

In these times of intermittent electricity supply and rising costs, the provision of adequate lighting for workers is a challenge faced by many businesses. Holleran and others remind readers that lighting contributes to healthy and safe work environments. Compliance with regulations and standards is measured using illuminance meters, but different types of meters measure light differently. The authors compared the performance of three illuminance meters and found differences in specifications and types of illuminance measures that must be considered when developing standards.

Manganyi and co-authors interviewed administrative support staff in the police service to explore the effects of secondary trauma experienced due to viewing incident dockets of traumatic events. They found that although staff members experienced secondary trauma, they were reluctant to utilise employee health and wellness services. The authors propose recommendations to assist traumatised administrative support staff.

On behalf of the *Occupational Health Southern Africa* Editorial Board, I thank the South African Society of Occupational Health Nursing Practitioners (SASOHN) for their involvement in the Journal since its inception 30 years ago. It has been a rewarding partnership and journey. We look forward to future collaborations with the Society and encourage SASOHN members to continue to submit papers for publication.

Finally, as we enter the last quarter of the year and begin the mad rush to meet annual work targets and personal resolutions for 2023, let us not forget to be kind to ourselves and take care of our physical and mental wellbeing.

REFERENCES

1. South African Government. Women's Month 2023. Accelerating Socio-Economic Opportunities for Women's Empowerment. Available from: <https://www.gov.za/WomensMonth2023> (accessed 1 September 2023).
2. Statistics South Africa. Equality in the job market still eludes women in SA. Available from: <https://www.statssa.gov.za/?p=16533> (accessed 1 September 2023).
3. Abdullahi SG. Women and occupational health. Available from: <https://www.slideshare.net/SaratuGarbaAbdullahi/women-and-occupational-health> (accessed 1 September 2023).
4. Matsuura H. Gender mainstreaming in occupational health and safety. In: Skjervén A, Fordham M, editors. *Gender and the Sustainable Development Goals*. London: Routledge, 2022; p. 46–60. Available from: https://books.google.se/books?hl=en&lr=&id=we53EAAQBAJ&oi=fnd&pg=PT49&dq=occupational+health+women&ots=Qur1xJw_35&sig=IJZFiMaiZ6XUt0yrVZqy3mQuhsg&redir_esc=y#v=onepage&q=occupational%20health%20women&f=false (accessed 1 September 2023).
5. International Labour Organization. Definition of gender mainstreaming. Geneva: ILO; undated. Available from: <https://www.ilo.org/public/english/bureau/gender/newsite2002/about/defin.htm> (accessed 1 September 2023).
6. Messing K, Punnett L, Bond M, Alexanderson K, Pyle J, Zahm S, et al. Be the fairest of them all: challenges and recommendations for the treatment of gender in occupational health research. *Am J Ind Med*. 2003; 43(6):618–629. doi: 10.1002/ajim.10225.
7. Girish VG. COVID-19 pandemic and the emergence of revenge travel. *Int J Hosp Tour Res*. 2021; 35(10):125–129. doi: 10.21298/IJTHR.2021.10.35.10.125. 

Letter to the Editor

In response to the Letter to the Editor published in the previous issue of *Occupational Health Southern Africa* (Vol. 29 No. 2 of 2023), SAIOH received requests from members to provide more information regarding the decision about recognition of the Wits School of Public Health MSc Med in Exposure Science (ES) programme.

SAIOH included reference to “*recognised programmes*” in its criteria for members to apply for upgrading of their certification levels. If a candidate did not complete a SAIOH-recognised programme, s/he needs to complete the International Certificate in Occupational Hygiene (ICertOH) offered by the Occupational Hygiene Training Association (OHTA), in addition to the academic programme. By recognising a programme, SAIOH declares that, to its knowledge, it covers at least the content covered in the OHTA modules, and sufficient information regarding the 17 skill sets included in the SAIOH self-assessment tool, i.e. the referred to 50% occupational hygiene content. This was, amongst other reasons, an attempt to improve the assessment pass rate, by ensuring that members applying for upgrades have completed an academic programme that covered all topics that may be addressed in assessments, thereby improving knowledge and competency in the occupational hygiene field.

The minimum qualification requirement to apply for upgrade to the Registered Occupational Hygiene Technologist (ROHT) level is a recognised NQF Level 7 qualification. The minimum qualification requirement to apply for upgrade to the Registered Occupational Hygienist (ROH) level is a B Tech Environmental Health degree at NQF Level 7, or a recognised NQF Level 8 qualification, provided that the aforementioned qualifications meet the SAIOH occupational hygiene content requirements.

The Wits MSc Med ES programme is offered at NQF Level 9, with entry requirements into the programme being a relevant four-year B-degree, e.g. BSc Hons or B Tech. This may include the fields of occupational hygiene, occupational health, engineering and environmental health, or other relevant areas.

The course content of the Wits ES programme does cover the health effects and possible control approaches for most occupational health hazards. However, as stated in the application for recognition to SAIOH, the ES programme “... *does not go into the technical details of a measurement method, since our approach is that these kinds of technical skills should be learned in practice, or at an undergraduate level*”. Therefore, if a candidate completed a qualification that did not address occupational hygiene measurements before enrolling in the ES programme, his/her knowledge thereof may be lacking. Occupational hygiene certification assessments administered by SAIOH focus extensively on the technical details of measurement, as well as “*compliance testing*” as referred to by the author of the previous Letter, which is a regulated requirement within the occupational environment in South Africa.

It is important to note that recognition by SAIOH does not constitute endorsement of a programme in general, but merely recognises programmes already identified and offered by tertiary institutions as occupational hygiene degrees, or degrees with an occupational hygiene content of 50% or more.

The author referred to the Exposure Science-Industrial Hygiene programme offered by the University of Michigan. On the University's website, the mission of the programme is described as follows: “*Studying Exposure Science-Industrial Hygiene at U-M: The mission of the Industrial Hygiene program is to provide outstanding comprehensive graduate-level education in occupational health science; ensuring that graduates (sic) are qualified to pursue careers and assume leadership roles in the modern practice of industrial hygiene.*” <https://sph.umich.edu/ehs/programs/ih.html>

The aim of the programme offered by Wits is described on their website as follows: “*This degree is targeted at potential academics, specialists or professionals in the field of occupational hygiene, environmental health, environmental sciences, chemistry, toxicology, physiology etc., with a scientific interest to bridge these fields.*” <https://www.wits.ac.za/course-finder/postgraduate/health/mscmed-exposure-science/>

The SAIOH Occupational Hygiene Skills Forum (OHSF) recognises the Wits MSc ES programme as an excellent post-certification degree for SAIOH members wishing to study towards an NQF Level 9 qualification, to broaden their understanding of a holistic approach to exposure, and control thereof, within and beyond the occupational environment. In our opinion, this aligns well with the purpose of the programme as stated on the Wits website, and as mentioned by the author.

Candidates who completed the Wits MSc ES programme after obtaining a B Tech Environmental Health degree at NQF Level 7, or a recognised four-year B-degree at NQF Level 8 in the field of occupational hygiene, will be recognised as suitably qualified to apply for ROHT or ROH upgrade.

Candidates who did not obtain a recognised occupational hygiene qualification at NQF Level 7 or 8 prior to enrolling for the Wits MSc ES programme and wish to obtain SAIOH certification, will have to complete the following OHTA modules, in addition, before applying for certification at ROHT or ROH level:

- W201: Basic Principles in Occupational Hygiene – strongly recommended if not familiar with basic occupational hygiene concepts
- W501: Measurement of Hazardous Chemicals – required
- W503: Noise – required

The above applies to the qualification requirement for certification. Candidates wishing to apply for SAIOH certification also need to prove practical experience relevant to the respective certification levels, as specified on the SAIOH website.

Any further information on the matter can be obtained from SAIOH on request. 

The SASOM Annual Author Prize

On behalf of *Occupational Health Southern Africa*, the South African Society of Occupational Medicine (SASOM) encourages researchers working in the field of occupational health in Africa to publish their research findings. SASOM provides a cash award to a novice author who is the first author of the best paper published in *Occupational Health Southern Africa* in a calendar year, as judged by the Editorial Advisory Panel. Eligibility for the prize is limited to researchers who have not previously published a paper in *Occupational Health Southern Africa* or any other accredited academic journal. Membership of SASOM is not a criterion.

We are pleased to announce that Ms Leandr  To a is the winner of this award for 2022. She published the following paper in the first issue of the Journal in 2022:

To a L, Van der Merwe B, Van der Linde B. Chest radiography: optimising the radiation dose at industrial mines in the Northern Cape province of South Africa. *Occup Health Southern Afr.* 2022; 28(1):5-10.

Leandr  is a diagnostic radiographer who completed her National Diploma in Radiography (Diagnostic) at the Central University of Technology, Free State in 2013. In 2014, she started her professional career as a community service radiographer at Kuruman District Hospital in the Northern Cape, and is still employed by the Department of Health. At the start of her career, she occasionally assisted the mines with radiography. She began to ask herself questions, which she decided to answer by conducting research. She completed her BTech degree, and immediately started studying towards a breast screening certificate and a Master's degree. She has grown a great deal as a researcher and professional and developed a passion for research



Leandr  To a is the winner of the SASOM Annual Author award for 2022 Photograph: Leandr  To a

during her Master's degree. She hopes to pursue her PhD and would like to lecture in the future as she comes from a family of teachers. She cares for her patients and interacts with them daily. In her free time, she spends time with her children and family. She plays netball for the Kuruman Netball Club to maintain a healthy life-work balance. 🇿🇦



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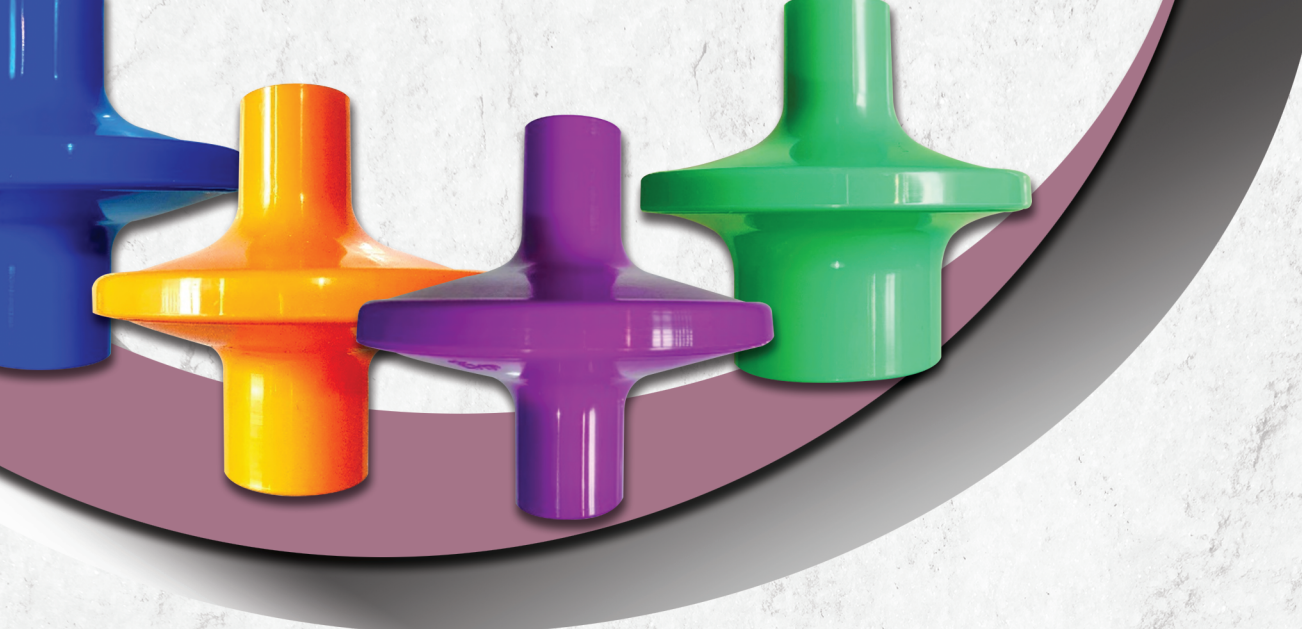
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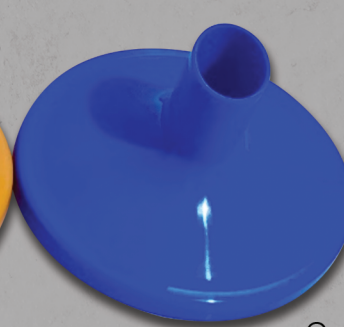
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Q(h)ubeka Trust announces final results and lessons learned as it closes

The Q(h)ubeka Trust, which was formed in 2016 to allocate funds to silicosis-affected mine workers, held its final annual general meeting (AGM) on 5 July 2023 and announced its closure as of 21 April 2023, as provided for in the Trust Deed.

By the date of closing, the Trust had awarded R421 789 144 to 2 280 beneficiaries, based on medical assessments of disease development. Amounts awarded represent 99.2% of the total amount due to 2 301 beneficiaries.

The remaining 0.8% is due to the dependants of 37 claimants, 16 of whom have received their first tranche of payment. These families still need to supply legal proof that they are the heirs of the original mine worker claimants. This money, amounting to R3 503 660, has been set aside for the families to claim – as soon as they have all the necessary official documents from the Department of Home Affairs and the courts.

One of the many problems the Trustees faced was the large number of claimants who passed away since lodging compensation claims against particular mining companies in 2011. Where the claimants were diagnosed with silicosis, the compensation money was due to their heirs. But only a single claimant had written a will – and the courts, which settle estates, are often slow.

The Trust was established following the successful conclusion of a lengthy compensation battle by lawyers representing former mine workers Richard Meeran and Zanele Mbuyisa, who had contracted silicosis as a result of working for various mines owned by Anglo American South Africa Limited and/or AngloGold Ashanti Limited.

The lawyers gave the Q(h)ubeka Trustees (Dr. Sophia Kisting-Cairncross, Alicia Kistan, Goolam Aboobaker, and John Doidge) a list of 4 365 claimants. All had worked underground in South Africa's deep and dusty gold mines. Together, they had sued the mining companies for dust-related lung diseases, which they believed were contracted from working in unsafe conditions in the mines. The Trustees arranged 3 853 medical assessments by an expert panel of doctors and radiologists. They determined that 2 301 were 'qualifying claimants' in terms of the Trust Deed, who had silicosis and could share in the compensation. The Trustees decided how much to pay claimants, depending in each case on their degree of sickness from silicosis and their age.

Dr Sophia Kisting-Cairncross, Chairperson of the Q(h)ubeka Trust, paid tribute to the efforts of her fellow Trustees, the Q(h)ubeka Trust managers, the network of medical teams, researchers, actuaries, IT experts, rural taxi drivers, food providers, and Q(h)ubeka office and outreach staff in completing the work of the Trust, which had been extended for one year due to the delays of the pandemic and other challenges.

The Trust has also assisted claimants to apply for statutory benefits under the Occupational Diseases in Mines and Works Act (ODMWA), thereby securing potential additional compensation for the claimants.

Dr Kisting-Cairncross said that they were happy with the work that the Trust has been able to achieve. Further, she noted some key lessons learned in the past few years to shape the work of such trusts in future. These include:

1. Mine workers and ex-mine workers must be encouraged to make a will. The Department of Justice runs excellent and informative workshops on how to make a will. The Deputy Master in the Mthatha office, amongst others, has run such workshops in the past year.
2. The high prevalence and severity of silicosis amongst the older group of the Q(h)ubeka Trust cohort is of great concern. This may suggest that we are underdiagnosing silicosis in our region. It is important for us to strive to arrive at the actual burden of silicosis among gold mine workers. It is not an issue for an individual doctor or nurse but requires a collective effort to have ongoing and standardised medical education, quality assurance, and the rigour of scientific research to arrive at that true burden of disease. We owe it to past and to future generations to do this with accuracy. We certainly have the capacity to do this in southern Africa. The effective use of the ILO (International Labour Organization) International Classification on Radiographs of Pneumoconiosis is but one pillar in this process.
3. Doctors and nurses should take the time to obtain a good occupational history from the mine worker or ex-mine worker during the medical examination for occupational lung diseases. Workers should be allowed to have their own work history recorded as they know best what work they have done. We owe them that. Research on the Q(h)ubeka Trust data has shown it is amongst the most trustworthy information we can obtain and will add to the information we already have from other sources.
4. Banks can be approached collectively by different compensation systems and trusts to improve and provide more caring services to mine workers and ex-mine workers in both urban and rural areas. Many of the banks' service providers have been extremely helpful and empathetic to the mine workers, and many will cooperate.
5. Mine workers and their families need to know their legal right to post-mortem services under the ODMWA. This often constitutes the only opportunity a family has to access compensation for an occupational disease and should be discussed with miners during their medical examinations.
6. Given the interconnectedness of families and the number of claimants who have passed on, it is imperative that gender equality, equity, and gender-inclusive aspects of our compensation processes must be fully integrated in trust systems from inception.
7. Research and, where possible, participatory research is of great importance to share knowledge gained towards greater *prevention* of occupational lung diseases and tuberculosis.
8. Mine workers and ex-mine workers should be an integral part of the writing of any future settlement trust deeds and be represented by the board of trustees.

Please see <http://www.qhubekatruster.co.za> for additional information. 

Tshiamiso Trust Reviewing Authorities commence with their dispute resolution function

The Tshiamiso Trust is pleased to announce that the much-anticipated Reviewing Authorities have begun their work considering disputes logged by claimants who are not satisfied with the Notice of Ineligibility, Certificate of Medical Finding, or Trust Certification.

The Tshiamiso Trust Deed allows for any claimant who wishes to dispute his or her claim findings, for the reasons listed above, to lodge an appeal with the Reviewing Authority within 30 days of being issued with a disputed determination. The Reviewing Authority Panel comprises independent experts who were not involved in determining the original claim outcome. It is made up of two independent authorities – the medical practitioners appointed to the Medical Reviewing Authority (MRA) review disputes related to medical certification findings, while the lawyers who make up the Certification Reviewing Authority (CRA) review Notices of Ineligibility issued by Lodgement Officers and certifications issued by the Trust Certification Committee. The MRA reviewed its first disputed claims on 15 May 2023 and the CRA considered the first of its disputes on 22 May 2023. The Trust aims to clear the backlog by the end of September 2023.

Tshiamiso Trust CEO, Dr Munyadziwa Kwindu, explains: *“The Trust Deed is very prescriptive on eligibility criteria, and we cannot deviate from its stipulated terms. It also makes a provision for claimants to submit a dispute should they disagree with the Trust’s findings. The disputing claimants are encouraged to adhere to the prescribed thirty-day period within which to refer the disputed determination to the reviewing authority. It is important to note that the Trust is mandated to carry out the terms of the settlement agreement, guided by the Trust Deed, which cannot be changed by the Trustees or the management of the Trust.”*

As of the end of July 2023, the MRA has considered 1 127 disputes; 48 have been rescinded and 997 have been upheld. The remaining disputes require further consultation, information, or documentation. The CRA has considered 154 disputes of which one has been rescinded and 112 have been upheld. The remaining disputes require further documentation or information.

About the Tshiamiso Trust

The Trust was established to give effect to the settlement agreement reached between six mining companies and claimant attorneys in the historic silicosis and TB class action. The Trust is responsible for ensuring that all eligible current and former mine workers across southern Africa, with permanent respiratory impairment due to silicosis or work-related cardio-respiratory TB, (or their dependants where the mine worker has passed away), are compensated. These beneficiaries are front and centre in all that the Trust does. African Rainbow Minerals, Anglo American South Africa, AngloGold Ashanti, Harmony Gold, Sibanye-Stillwater, and Gold Fields are Founders of the Trust.

Potential claimants, including mine workers or, if deceased, their families, are encouraged to call the Tshiamiso Trust call-back number on 0027 10 500 6186. They can also connect on the [Tshiamiso Trust Facebook page](#) and have their questions answered. Visit www.tshiamisotrust.com for more information.

Issued on behalf of:

Tshiamiso Trust: Stakeholder Relations & Communications

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Comparison of illuminance meters in measuring light emitted from incandescent, compact fluorescent, and LED lamps

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ABSTRACT

Background: To determine if illumination in the workplace complies with regulations and standards, illuminance meters are used to quantify the amount of light illuminating an object, surface, or general workplace. For accurate measurements, the calibration conditions and spectral response of the illuminance meter, and the characteristics of the light source being measured, must be considered.

Objective: We compared the performance of the Goldilux auto-ranging illuminance meter (GL), the Goldilux-LED auto-ranging illuminance meter (GL-LED), and the Konica Minolta CL-70f (KM CL-70f) illuminance meter in measuring light emitted by halogen incandescent lamps (hICLs), compact fluorescent lamps (CFLs), and light-emitting diodes (LEDs).

Methods: The three meters were used to measure illuminance from low-, medium, and high-powered hICLs, CFLs, and LEDs, one metre away from the outer casings of the lamps.

Results: Results from the three meters were similar when measuring low- and medium-powered hICLs. Substantial differences in illuminance values were observed when measuring high-powered hICLs, and all CFLs and LEDs.

Conclusion: The GL, GL-LED, and KM CL-70f meters measured statistically significant differences in illuminance of hICLs, CFLs, and LEDs. To achieve accurate illuminance measurements, illuminance meters with low spectral mismatch uncertainties, spectral responses capable of measuring the entire visible spectrum, and which are calibrated to measure modern lamps, should be used. The South African National Standard (SANS 10114-1:2020) should be revised to include guidelines for the types of illuminance meters used, to promote accurate measurements in the workplace.

INTRODUCTION

Light is a form of radiant energy, which is necessary to be able to see. The advent of artificial lighting has made humans less dependent on natural light, particularly in the workplace.¹ Although often overlooked, the use of artificial lighting is fundamental in reducing risks to health and safety, while also promoting increased productivity in the workplace.^{1,2}

The incandescent lamp (ICL) has, historically, been the most commonly used light source in domestic and industrial settings.³ It is a simple source of electrical light⁴ and has been the universal symbol for bright ideas and innovation since its inception. The light emitted from ICLs is unrivalled in terms of colour rendering, colour temperature, and spectral distribution quality. However, ICLs are inefficient sources of artificial light³ and, consequently, many governments have discontinued their use.⁴ Following the gradual phasing out of ICLs in other countries, South Africa banned their import and manufacture from 2015⁵ due to newer technologies being more energy efficient.³ Newer lighting technologies such as halogen ICLs (hICLs), compact fluorescent lamps (CFLs), and light-emitting diodes (LEDs) consume less electricity and have longer lifespans than traditional ICLs.^{4,6}

To determine if the lighting in an occupational environment complies with regulations and standards, illuminance meters – also referred to as light/lux meters – are used to measure the quantity of light illuminating an object, surface, or general workplace with lux as the unit of measurement.⁷ In South Africa, Section 8 of the Occupational Health and Safety Act (1993) states that: “Every employer

shall provide and maintain, as far as is reasonably practicable, a working environment that is safe and without risk to the health of his employees.”⁸ The Environmental Regulations for Workplaces (1987) of the Occupational Health and Safety Act (1993), state that: “Employers must illuminate every work area in their undertaking according to the illumination values listed in the Schedule specified within the regulations.” This Schedule lists mandatory minimum values of maintained illuminance for specified areas and tasks in the workplace.⁹ The accurate measurement of light requires important considerations, such as the conditions under which illuminance meters are calibrated, the spectral response of the meters, and the spectral qualities of the light source being measured.^{10,11}

The human eye does not have the same visual response throughout the entire visible spectrum. The response changes, depending on the spectral wavelength of light and the physiological and/or emotional state of the observer.¹² Due to these visual response variations, the International Commission on Illumination (CIE) developed the relative luminous efficiency curve [$V(\lambda)$], also known as the spectral luminous efficiency function, which represents how the human eye perceives light, according to photopic vision.^{13,14} Photopic sensors of illuminance meters are designed to imitate the $V(\lambda)$ in order to simulate the response of the human eye to visible light. The spectral response of illuminance meters does not, however, perfectly match the $V(\lambda)$. Thus, errors in illuminance measurements (spectral mismatch errors) occur. The magnitude of the error is dependent on the spectral response of the photodetector and the spectrum of the lamp being measured.¹³

The American Medical Association (AMA) (2016)¹⁵ and Bergen (2017)¹³ state that modern lamps, such as LEDs and CFLs, have entirely different spectral properties in comparison to the previously popular ICLs. Although newer lighting technologies have rendered traditional ICLs obsolete, illuminance meters are still calibrated using light from a standard, unpolarised ICL with a colour-correlated temperature (CCT) of 2 856 K.^{7,11} Due to the differences in the spectral responses of the photodetectors used in illuminance meters, and the differences in the spectrum of light sources being measured, spectral mismatch errors in illuminance measurements may occur.¹³ Using illuminance meters without considering the impact that illuminance meter specifications and qualities may have on measurement results (such as calibration), could lead to the inadvertent use of the incorrect type of illuminance meter.

There is no published literature comparing the capabilities of the Goldilux auto-ranging illuminance meter (GL) (MIT, South Africa), the Goldilux-LED auto-ranging illuminance meter (GL-LED) (MIT, South Africa), and the Konica Minolta CL-70f (KM CL-70f) illuminance meter (Konica Minolta, Japan) when measuring different light sources such as hICLs, CFLs, and LEDs.

The aim of this study was to compare the performance of three illuminance meters in measuring light emitted by hICLs, CFLs, and LEDs.

METHODS

Illuminance levels of three different lamp types were measured in a laboratory, under controlled conditions, in February and March 2021, using GL (MIT, South Africa), GL-LED (MIT, South Africa), and KM CL-70f (Konica Minolta, Japan) light/illuminance meters. Quantitative spectral wavelengths and CCTs of the same three lamp types were measured using the KM CL-70f illuminance meter.

Illuminance meters

The GL is a sturdy, handheld, illuminance meter with a solid-state sensor capable of measuring visible light within the spectral range of 410–680 nm. The embedded light measuring cell, a silicon photodiode sensor, is calibrated with light from an unpolarised ICL with a CCT of 2 856 K. The GL is cosine and colour corrected and can measure light sources with an accuracy of < 3% uncertainty.¹⁶

The GL-LED is an illuminance meter specifically calibrated for accurate measurement of LED sources and is embedded with a solid-state sensor that, like the GL illuminance meter, can measure visible light within the spectral range of 410–680 nm. The GL-LED is calibrated against an ISO 17025-compliant Goldilux Master LED illuminance meter (MIT, South Africa), using a stabilised 4 000 K LED lamp. The GL-LED is cosine and colour corrected and can measure light sources with an accuracy of < 3% uncertainty.¹⁶ Although designed to measure LEDs accurately, the GL-LED was used to measure hICLs and CFLs to demonstrate that inaccurate measures can be obtained from illuminance meters if the user is unfamiliar with the specifications and qualities thereof.

The KM CL-70f is a portable, handheld, illuminance meter that features a touchscreen interface and a rotating head with an embedded light receptor that measures visible light within the spectral range of 380–780 nm, with an accuracy of < 9% uncertainty. This illuminance meter can measure CCT, colour rendering index, spectral wavelengths, and illuminance with a cosine corrected complementary metal-oxide-semiconductor (CMOS) linear image sensor, which is calibrated with light from an unpolarised ICL with a CCT of 2 856 K.¹⁷

Lamp preparation

Three new low-, three new medium-, and three new high-powered lamps of each type (2 900 K hICLs, 4 000 K CFLs, and 6 500 K LEDs) were used in this study (a total of 27 lamps). Lamp seasoning, also referred to as lamp ageing, was conducted before the experiment commenced. The lamp seasoning process included the operation of the selected lamps for a duration of 1% of the lamp's total rated lifespan.¹⁸ This process is essential before taking illuminance measurements of new and unseasoned lamps, as there is a fluctuation in the amount of light emitted from the lamps until they have been operated for 1% of their total rated lifespans.¹⁹ To prevent the phenomenon of lamp flicker, a Mecer ME-3000-GTU uninterruptible power supply (UPS) (Mecer, South Africa) was used to regulate and measure the voltage and frequency of the electricity supplied to the lamps. This ensured that light output from the lamp did not fluctuate due to an unstable electricity supply.

Site preparation

A 1.98 m illuminance stand was assembled. The CIE specifies that light testing should take place in a draught-proof room with air movement not exceeding 0.25 m/s.²⁰ Both the CIE and South African National Standard state that lamps are designed to operate at an optimum ambient temperature of 25 °C, and that standard ambient temperatures for light testing should be at 25 °C (with a tolerance interval of ± 1.2 °C), and at a maximum relative humidity of 65%.^{11,14,19,20}

The ambient conditions within the test facility were kept constant throughout the experiment. Doors and windows were closed to prevent air movement. A split-unit air conditioning unit, set at a low fan speed, was used to maintain the temperature at a constant 25 °C. A TSI VelociCalc with TSI hotwire anemometer attachment (TSI, Minnesota, USA) was used to measure air movement within the test facility and to verify that it did not exceed 0.25 m/s. A QUESTemp 34 thermal environment monitor (TSI QUEST, Minnesota, USA) was used to measure the dry-bulb temperature and to verify that the relative humidity did not exceed 65%. The QUESTemp 34 monitor was placed next to the illuminance stand and allowed to acclimatise for 30 minutes after it was switched on. It remained on for the duration of the experiment.

Illuminance measurement preparation

Once the standard ambient conditions were met, the illuminance meters were placed inside the room and given an hour to stabilise in the ambient environment.¹¹ The Illuminating Engineering Society (2008) states that, before illuminance measurements are taken, the selected lamp should be operated long enough to stabilise in the ambient environment.²¹ Before illuminance measurements were taken, each selected lamp was switched on for 15 minutes to acclimatise to the ambient conditions. Lamps were randomly selected by making use of a Latin square design method.²²

Measurement

After the selected lamp and illuminance meters had acclimatised to the ambient conditions, all other light sources were switched off. Background illumination in the test facility was zero lux, which ensured that measurements were not affected by external light sources. Each lamp was measured individually by each illuminance meter at a distance of one metre (between the outer casing of the lamp and the sensor of the illuminance metre). This was achieved by placing the illuminance meter on a levelled tripod stand to adjust the distance between the outer casing of the lamp and the

sensor of the illuminance meter. Three low-, three medium-, and three high-powered lamps were tested for each lamp type. Each individual lamp was, thereafter, measured three times with each illuminance meter (nine times in total). The GL and GL-LED meters measured the illuminance levels. In addition to illuminance, the KM CL-70f measured the spectral wavelengths and CCTs of the lamps.

Data analysis

GraphPad Prism 8 (GraphPad Prism, version 8, GraphPad Software Inc., USA) was used for statistical analysis and the creation of figures. Basic descriptive statistics, including means, standard deviations, and ranges were calculated. The D'Agostino and Pearson omnibus test was used to test for normality; it was found that the data were normally distributed, using $\alpha = 0.05$ as a cut-off point for significance. Welch's analysis of variance (ANOVA) test was used to determine any significant variation in the covariate ambient conditions, such as dry-bulb temperature ($^{\circ}\text{C}$), output voltage (V), and output frequencies (Hz). A one-way ANOVA test, followed by Tukey's pairwise comparisons post hoc test, was used to determine if there were any significant differences between the illuminance levels of the different lamp types, as measured by the three illuminance meters. A p value of ≤ 0.05 was considered statistically significant.

The study was approved by the Health Research Ethics Committee (HREC) of the North-West University (NWU) Potchefstroom Campus (clearance certificate number: NWU-00444-20-A1).

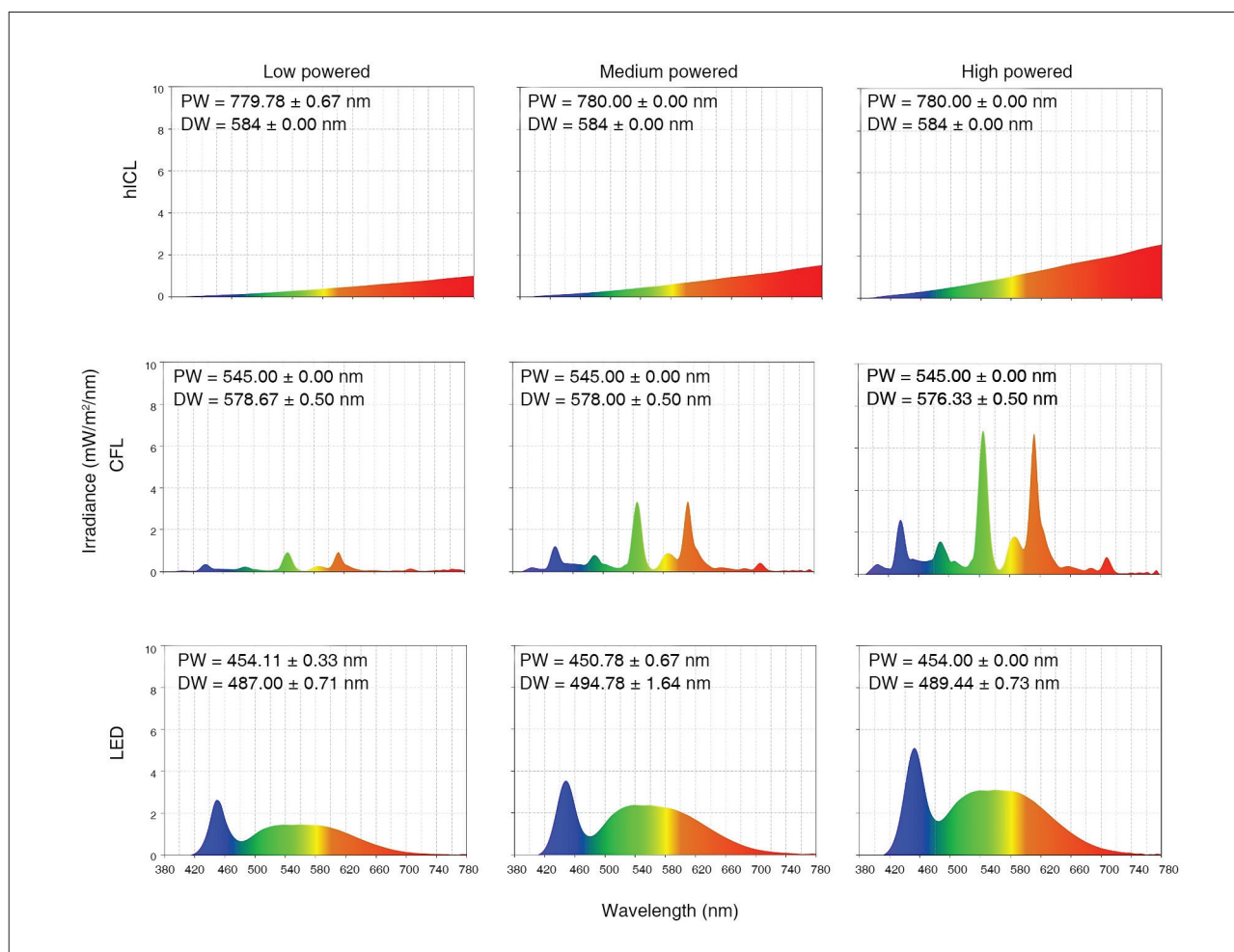
RESULTS

The results of a Welch's analysis of variance (ANOVA) determined that covariate ambient conditions (dry-bulb temperature ($^{\circ}\text{C}$), output voltage (V), and output frequency (Hz)) did not vary significantly ($p > 0.05$). Detailed descriptive statistics of illuminance values obtained from each meter are provided in [Supplementary Table S1](#).

Spectral qualities of the lamps

Figure 1 represents the spectral wavelengths of the hiCLs, CFLs, and LEDs, where peak wavelength (PW) and dominant wavelength (DW) were measured using the KM CL-70f illuminance meter. The mean PW of all three power levels (low, medium, and high) of CFLs was shorter than that of the hiCLs. The DWs of the low-, medium-, and high-powered CFLs were similar to those of the hiCLs. The mean PWs and DWs of all LEDs were shorter than those of the other lamp types.

[Supplementary Figure S1](#) shows an example of the quantitative CCT measurements from the KM CL-70f. The manufacturers' CCT ratings of the hiCLs, CFLs and LEDs were 2 900 K, 4 000 K and 6 500 K, respectively. The measured CCT values were similar to the manufacturers' ratings. The CCT measurements of the low-, medium-, and high-powered hiCLs were 2 656.56 K, 2 721.00 K, and 2 731.56 K, respectively. The CCT measurements of the low-, medium-, and high-powered CFLs were higher, at 3 858.44 K, 3 824.89 K, and 3 908.67 K, respectively; and even higher for the low-, medium-, and high-powered LEDs (6 577.11 K, 6 142.78 K, and 6 385.00 K).



PW: peak wavelength, DM: dominant wavelength

Figure 1. Spectral wavelengths of low-, medium-, and high-powered hiCLs, CFLs, and LEDs, measured using the KM CL-70f

Illuminance levels of the lamps

Halogen incandescent lamps (hICLs)

Figure 2 shows the illuminance values of low- (28 Watt), medium- (42 Watt), and high- (70 Watt) powered hICLs. There were no significant differences in illuminance levels of low-powered hICLs, using the three illuminance meters ($p > 0.05$). Illuminance values of medium-powered hICLs, obtained with the GL-LED and KM CL-70f, were not significantly different. In contrast, significant differences between lux values were obtained with the GL and KM CL-70f. Significant differences were observed between illumination values obtained by the three different illuminance meters for the high-powered hICLs.

Compact fluorescent lamps (CFLs)

Figure 3 illustrates illuminance values of low- (9 Watt), medium- (20 Watt), and high-powered (45 Watt) CFLs. Differences between values obtained using the three illuminance meters were significant, irrespective of the power of the lamp being measured.

Light-emitting diodes (LEDs)

Figure 4 illustrates illuminance values obtained for low- (5 Watt), medium- (9 Watt), and high-powered (14 Watt) LEDs, respectively. Similarly to CFLs, illuminance values obtained from LEDs were significantly different, irrespective of the power of the lamp being measured or the illuminance meter used.

DISCUSSION

There are many factors to consider when measuring illuminance, such as the spectral qualities of the light source(s) being measured and the distance between the light source and the illuminance

meter.^{10,11} Illuminance meter characteristics, such as spectral response and range capability, cosine response, colour correction, and the quality of the detector embedded within the illuminance meter may all impact accuracy.¹¹

hICLs have a continuous and smooth wavelength spread across the visible spectrum (shown in Figure 1), which is identical to the spectral wavelength distribution of traditional ICLs.³ The PWs obtained for all three power levels of hICLs lay within the red spectral band of the visible spectrum (779.78 ± 0.67 – 780 ± 0.00 nm).²³ Unlike the hICLs, the CFLs displayed various narrow and sharp peaks within the visible spectrum, similar to findings reported by Van Bommel (2011).²⁴ The PWs of the CFLs were within the green spectral band of the visible spectrum (545.00 ± 0.00 nm), with a smaller peak in the red, and a small peak in the blue spectral bands of the visible spectrum. LEDs presented a prominent PW within the 450.00–485.00 nm blue spectral band of the visible spectrum (450.78 ± 0.67 – 454.11 ± 0.33 nm) followed by a partially continuous distribution of visible light throughout the rest of the visible spectrum.²⁴ The hues, determined by the DWs, indicated that hICLs and CFLs had similar DWs, while LEDs had substantially shorter DWs than both hICLs and CFLs. These findings confirm that – apart from DWs, in the case of CFLs and ICLs – CFLs and LEDs have different spectral wavelength qualities than both traditional ICLs and hICLs.¹³ Of note is that, for any specific type of lamp, the spectral compositions were almost identical for the different power levels. Measured CCTs compared favourably with the lamp specifications, with all measurements falling within 10% of the manufacturers' specifications.

The three illuminance meters recorded significantly different values in most instances (22 of 27). For all three meters, the

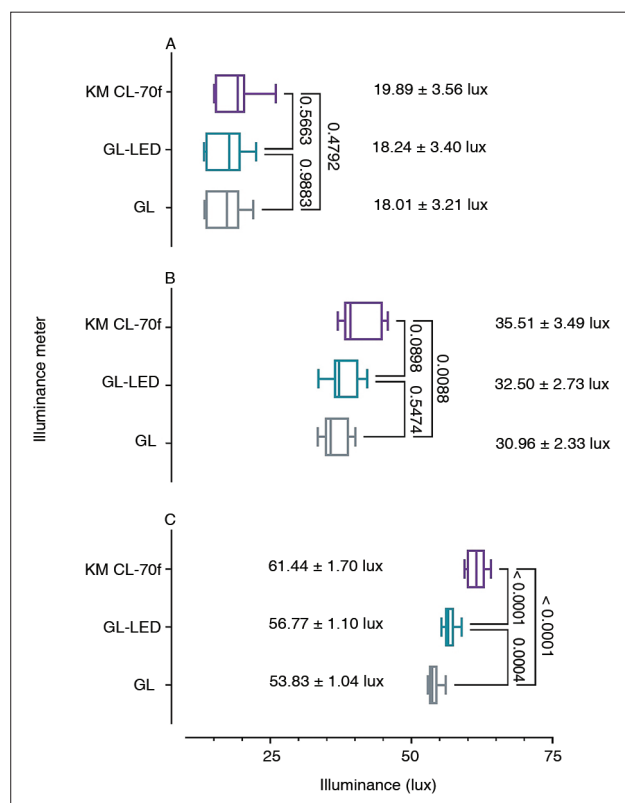


Figure 2. Box and whisker plot of illuminance levels of (A) low-, (B) medium-, and (C) high-powered hICLs measured by three illuminance meters, showing the p values of pairwise comparisons as well as means and standard deviations

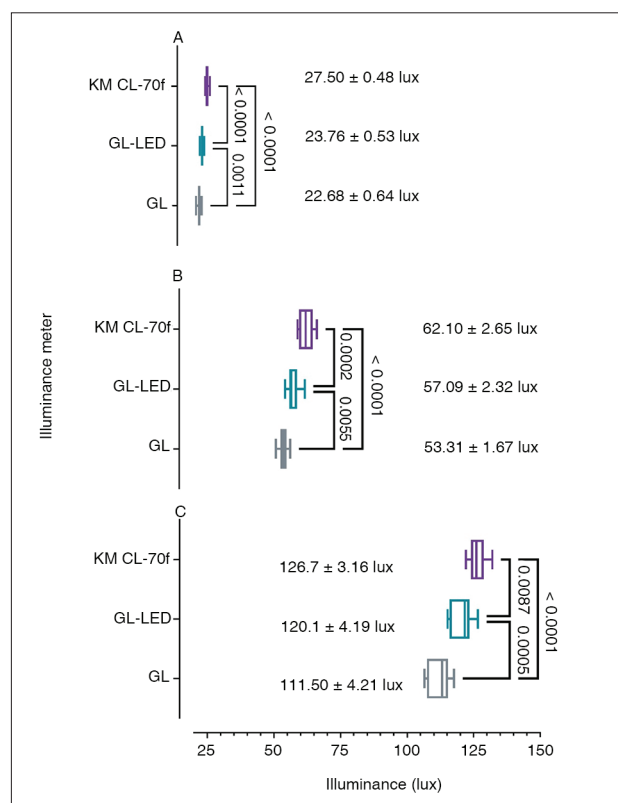


Figure 3. Box and whisker plot of illuminance levels of (A) low-, (B) medium-, and (C) high-powered CFLs measured by three illuminance meters, showing the p values of pairwise comparisons as well as means and standard deviations

only measurements that did not differ significantly were those recorded for the low-powered hICLs, and for two of the three comparisons of the medium-powered hICLs, as the measurements recorded by the GL and KM CL-70f were significantly different. Despite the GL and the KM CL-70f being calibrated with an unpolarised ICL with a CCT of 2 856 K, significant differences in illuminance values were observed (Figure 2) when comparing medium- and high-powered hICLs, which have similar CCTs as the lamp used to calibrate these illuminance meters.

One explanation for this phenomenon may be the difference in spectral range of the two instruments (410–680 nm for the GL and 380–780 nm for the KM CL-70f).^{16,17} This was confirmed when comparing the three illuminance meters, as the KM CL-70f measured the highest illuminance values in all instances, irrespective of lamp type or power level, followed by the GL-LED and the GL. An alternative explanation may be spectral mismatch errors. Several studies have reported illuminance errors when measuring CFLs and LEDs due to spectral mismatch errors in illuminance meters.^{10,25} When comparing the specifications of each illuminance meter, the GL and GL-LED have a low spectral mismatch uncertainty of < 3% whereas the KM CL-70f has a higher spectral mismatch uncertainty of < 9% (as stated in the specifications of each meter).

In contrast to the above explanations regarding spectral mismatch errors, the differences in illuminance values obtained with the GL and GL-LED cannot be explained by a difference in spectral range (410–680 nm) or spectral mismatch uncertainty (< 3%). Differences between the GL and GL-LED may be due to differences in the calibration methodology. The GL and the KM CL-70f were calibrated using light from an unpolarised ICL with a CCT of 2 856 K, whereas the GL-LED was calibrated against an ISO 17025-compliant Goldilux Master LED illuminance meter (MIT, South Africa), using a stabilised 4 000 K LED lamp.

Quantifying light illuminating an object, surface, or general workplace is vital to determine if lighting in an occupational environment complies with regulations and standards.⁷ However, in the scope of occupational hygiene, information regarding which specifications an illuminance meter needs to conform to, in order to obtain accurate illuminance measurements in the workplace, are incomplete. Considering the technological development/progress of available lighting technology used in the workplace, illuminance meters should also advance to measure modern light sources accurately. Occupational hygiene practitioners should be aware of the limitations of the instruments used for measuring illuminance and should apply careful considerations when selecting an illuminance meter for monitoring workplaces. There is a need for the revision of the South African National Standard (SANS 10114-1:2020) to indicate which illuminance meter specifications are required to measure light in the workplace accurately, to enable employers to provide a workplace that is free of risks to health and safety while also promoting increased productivity.^{1,2} Currently, the SANS 10114-1:2020 states that illuminance meters should be cosine and colour corrected but does not indicate the recommended spectral mismatch uncertainty, the spectral range capabilities, or the conditions under which illuminance meters need to be calibrated.²⁶

Limitations of this study include that it was conducted under strictly controlled conditions where illuminance meters were placed precisely one metre away from the selected lamp. In workplace settings, lighting positioning, lamp type, and required illuminance levels are adjusted to best visually aid the task being

conducted. A future study should compare measurements from illuminance meter measurements in practical workplace settings where the meters are placed at different distances from a light source. This will more realistically depict illuminance levels in the workplace. In addition, illuminance values obtained using different meters could be assessed against regulations and standards for minimum values of illuminance for specific areas and tasks. Such information will indicate whether illuminance measurements from one meter differ from those from another meter, resulting in differences with regard to compliance for illuminance.

While the differences identified between illuminance meters in this study were statistically significant, only the end user of such instruments can judge the practical significance of these differences, as applicable to a specific context.

CONCLUSION

We compared measurements recorded by three different illuminance meters and found statistically significant differences in most cases. Thus, one can measure the same lamp and get different illuminance values from different meters. This can be ascribed to differences in spectral range, spectral mismatch errors, calibration methodology, or combinations thereof. To achieve accurate measurements of illuminance, meters with a low spectral mismatch uncertainty and a spectral response capable of measuring the entire visible spectrum should be used. Currently, SANS 10114-1:2020 does not prescribe minimum requirements for illuminance meters. This standard should be revised to provide guidance in terms of the specification of illuminance meters used to measure light in the workplace.

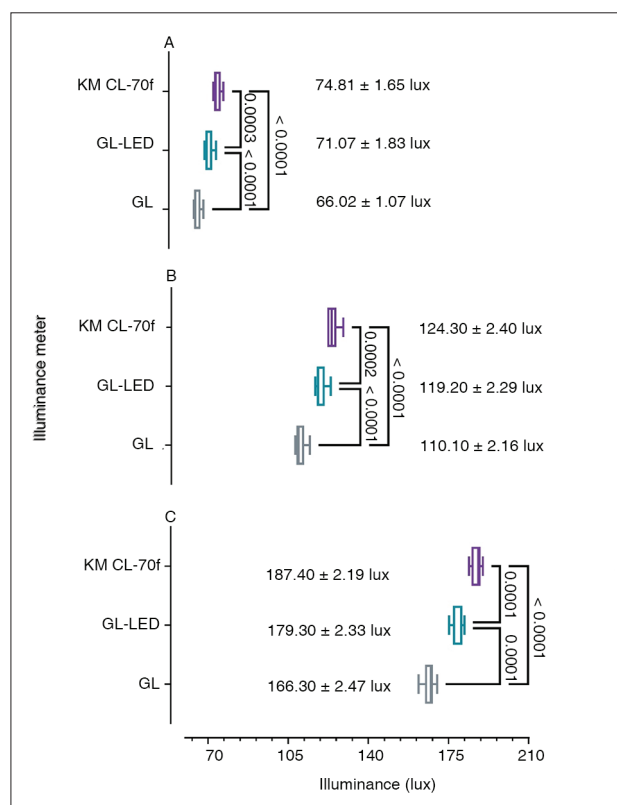


Figure 4. Box and whisker plot of illuminance levels of (A) low-, (B) medium-, and (C) high-powered LEDs measured by three illuminance meters, showing the p values of pairwise comparisons as well as means and standard deviations

KEY MESSAGES

1. Different illuminance meters record different illuminance measures from the same light source, due to differences in meter specifications.
2. Illuminance meter characteristics in terms of spectral range, spectral mismatch errors, and calibration methodology should be considered before conducting an illumination survey, as the level of accuracy required may dictate the characteristics of the illuminance meter used.

DECLARATION

The authors declare that this is their own work; all the sources used in this paper have been duly acknowledged and there are no conflicts of interest.

ACKNOWLEDGEMENTS

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AUTHOR CONTRIBUTIONS

Conception and design of the study: CIH, CJvdM, JLdP

Data acquisition: CIH

Data analysis: CIH, JLdP

Interpretation of the data: CIH, CJvdM, JLdP

Drafting of the paper: CIH, CJvdM, JLdP

Critical revision of the paper: CIH, CJvdM, JLdP

REFERENCES

1. Smith NA. Light and Lighting. In: Gardiner K, Harrington JM, editors. Occupational Hygiene. 3rd ed. Malden (Mass): Blackwell; 2005. pp. 268-285. doi: 10.1002/9780470755075.ch19.
2. Jayawardena A, Duffy D, Manahan JM. Lighting matters in industrial environments: a framework linking workplace safety to lighting quality metrics. *IEEE Trans Ind Appl.* 2017; 23(3):54-63. doi: 10.1109/MIAS.2016.2600697.
3. Giannuzzi A, Sansoni P. Halogen and incandescence Lamps. In: Sansoni P, Mercatelli L, Farini A, editors. Sustainable indoor lighting. London: Springer; 2015. p. 87-106. Available from: <https://link.springer.com/content/pdf/10.1007%2F978-1-4471-6633-7.pdf> (accessed 27 November 2022).
4. Cole M, Driscoll T. The lighting revolution: if we were experts before, we're novices now. *IEEE Trans Ind Appl.* 2014; 50(2):1509-1520. doi: 10.1109/TIA.2013.2288210.
5. Heyes J. Incandescent bulb banned... now what? EE Publishers. 2014 June 16 [cited 2021 April 21]. Available from: <https://www.ee.co.za/article/incandescent-bulb-banned-now.html> (accessed 21 April 2021).
6. American Conference of Governmental Industrial Hygienists. TLVs® and BEIs®: Threshold limit values for chemical substances and physical agents & biological exposure indices. 7th ed. Cincinnati, OH: ACGIH Worldwide; 2019. pp. 251-253.
7. Van den Heever DJ, Schoeman JJ. Illumination. In: Van den Heever DJ, Schoeman JJ, editors. Occupational hygiene: the science. 4th ed. Vol. 2. Bloemfontein: Sun Media; 2015. pp. 139-174.
8. South Africa. Occupational Health and Safety Act, 1993 (Act No. 85 of 1993).
9. South Africa. 1987. Machinery and Occupational Safety Act. Environmental Regulations for Workplaces, 1987. Government Gazette No. 10988, 1987 October 16 (Published under Government Notice R 2281).
10. Bizjak G. LEDs and measurements – how much light source influence the measurement results. In: Proceedings of the 11th International Conference and Exposition on Electrical and Power Engineering; 2020 Oct 22-23; Lasi, Romania. New York: IEEE; 2020. pp. 755-761.
11. International Commission on Illumination (CIE). CIE ISO/CIE 19476:2014 – Characterization of the performance of illuminance meters and luminance meters. Vienna: CIE Central Bureau; 2014.
12. Giannini A. Radiometric and photometric quantities and laws. In: Sansoni P, Mercatelli L, Farini A, editors. Sustainable indoor lighting. London: Springer; 2015. pp. 1-22. Available from: <https://link.springer.com/content/pdf/10.1007%2F978-1-4471-6633-7.pdf> (accessed 30 March 2021).
13. Bergen T. Photometry of led lighting devices. *Light Eng.* 2017; 25:80-85.
14. International Organization for Standardization. ISO 23539:2005. Photometry – The CIE system of physical photometry. Geneva: ISO; 2005.
15. Council on Science and Public Health. CSAPH Report 2-A-16: Human and environmental effects of light emitting diode (LED) community lighting; 2016. Available from: https://www.darksky.org/wp-content/uploads/bsk-pdf-manager/AMA_Report_2016_60.pdf (accessed 2 June 2023).
16. Marmit. Goldilux. Available from: <https://www.marmit.co.za/goldilux/> (accessed 23 March 2020).
17. Konica Minolta Sensing Americas. CL-70F CRI Illuminance Meter, Konica Minolta sensing. Available from: <https://sensing.konicaminolta.us/products/cl-70f-cri-illuminance-meter/> (accessed 28 February 2020).
18. IES guide to lamp seasoning. *JIES.* 1989; 18(2):150-152. doi:10.1080/00994480.1989.10748775.
19. The South African Bureau of Standards. South African National Standards. Self-ballasted lamps for general lighting services – performance requirements. SANS 60969:2010.
20. International Commission on Illumination (CIE). CIE S 025/E:2015. Test method for LED lamps, LED Luminaires and LED Modules. Vienna: CIE Central Bureau; 2015.
21. Electrical and photometric measurements of solid-state lighting products. New York, NY: Illumination Engineering Society; 2008.
22. Ellison SLR, Barwick VJ, Duguid Farrant TJ. Practical statistics for the analytical scientist: a bench guide. 2nd ed. Cambridge: RSC Publishing; 2009.
23. Fontani D, Francini F, Sansoni P. Building glasses and skylights: optical characterization sustainable indoor lighting. In: Sansoni P, Mercatelli L, Farini A, editors. Sustainable Indoor Lighting. London: Springer; 2015. pp. 167-193. Available from: <https://link.springer.com/content/pdf/10.1007%2F978-1-4471-6633-7.pdf> (accessed 29 November 2022).
24. Van Bommel W. Incandescent replacement lamps and health. *Light Eng.* 2011; 19:8-14.
25. Ouellette M. Photometric errors with compact fluorescent sources. *IEEE Industry Applications Society Annual Meeting, Houston, TX, USA, 1992.* pp. 1865-1867, Vol.2. doi: 10.1109/IAS.1992.244545.
26. The South African Bureau of Standards. South African National Standards. Interior lighting, Part 1: Artificial lighting of interiors. SANS 10114-1:2020. 

Wind-driven roof turbines' effectiveness in enhancing household ventilation: a potential tool to reduce tuberculosis infection

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ABSTRACT

Background: South Africa's overburdened healthcare systems have led to criticism of its unsustainable tuberculosis management interventions. In 2011, the National Department of Health implemented an outpatient, decentralised care model, but this increased costs and jeopardised the long-term viability of prevention measures. Home confinement is now recognised as a viable intervention option, when combined with safety precautions such as ventilation and medical support. However, little is known about the risk of infection in this context.

Objectives: To assess the effectiveness of wind-driven roof turbines in enhancing ventilation and their potential to lower the risk of *Mycobacterium tuberculosis* infection in a residential setting.

Methods: Eight houses were selected and divided equally into intervention (wind turbines installed) and control groups, using a pairwise comparison method. The CO₂ decay method was used as a proxy to determine ventilation in the houses. The wind-driven roof turbines' potential to lower the risk of *Mycobacterium tuberculosis* infection was stochastically evaluated using the Wells-Riley mathematical model.

Results: During two seasons, installation of a roof turbine resulted in twofold ventilation rates compared to the control houses. Consequently, the Wells-Riley model predicted a twofold reduction in the probability of infection in the intervention compared to the control households.

Conclusion: Low-cost, low-maintenance wind-driven roof turbines are effective in increasing ventilation in houses, and should be considered as an additional layer of protection against *Mycobacterium tuberculosis* and other infections in residential settings.

INTRODUCTION

A cost-analysis study showed that tuberculosis (TB) management interventions are an efficient investment for South Africa.¹ While previous national TB guidelines stipulated mandatory hospitalisation, which made treatment easier by enabling the close monitoring of adherence and side effects, and preventing population transmission,² opponents argue that this type of care is unsustainable in an already overburdened healthcare system. This includes a shortage of hospital beds to accommodate all multiple drug-resistant (MDR), rifampicin-resistant (RR), and extreme drug-resistant (XDR) TB patients' obligatory hospitalisation;³ high costs of extended hospitalisation;⁴⁻⁶ and long waiting lists at large specialised hospitals⁷ – all of which lead to abscondment^{5,8} and early release into the community.⁸ Fears have been raised that drug-resistant strains of tuberculosis may spread.

To increase access and reduce costs, the National Department of Health implemented an outpatient, decentralised model of care in 2011.⁷ While this strategy increased case finding for drug-resistant TB (DR-TB),⁸ treating this type of TB is expensive. It puts strain on and jeopardises the long-term viability of TB prevention programmes in South Africa and other countries with comparable budgetary constraints. Treatment rationing and early treatment

are not options in TB management,^{9,10} but those who run TB programmes are forced to decide which patients should receive, for example, drug susceptibility testing,¹¹ despite the World Health Organization's End TB Strategy call for universal testing.¹⁰ Tuberculosis infection prevention and control (IPC) targets are, thus, unlikely to be met unless new technologies that are accessible, cost effective, and easy to implement are considered.¹²

Home confinement of DR-TB patients to safeguard the health of others is recognised as an alternative and more acceptable option than hospitalisation,¹³ and is a viable option when combined with appropriate safety precautions such as ventilation and medical support.^{12,13} Research on ventilation system installation (as an additional safety measure) has established its effectiveness in reducing transmission when TB case identification and follow up have proved challenging.¹⁴⁻¹⁷ Natural or mechanical ventilation in a room has been determined to be essential for reducing and eliminating hazardous aerosols such as *Mycobacterium tuberculosis*.¹⁸ While natural ventilation is less expensive than mechanical ventilation, it is highly variable as it is dependent on wind speed, wind direction, etc., which affects the ability to measure the air exchange rate (AER) – an indication of the effectiveness of ventilation.^{17,18}

Recommendations have been made to investigate the feasibility of low-cost, simple-to-implement natural ventilation enhancers, as an alternative to mechanical ventilation in poor-resource settings.^{15,19,20}

The objective of this study was to assess the effectiveness of wind-driven roof turbines in improving ventilation in houses, and their potential to lower the risk of *Mycobacterium tuberculosis* infection in households in Diepsloot, a resource-constrained community in South Africa.

METHODS

The study was conducted over four months (July to October 2019) in the South African winter and spring. The Diepsloot township was chosen as a resource-constrained setting because most residents have limited access to medication, equipment, supplies, and technologies; and inadequate infrastructure. It is a densely populated urban township, covering an area of approximately 12 km² in the north of Johannesburg, and is home to approximately 450 000 people.²¹ Approximately 76% of residents live in backyard shacks made of scrap metal, wood, plastic, and/or cardboard.²² There are also formal housing units such as Reconstruction and Development Programme (RDP) houses, self-built houses on serviced sites, and a small number of bank-financed houses.^{22,23}

A theoretical relationship between ventilation and the risk of infection was used to estimate the impact of wind-driven roof turbines on transmission of *Mycobacterium tuberculosis*. The study design required a comparison household (control) group with baseline (pre-intervention) characteristics similar to the intervention group where wind turbines were installed. Information was collected on the determinants of indoor air quality (IAQ), i.e. building type, type of roof and flooring, house features (e.g. the number of doors and windows), leakage, occupant number, and indoor and outdoor activities.

The eight selected houses (four intervention and four control houses) were all single-room RDP houses with a floor space of 29.28 m². All the houses had pyramid-shaped tops on cube-shaped foundations. At the highest point, the ceiling was 3 m from the floor; the room volume was 70.86 m³. The mean age of the houses was 15.5 ± 2 years; the median number of inhabitants per house was four.

Before the intervention, all eight houses were visited to assess the aforementioned IAQ determinants and to measure some IAQ parameters, i.e. temperature, relative humidity, and CO₂ levels. A pairwise comparison was used to ensure similarity between pairs of intervention and control houses and households. In addition, some other house and household characteristics were analysed to test if they differed significantly between the two groups: distance of the house from main roads, indoor activities (i.e. cooking and smoking), occupancy, number of shacks in the yard, age of the house, quality of the house structure, and total number of hours that occupants slept in the house.

The intervention entailed installing an aluminium wind-driven turbine on the roof of each of the four houses. The turbines had a 240 mm diameter curved vane and spherical shape, and were ducted directly into the rooms. Trained technicians installed the turbines in accordance with a unique methodology tailored to the structure of the houses.

Each house was visited four times after the wind turbines had been installed; each visit started with hour-long morning and evening measurements of the IAQ parameters of temperature, humidity, and CO₂ concentrations, using a TSI-integrated VelociCalc[®] Model 9545 Airflow Meter, and then averaged within the two groups.

The natural ventilation in the houses was assessed using the CO₂ decay method. At every visit – after the windows and doors were closed and the residents had left – CO₂ gas was slowly released from a cylinder and pumped into the house until it reached a level of

4 500 ppm. After allowing the CO₂ to mix with the room air for an hour, the CO₂ concentration was measured using an infrared gas analyser (TSI IAQ-CalculTM Meter, Model 7525) at five-minute intervals over an hour.

The Human Research Ethics Committee (Medical) at the University of the Witwatersrand approved the study (clearance certificate number M190426).

Data analysis

Stata version 15 was used for data analysis. The ventilation in the houses was determined using the CO₂ decay levels pooled per season and time for both the intervention and control houses.

The CO₂ concentrations were log-transformed and the log values were plotted on a graph, with time (t) as the predictor variable and CO₂ concentration levels as the outcome variable. The air exchange rate in air changes per hour (ACH) was determined as the slope of line of best fit.

The ventilation rate in the houses was calculated from the air exchange rate, using Equation 1:

$$Q = ACH \cdot V \cdot cf \quad (\text{Equation 1})$$

where Q = ventilation rate (L/s), ACH = air change rate (h⁻¹), V = room volume (m³), and cf = correction factor (1000 (l/m³)/3600 (s/hr)). The ratio VR/average number of house occupants provides an estimate of the ventilation rate per person.

The value of Q was further converted into an average natural infiltration rate, based on the South African Residential Ventilation Building Code (SARVBC), which recommends an average natural infiltration rate of 0.35 m³/h/m².²⁴ This is equivalent to 6.9 L/s per person. In this paper, the term 'infiltration' refers to the flow of air into and out of buildings caused by unintentional leakage in the exterior building envelope – through windows, doors, and other openings – attributed to pressure differences caused by wind, indoor-outdoor temperature differences,²⁵ and the operation of the wind-driven roof turbine.

The Wells-Riley mathematical model²⁶ was used to estimate the probability that a person in the household could be infected when a single infectious person is present:

$$Pi = \frac{C}{S} = 1 - \exp\left(-\frac{Iqpt}{Q}\right) \quad (\text{Equation 2})$$

where Pi is the probability of infection, C is the number of infection cases, S is the number of susceptible people in the indoor space, I is the number of people potentially transmitting the infectious aerosol, p is the pulmonary ventilation rate of a person, q is the quanta generation rate, t is the exposure time interval, and Q is the room ventilation rate with clean air.

Pi , expressed as a percentage, was calculated using the median number of occupants in each home; p was calculated using a value of 0.6 m³/h based on findings in a household environment;²⁰ and t was calculated using the average time spent in the dwellings. A quanta generation rate of 13 quanta per hour, representing active tuberculosis patients not on treatment, was used.²⁷ Q was calculated as the product of A and V , where A is the AER by ventilation per hour (h⁻¹) and V is the volume of the ventilated space (m³).²⁸

The infection risk (P) reduction, i.e. the comparison of the infection risk of the intervention houses with the control houses, was calculated as:

$$1 - \frac{P_{\text{control}}}{P_{\text{intervention}}} \cdot 100\% \quad (\text{Equation 3})$$

RESULTS

Table 1 shows the results of the matching of the participating households regarding some key attributes. Prior to the installation of the wind turbines, there were no statistically significant differences in CO₂ level and temperature ($p > 0.05$), and a marginal difference in relative humidity levels ($p = 0.057$).

Once the wind turbines were installed, the mean indoor temperature, relative humidity, and CO₂ concentration were lower in houses with wind turbines than in those without (Table 2).

Table 3 shows the comparison of air exchange and ventilation rates in houses with and without the wind turbine. The AERs were > 1 for the houses with wind turbines, and < 1 for those without, for both times of day and both seasons, and differed approximately by a factor of two.

The estimated ventilation rate in houses with and without wind turbines was lowest in winter during the day, at 5.0 and 2.1 L/s/person, respectively. The acceptable ventilation rate of 6.9 L/s per occupant, as per the SARVBC requirements, could only be achieved during spring evenings in the intervention houses.

Table 4 shows the the risk of infection in the houses with and without wind turbines, by time of day and season. In all instances, the risk of infection was greater in the houses without than in those with wind turbines.

Because the ventilation rate (Q) in the houses with wind turbines was roughly twice that in the control houses (Table 3), the risk of infection in the houses without wind turbines would have been roughly twice that of the infection risk in houses with wind turbines.

DISCUSSION

In this study, we demonstrated that installing wind-driven turbines effectively increases house ventilation, and reduces the risk of infections such as *Mycobacterium tuberculosis* for occupants. Studies on ventilation and *Mycobacterium tuberculosis* transmission have identified and detailed that a comparable cluster of physical architectural aspects such as tightness of the building envelope, local topography, and wind shielding; and socio-demographic characteristics such as occupancy and activities, is required to draw

such conclusions.^{15,25,27,29} The characteristics of the houses and households in our study demonstrated that a sufficient match was achieved between control and intervention houses and households.

In addition to the improved ventilation, IAQ parameters, indicating comfort levels, were also improved in the intervention houses.³⁰ This can be explained by differential temperatures, with indoor air being heated by the sun, which raises the thermal temperature at night.²⁵ Consequently, thermal currents form, inducing turbine rotation and expelling warm air from the structure. The wind-driven technology is described as 'passive ventilation' because of the resultant reductions in temperature.³¹ Our findings that wind turbine houses may generate comfortable interior environments are, thus, satisfying, because the most likely time for internal air pollution is at night, when all necessary ventilation components are closed for safety reasons, and all the residents are inside.^{18,30}

The CO₂ decay is a surrogate measure for ventilation effectiveness. It is used as a proxy for infection risk, because the CO₂ concentration can be considered as the surrogate for a contaminant in a space. Therefore, determining the ACH can help estimate how many times the contaminant is completely removed and replaced with clean air. The intervention houses, i.e. those equipped with wind turbines, demonstrated the highest ACH compared to the control group of houses, highlighting their potential role in reducing airborne contaminants. Moreover, wind-driven roof turbines offer a distinct advantage over conventional open doors and windows by obviating draughts. The benefits of roof turbines extend beyond reducing draughts, as their operation is not solely dependent on human behaviour from a public health and occupational hygiene perspective. Moreover, the efficacy of wind-driven turbines remains unaffected by electricity dependency, rendering them suitable for deployment in areas without access to electricity or during instances of power outages.

A previous study,¹⁵ emphasising individuals' difficulties in closing roof turbines, underscores the roof turbine's capability of functioning with less reliance on humans, engendering the potential of sustained ventilation. There are minimal practical ways for human activity to restrict the turbine's performance except for an occupant to block the turbine. However, cultural beliefs are a

Table 1. Matching participating households

Parameter	Pair 1		Pair 2		Pair 3		Pair 4	
	T1	C1	T2	C2	T3	C3	T4	C4
Number of occupants	5	6	4	3	5	5	4	7
Age of house	15	14	13	13	17	17	15	15
Indoor activities	cooking smoking	cooking smoking	cooking	cooking	cooking	cooking	cooking	cooking smoking
Total hours sleeping	7	11	8	9	9	9	8	10
No. of shacks in yard	6	7	4	3	6	5	4	4

T: household with turbine, C: control household (4 pairs)

Table 2. Differences in IAQ parameters between houses with and without wind turbines during the study period

IAQ parameter	Wind turbine installed				p value
	Yes		No		
	mean	(SD)	mean	(SD)	
Relative humidity (%)	23.2	(5.4)	28.7	(7.1)	< 0.001
Δ Indoor-outdoor temperature (°C)	1.3	(2.8)	0.4	(2.8)	< 0.001
CO ₂ concentration (ppm)	435.3	(106.3)	599.1	(138.4)	< 0.001

SD: standard deviation, ppm: parts per million

crucial social determinant within diverse communities, shaping the acceptance of innovative technologies like wind-driven roof turbines.

Since many South Africans have developed tuberculosis immunity from earlier exposure to the bacterium, the projected risk reduction figures in this study are relatively high. As a result, this infection probability should be regarded as an estimate rather than an actual probability. Furthermore, initiating effective TB treatment reduces a person's infectiousness when treatment guidelines are followed. However, there is substantial evidence to refute doctrinal claims that patients are no longer infectious after two weeks of TB treatment. The Wells-Riley model, which is used for generic quantitative infection risk assessment of respiratory infectious diseases in indoor settings, lacks specificity for TB infection since the quanta generation rate and the effective dose are lacking. However, in our study the same assumptions for these parameters were assumed for all scenarios, enabling a risk comparison. Although there is evidence that ventilation reduces the risk of tuberculosis infection,^{27,28,30} the maximum ventilation rate at which the risk is no longer reduced, in practice, is unknown, and the risk of infection of household members during tuberculosis patients' home care remains unclear.

Limitations

This study had some limitations. First, we included a relatively small number of intervention and control houses, prompting questions regarding the extent to which houses were perfectly matched. Second, time constraints resulted in shorter-term follow-up assessments post-intervention implementation. Third, equivalent host susceptibility, uniform droplet sizes, constant ventilation, homogenous mixing of air, and a minimum clearance of infective particles by means other than ventilation were assumed. Last, the research area did not have electric power during the investigation. As a result, when CO₂ gas was introduced into the house, homo-geneous mixing of air, aided by a fan, was not attained.

Recommendations

Since we demonstrated the beneficial effects of installing wind-driven turbines, it is recommended to apply the intervention on a systemic level; some social science research on acceptance will be required to bring such an approach closer to systematic application. Understanding the perspectives of community members is critical, because the successful implementation of an intervention is dependent on the population's attitudes, social conventions, and behavioural aspects.

Table 3. Comparison of air exchange and ventilation rates in houses with and without wind turbines

Wind turbine installed	Winter*		Spring	
	Day	Evening	Day	Evening
Air exchange rate per hour (m³/h/m²)				
Yes	1.1	1.2	1.3	1.6
No	0.6	0.7	0.8	0.8
House ventilation rate Q (L/s)				
Yes	22.4	24.0	25.6	31.9
No	11.0	12.8	16.5	15.5
Ventilation rate per occupant (L/s/person)**				
Yes	5.0	5.3	5.7	7.1
No	2.1	2.5	3.1	3.4

*Windows and exterior door closed, ** For average house occupancy

CONCLUSION

Wind turbines were effective in improving ventilation in houses. The effectiveness of the ventilation intervention can be regarded as a step towards reducing the risk of tuberculosis infection in residential settings. Low-cost, low-maintenance wind-driven ventilation systems should be considered for an additional layer of protection against transmission of *Mycobacterium tuberculosis* and other infections in residential settings, particularly when linking inpatient health facilities with home-based/community care.

KEY MESSAGES

1. Wind-driven roof turbines enhance IAQ and comfort by promoting air exchange, reducing temperature and humidity, and preventing draughts without human intervention.
2. Improved ventilation achieved by installing wind-driven roof turbines can significantly reduce airborne TB infection risk.

DECLARATION

The authors declare that this is their own work; all the sources used in this paper have been duly acknowledged and there are no conflicts of interest.

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AUTHORS' CONTRIBUTIONS

Conception and design of the study: DB, TS

Data acquisition: EM

Data analysis: EM, DB

Interpretation of the data: EM, DB

Drafting of the paper: EM

Critical revision of the paper: EM, TS, DB

REFERENCES

1. Bozzani FM, McCreesh N, Diaconu K, Govender I, White RG, Kielmann K, et al. Cost-effectiveness of tuberculosis infection prevention and control interventions in South African clinics: a model-based economic evaluation informed by complexity science methods. *BMJ Global Health*. 2023; 8:e010306. doi: 0.1136/bmjgh-2022-010306.

Table 4. Risk of infection in households with and without wind turbines

Wind turbine installed	Infection risk (%)			
	Winter*		Spring	
	Day	Evening	Day	Evening
Yes	52.8	51.4	49.2	41.9
No	79.2	74.2	64.9	67.2
<i>Infection risk reduction**</i>	33.3	30.7	24.2	37.6

*Windows and exterior door closed, ** Calculated from Equation 3

2. Vanleeuw L, Loveday M. Tuberculosis. In: District Health Barometer 2015/2016. Padarath A, Barron P, Day C, editors. Health Systems Trust; 2016. pp. 180-208. Available from: https://www.hst.org.za/publications/District%20Health%20Barometers/District%20Health%20Barometer%202015_16.pdf (accessed 5 September 2023).
3. Five deadly barriers to effective TB care. ReliefWeb; 2018 March 23. Available from: <https://reliefweb.int/report/south-africa/five-deadly-barriers-effective-tb-care> (accessed 5 September 2023).
4. Hughes J, Osman M. Diagnosis and management of drug-resistant tuberculosis in South African adults. *S Afr Med J*. 2014; 104(12):894. doi: 10.7196/SAMJ.9097.
5. Pietersen E, Ignatius E, Streicher EM, Mastrapa B, Padanilam X, Pooran A, et al. Long-term outcomes of patients with extensively drug-resistant tuberculosis in South Africa: a cohort study. *Lancet*. 2014; 383(9924):1230-1239. doi: 10.1016/S0140-6736(13)62675-6.
6. Schnippel K, Firnhaber C, Conradie F, Ndjeka N, Sinanovic E. Incremental cost effectiveness of Bedaquiline for the treatment of Rifampicin-resistant tuberculosis in South Africa: model-based analysis. *Appl Health Econ Health Policy*. 2018; 16(1):43-54. doi: 10.1007/s40258-017-0352-8.
7. Multi-drug resistant tuberculosis. A policy framework on decentralised and deinstitutionalised management for South Africa. Pretoria: Department of Health; 2019. Available from: https://www.health.gov.za/wp-content/uploads/2020/11/policy-framework-on-decentralised-management-of-mdr-tb-may-2019_compressed.pdf (accessed 5 September 2023).
8. Van Rensburg C, Berhanu R, Hirasen K, Evans D, Rosen S, Long L. Cost outcome analysis of decentralized care for drug-resistant tuberculosis in Johannesburg, South Africa. *PLoS ONE*. 2019; 14(6):e0217820. doi: 10.1371/journal.pone.0217820.
9. Martin LJ, Roper MH, Grandjean L, Gilman RH, Coronel J, Caviedes L, et al. Rationing tests for drug-resistant tuberculosis – who are we prepared to miss? *BMC Med*. 2016; 14:30. doi: 10.1186/s12916-016-0576-8.
10. World Health Organization. The end TB strategy. Geneva: WHO; 2015. Available from: <https://www.who.int/publications/i/item/WHO-HTM-TB-2015.19> (accessed 5 September 2023).
11. Knight GM, Dodd PJ, Grant AD, Fielding KL, Churchyard GJ, White RG. Tuberculosis prevention in South Africa. *PLoS ONE*. 2015; 10(4):e0122514. doi: 10.1371/journal.pone.0122514.
12. Goemaere E, Ford N, Berman D, McDermid C, Cohen R. XDR-TB in South Africa: detention is not the priority. *PLoS Med*. 2007; 4(4):e162. doi: 10.1371/journal.pmed.0040162.
13. London L. Confinement in the management of drug-resistant TB: the unsavoury prospect of balancing individual human rights and the public good. *SAJBL*. 2008; 1(1):11-19. Available from: <http://www.sajbl.org.za/index.php/sajbl/article/view/8/6> (accessed 5 September 2023).
14. Nardell EA. Indoor environmental control of tuberculosis and other airborne infections. *Indoor Air*. 2016; 26(1):79-87. doi: 10.1111/ina.12232.
15. Cox H, Escombe R, McDermid C, Mtshemla Y, Spelman T, Azevedo V, et al. Wind-driven roof turbines: a novel way to improve ventilation for TB infection control in health facilities. *PLoS ONE*. 2012; 7(1):e29589. doi: 10.1371/journal.pone.0029589.
16. Bolashikov ZD, Melikov AK. Methods for air cleaning and protection of building occupants from airborne pathogens. *Build Environ*. 2009; 44(7):1378-1385. doi: 10.1016/j.buildenv.2008.09.001.
17. Zaniboni L, Albatici R. Natural and mechanical ventilation concepts for indoor comfort and well-being with a sustainable design perspective: a systematic review. *Buildings*. 2022; 12(11):1983. doi: 10.3390/buildings12111983.
18. World Health Organization. WHO guidelines on tuberculosis infection prevention and control: 2019 update. Geneva: WHO; 2019. Available from: <https://apps.who.int/iris/handle/10665/311259> (accessed 5 September 2023).
19. Escombe AR, Ticona E, Chávez-Pérez V, Espinoza M, Moore, DAJ. Improving natural ventilation in hospital waiting and consulting rooms to reduce nosocomial tuberculosis transmission risk in a low resource setting. *BMC Infect Dis*. 2019; 19(88). doi: 10.1186/s12879-019-3717-9.
20. Buregyeya E, Nuwaha F, Verver S, Criel B, Colebunders R, Wayenze R, et al. Implementation of tuberculosis infection control in health facilities in Mukono and Wakiso districts, Uganda. *BMC Infect Dis*. 2013; 13:360. doi: 10.1186/1471-2334-13-360.
21. South African History Online. Diepsloot, Johannesburg. SAHO; 2021. Available from: <https://www.sahistory.org.za/place/diepsloot-johannesburg> (accessed 5 September 2023).
22. Himlin R, Engel H, Mathoho M. Executive summary. Land use management and democratic governance in the City of Johannesburg. Case study: Diepsloot; 2007. Available from: <https://planact.org.za/wp-content/uploads/2020/02/2007-Executive-Summary-Diepsloot.pdf> (accessed 5 September 2023).
23. Johannesburg Development Agency. Diepsloot Ready for Development; undated. Available from: http://www.urbanlandmark.org.za/downloads/diepsloot_brochure.pdf (accessed 5 September 2023).
24. South African Bureau of Standards. South African National Standard 10400-O:2011. The application of the National Building Regulations. Part O: Lighting and Ventilation. Available from: <https://ia802908.us.archive.org/16/items/za.sans.10400.o.2011/za.sans.10400.o.2011.html> (accessed 5 September 2023).
25. Ng LC, Musser A, Persily AK, Emmerich SJ. Multizone airflow models for calculating infiltration rates in commercial reference buildings. *Energy Build*. 2013; 58:11-18. doi: 10.1016/j.enbuild.2012.11.035.
26. Wells WF. Airborne Contagion and Air Hygiene. An ecological study of drop-let infection. Cambridge, Mass: Harvard University Press; 1955. pp. 117-122.
27. Chamie G, Wandera B, Luetkemeyer A, Bogere J, Mugerwa RD, Havlir DV, et al. Household ventilation and transmission in Kampala, Uganda. *Int J Tuberc Lung Dis*. 2013; 17(6):764-770. doi: 10.5588/ijtld.12.0681.
28. Furuya H, Nagamine M, Watanabe T. Use of a mathematical model to estimate tuberculosis transmission risk in an Internet café. *Environ Health Prev Med*. 2009; 14(2):96-102. doi: 10.1007/s12199-008-0062-9.
29. Wallengren K, Scano F, Nunn P, Margot B, Buthelezi SS, Williams B, et al. Drug-resistant tuberculosis, KwaZulu-Natal, South Africa, 2001-2007. *Emerg Infect Dis*. 2011; 17(10):1913-1916. doi: 10.3201/eid1710.100952.
30. Makaka G, Xuza V, Meyer E, Mukumba P. On impact of the ventilation components on the ventilation rate in a passive solar energy efficient house. *Biomed Sci &Tech Res*. 2018; 8(2):6337-6343. doi: 10.26717/BJSTR.2018.08.001610.
31. Khan N, Su Y, Riffat SB. A review on wind-driven ventilation techniques. *Energy Build*. 2008; 40(8):1586-1604. doi: 10.1016/j.enbuild.2008.02.015. 

Secondary trauma amongst administrative support staff working with traumatic incident dockets within the South African Police Service in Johannesburg, South Africa

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ABSTRACT

Background: Secondary trauma is trauma experienced by those in close contact with the victims of trauma. Research shows that some individuals exposed to photographs or video presentations of traumatic events may experience secondary trauma. This includes administrative staff within the South African Police Service (SAPS), who work with trauma dockets.

Objectives: We explored the effects of secondary trauma on administrative support staff within the SAPS, their access to psychological support in the SAPS, and their use of the employee health and wellness (EHW) services in the SAPS.

Methods: An exploratory qualitative study was conducted among administrative support staff from one of the four Johannesburg clusters of the SAPS. In-depth interviews took place with seven staff members. The data were analysed using Atlas.ti.

Results: Administrative support staff are exposed to trauma through incident dockets, victim statements, and gruesome images. The study participants indicated that they experienced trauma daily, and symptoms of trauma such as flashbacks, anxiety, sadness, nightmares, paranoia, avoidance, recurrent thoughts, and fear of death. They were over-protective of their loved ones and paranoid. They were not utilising the EHW services due to lack of access to appropriate services, or the stigma attached to seeking help from mental health professionals.

Conclusion: The SAPS needs to develop and implement a strategy to mitigate the impact of secondary trauma on its personnel, which include administrative support staff. Evidence-based interventions, such as resilience training, should be considered as part of the strategy.

INTRODUCTION

Administrative support staff, working with traumatic incident dockets (police records of violent crimes and other gruesome incidents) in the South African Police Service (SAPS) read, summarise, scan, and capture statements from victims and witnesses. Working with traumatic incident dockets, such as gruesome killings with bodily mutilation, exposes individuals to deeply personal accounts of victims' experiences of violence and images that can carry a significant emotional cost.^{1,2} Police officers deal with trauma survivors and the traumatic events in which they have been involved, while the administrative staff deal with indirect trauma by capturing and recording the dockets.³ This involves typing statements from traumatic incident dockets and scanning gruesome images.

Exposure to these images may cause physical, emotional, and cognitive reactions, i.e. secondary trauma.⁴ Administrative staff may experience loss of motivation because of prolonged emotional stress, and features of burnout such as emotional exhaustion, depersonalisation, and feeling a lack of personal accomplishment.⁵ Secondary trauma is characterised by exhaustion, anger and irritability, and negative coping behaviour, such as drug and alcohol abuse.⁶ According to Benedek et al.,⁷ there are three categories of response to exposure to traumatic events. Most people experience mild and transient distress, e.g. sleep disturbance, anger, fear, sadness, or an increase in tobacco and alcohol use.⁷ A smaller group may have moderate symptoms, e.g. persistent anxiety, persistent insomnia, or changes in workplace behaviour.⁷ The third group

may develop psychiatric illnesses such as major depression or post-traumatic stress disorder.⁷ It is also possible that traumatic events may lead to increased resilience and post-traumatic growth.^{8,9}

Employee health and wellness (EHW) services are available to public service employees in South Africa, including employees of SAPS. These services comprise four pillars, viz. HIV/AIDS and TB management (pillar 1), health and productivity management (pillar 2), safety, health, environment, risk, and quality management (pillar 3), and wellness management (pillar 4).¹⁰ The management of mental health forms part of pillar 2, while individual psycho-social wellness is part of pillar 4.¹⁰ EHW services in the SAPS are provided by a multidisciplinary team, which includes social workers, psychologists, and occupational therapists.¹¹ Mental health programmes, as part of the SAPS EHW services, include suicide prevention, anger management, initial debriefing, stress management, and substance dependency.¹¹

As indicated in a systematic review by Greinacher et al. (2019),¹² several studies have identified that people directly working with victims are exposed to trauma, but individuals who are indirectly exposed as part of their work through listening and reading have not been the focus of research. They may be incorrectly perceived as being at low risk of trauma as they lack opportunities to share their experiences with clinically trained professionals.¹³

In this study we explored the effects of secondary trauma on administrative support staff working with traumatic incident dockets within the SAPS in Johannesburg, their access to psychological support in the SAPS, and their use of employee EHW services.

METHODS

An exploratory qualitative study was conducted amongst administrative support staff working in the Johannesburg East cluster of the SAPS. Johannesburg East is one of four organisational clusters of the SAPS in the City of Johannesburg and comprises seven police stations. Seven EHW personnel (four social workers, one psychologist, and two chaplains) are employed to support staff within the cluster, and SAPS members can be referred to two psychiatric institutions for further intervention. Johannesburg East was selected for the study for logistical reasons.

The study population comprised the 21 administrative support staff working with traumatic incident dockets in the seven police stations in the cluster, with at least one year of service. All those administrative support staff who could be reached were invited to participate in the study. Access to some potential participants was limited due to them working on the night shift at the time of the study, lack of support for the research from a few station commanders, and the COVID-19 pandemic. Twelve administrative support staff were contacted, seven of whom consented to participate in the study.

Data were collected from in-depth interviews from October to December 2021. MFM, who was trained in qualitative research methods during her Master's degree, interviewed the study participants, using a semi-structured in-depth interview guide with open-ended questions, and following up with probes for clarification and elaboration on responses. Demographic data – age, sex, years employed, and job title – were recorded. The questions covered the participants' understanding of exposure to trauma, thoughts and feelings when capturing gruesome images, the effect of the work on home and family life, and the availability of support in the workplace.

The interviews took place in a private space where there were no disturbances. Before the interviews began, the participants signed informed consent forms, which were audio recorded. Non-verbal cues were noted and a journal was used to record the interviewer's thoughts immediately after each interview. Each interview took 45–60 minutes to complete. Six of the seven study participants responded in English; one responded in Xitsonga. All audio recordings were transcribed. The Xitsonga interview was translated into English by an expert in both languages.

The Faculty of Health Sciences Research Ethics Committee of the University of Pretoria approved the study (ethics reference number: 231/2021). The participants completed an informed consent form before the interview, and received assurance of confidentiality, especially regarding the processing of the data after the recording. Participant numbers were used instead of the participants' names.

Data analysis

The analysis began with reading through all the transcripts to get a general sense of the information, and to reflect on the responses and the overall depth, credibility, and use of the information. Open coding technique, as described by Khandkar (2009), was used as a first step,¹⁴ after which similar codes were clustered. Categories and topics relating to each other were grouped, and lines were drawn between categories to show interrelationships. The resulting categories were combined to form overarching themes or sub-themes, depending on the complexity of the categories. The sub-themes and themes were discussed between the first and second authors to reach agreement before being finalised. Atlas.ti was utilised for data analysis.

RESULTS

The seven participants were from four different police stations. Five of the seven participants were 40 years of age or older, and four were male. Five had worked in the SAPS for 10 or more years.

Occupational exposure to trauma

There was a sense amongst the participants that their exposure to trauma was through dockets that contained gruesome images and distressing statements:

"I work with murder dockets and serious groups. When I have to scan the dockets or file it, along with the statements, it is traumatising because I have to go through those pages." (P6, male)

"Now you are seeing a photo, it is traumatic, but they had to see it visually with their own eyes. It's a hard thing to see and a hard pain to swallow. But is the reality of what's happening in our society or community." (P3, male)

"The trauma, sometimes you are not expecting to see something like that in the docket. And that thing sits with you for a long time." (P4, female)

When asked how often they are exposed to trauma, the majority said daily. Participants shared that there was a delay in scanning inquest dockets because of their gruesome nature:

"Usually, filing the dockets, for me it just a seconds thing but with that one, I can take the whole day because I will do the first page, the second page, when I am... in that page with that photo, I will close the docket and put it there." (P4, female)

Impact on mental health

The study participants indicated that they had mental health symptoms such as avoidance, flashbacks, fear of death, nightmares, worries, recurrent thoughts, paranoia, and sadness. Some appeared exhausted and burnt out. They were not motivated to be at work because of the emotional stress.

"Because when the traumas start to pile up, it makes you not live the normal life that you used to live. You change your behaviour." (P7, male)

"I didn't sleep. I wasn't sleeping at night because of those things. I would picture every docket that I would see, but for now, no more dreams." (P5, female)

"But when you are alone, then you start to imagine all that you have seen." (P6, male)

"So, I just become quiet and sit. Feel like not going to work. It is too much." (P3, male)

Impact on family life

The secondary trauma also appeared to affect the participants' family lives and parenting. It had made some of them paranoid and more protective of their children:

"You become paranoid because you have seen it happen. So, like I saw a child that was killed, I don't know how but they were in the presence of their parents but was killed so you become paranoid."

You think right now if kids are being killed in the presence of their parents, how am I supposed to trust other people with my kids. So, you should always have your kids next to you.” (P3, male)

“The only thing is that I am overprotective. My child is a girl so that is why.” (P5, female)

“If I am stressed at work or ...working in an environment that is not good is going to affect me even when I am at home. When I get home will start to complain or be grumpy, so it will affect me. Ja.” (P2, male)

Employee health and wellness (EHW) services: access and utilisation

Some participants mentioned that they did not have access to the appropriate EHW services to deal with their exposure to trauma, while others revealed they did not utilise the services because of the stigma attached to help seeking. Participants stated that their colleagues were afraid to go to the EHW offices because of trust issues, and being afraid of being labelled as crazy:

“They feel as if there are victims of the circumstances, people will gossip about them and staff, yes, so they are not free to go to EHW because of the gossip of the people.” (P1, male)

One participant noted that another reason might be that:

“...they think talking doesn't help. Ja, that's why they are reluctant.” (P2, male)

However, the majority of participants acknowledged the need for psychological support:

“I think, we need people to come and help us. Prepare us and lecture us. Because even if you are a police officer, you can't deal with this. Deal with this every day, it will affect your mind.” (P4, female)

“I think for now when people start working, they have to do counselling. Although it will depend on a person.” (P5, female)

DISCUSSION

The findings from this study showed that administrative support staff working in high-risk environments in the SAPS were affected by secondary trauma, which impacted their mental health and family life. Their symptoms were suggestive of mental health issues, but we did not assess them for psychiatric disorders. An interesting finding was the effect of traumatic exposure on parenting: participants overcompensated with excessive control of their children. The negative effects of secondary trauma affected all participants regardless of sex, age, or number of years in the service.

Interventions to address secondary trauma amongst administrative support staff working with traumatic incident dockets should be included in the SAPS' EHW programmes. While the EHW programme may address some mental health issues, including post-traumatic stress disorder among police officers, we found no evidence of specific services, programmes, or interventions currently in place to address the issue of secondary trauma amongst administrative staff. Interventions to build resilience would be useful as higher levels of resilience have been found to result in lower levels of burnout, psychological distress, and secondary traumatic stress.¹⁵ A curriculum for building resiliency

to protect against secondary traumatic stress has been proposed by Kerig (2019)¹⁶ and comprises six core elements, viz. appraisals, self-efficacy, emotional awareness, affect regulation, resilience, and prevention. Mindfulness-based programmes have also been suggested as potentially useful interventions with respect to secondary trauma.^{17,18} A recent systematic review by Rushforth et al. (2013)¹⁹ found promising evidence for self-compassion training in the improvement of secondary traumatic stress.

The poor utilisation of employee health and wellness services due to concerns about being labelled as mentally ill, as well as trust issues, is concerning as this prevents individuals from using these potentially beneficial services. The findings are consistent with a study conducted by Dilepela (2016),²⁰ which also found that few SAPS members were using EHW services because of the attached stigma.²⁰ The provision of an external employee assistance programme (rather than internal EHW services) may allay some of these concerns.

Interventions such as education and training, and reassurance and guidance, are critical.⁷ The administrative support staff require education about mental health issues, including the nature of such conditions, progression, the consequences of ignoring symptoms, prognosis, and treatment. The participants in our study expressed their need for regular counselling. Counselling is also necessary when preparing new administrative support staff at the beginning of their employment.

Although this was a small exploratory study, it raises an important issue for future research within the South African Police Service and other organisations in which there is a high risk of secondary trauma. A larger survey is needed to determine how widespread secondary trauma and its consequences are within the SAPS. Future research should include screening for and reporting on specific psychiatric symptoms and disorders, in order to develop policies for appropriate interventions. The perspectives of EHW managers and staff regarding the provision, access, and utilisation of EHW services for mental health and secondary trauma would be useful for policy development.

Limitations

The study took place during the COVID-19 pandemic. It was, thus, not possible to contact all potential participants as some were in isolation after testing positive for COVID-19, and others were working in rotational shifts. In addition, a few station commanders did not provide support for the study, which limited access to potential participants. Staff working on the night shift were not included because of logistical issues. As only seven support staff from four police stations in one SAPS cluster in Johannesburg participated in the study, the findings may not be representative of the entire SAPS.

CONCLUSION

Administrative support staff working with trauma-related dockets experience secondary trauma. This impacts their mental health, and their work and family lives. Evidence-based interventions such as resilience training could reduce the impact of secondary trauma in the SAPS. A strategy is needed to remove the stigma associated with mental health issues, and to address the concerns of staff regarding the utilisation of SAPS' internal EHW services.

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DECLARATION

The authors declare that this is their own work; all the sources used in this paper have been duly acknowledged and there are no conflicts of interest.

AUTHOR CONTRIBUTIONS

Conceptualisation of the study: MFM

Review of the literature: MFM

Design of the study: MFM, SVM, JS

Data acquisition: MFM

Data analysis: MFM

Interpretation of the data: MFM, SVM, JS

Drafting of the paper: MFM

Critical revision of the paper: SVM, MFM, JS

REFERENCES

- Sexual Violence Research Initiative. Guidelines for the prevention and management of vicarious trauma among researchers of sexual and intimate partner violence. Pretoria: Sexual Violence Research Initiative, MRC; 2015. Available from: <https://www.svri.org/sites/default/files/attachments/2016-06-02/SVRIVTguidelines.pdf> (accessed 2 June 2022).
- Levin AP, Albert L, Besser A, Smith D, Zelenski A, Rosenkranz S, et al. Secondary traumatic stress in attorneys and their administrative support staff working with trauma-exposed clients. *J Nerv Ment Dis*. 2011; 199(12): 946-955. doi: 10.1097/NMD.0b013e3182392c26.
- Kaminer D, Eagle G. Traumatic stress in South Africa. Johannesburg: Wits University Press; 2010. Available from: <https://muse.jhu.edu/book/60607> (accessed 28 August 2023).
- Penix EA, Kim PY, Wilk JE, Adler AB. Secondary traumatic stress in deployed healthcare staff. *Psychol Trauma* 2019; 11(1):1-9. doi: 10.1037/tra0000401.
- Maslach C. Job burnout: new directions in research and intervention. *Curr Dir Psychol Sci*. 2003; 12(5):189-192. doi: 0.1111/1467-8721.01258.
- Cocker F, Joss N. Compassion fatigue among healthcare, emergency and community service workers: a systematic review. *Int J Environ Res Public Health*. 2016; 13(6):618. doi: 10.3390/ijerph13060618.
- Benedek DM, Fullerton C, Ursano RJ. First responders: mental health consequences of natural and human-made disasters for public health and public safety workers. *Annu Rev Public Health*. 2007; 28:55-68. doi: 10.1146/annurev.publhealth.28.021406.144037.
- Shahan K, Ponder WN, Malthaner LA, Jetelina KK, Schuman DL, Carbajal J. Resilience measured as an outcome variable in a sample of emergency medical service (EMS) professionals. *Abuse*. 2022; 3(1):12-21. doi: <https://doi.org/10.37576/abuse.2022.028>.
- Yuan G, Park CL, Birkeland SR, Yip PS, Hall BJ. A network analysis of the associations between post-traumatic stress symptoms and post-traumatic growth among disaster-exposed Chinese young adults. *J Trauma Stress*. 2021; 34(4):786-798. doi: 10.1002/jts.22673.
- Department of Public Service and Administration. Employee health and wellness strategic framework for the public service. Pretoria: DPSA; 2019. Available from: <https://www.dpsa.gov.za/dpsa2g/documents/ehw/2019/EHW%20Strategic%20Framework%20-%20February%202019.pdf> (accessed 18 August 2023).
- South African Police Service Employee Health and Wellness. EHW risk factors facing police officers; 2016. Available from: <https://static.pmg.org.za/160217EHW.pdf> (accessed 18 August 2023).
- Greinacher A, Derezza-Greeven C, Herzog W, Nikendei C. Secondary traumatization in first responders: a systematic review. *Eur J Psychotraumatol*. 2019; 10(1):1562840. doi: 10.1080/20008198.2018.1562840.
- National Child Traumatic Stress Network. Secondary trauma and child welfare staff: guidance for supervisors and administrators. Los Angeles, CA: NCTSN; 2016. Available from: https://www.nctsn.org/sites/default/files/resources/fact-sheet/cac_understanding_secondary_traumatic_stress_resources_network.pdf (accessed 16 April 2022).
- Khandkar SH. Open coding. University of Calgary; 2009. Available from: <https://pages.cpsc.ucalgary.ca/~saul/wiki/uploads/CPSC681/open-coding.pdf> (accessed 8 April 2021).
- Harker R, Pidgeon AM, Klaassen F, King S. Exploring resilience and mindfulness as preventative factors for psychological distress burnout and secondary traumatic stress among human service professionals. *Work*. 2016 Jun 8;54(3):631-637. doi: 10.3233/WOR-162311.
- Kerig PK. Enhancing resilience among providers of trauma-informed care: a curriculum for protection against secondary traumatic stress among non-mental health professionals. *J Aggress Maltreat Trauma*. 2019; 28(5):613-630. doi: 10.1080/10926771.2018.1468373.
- Berceli D, Napoli M. A proposal for a mindfulness-based trauma prevention program for social work professionals. *Complement Health Pract Rev*. 2006; 11(3):153-165. doi: 10.1177/1533210106297989.
- Crumpton NM. Secondary traumatic stress and mindfulness training. *J Emerg Nurs*. 2010; 36(1):3-4. doi: 10.1016/j.jen.2009.11.007.
- Rushforth A, Durk M, Rothwell-Blake GA, Kirkman A, Ng F, Kotera Y. Self-compassion interventions to target secondary traumatic stress in healthcare workers: a systematic review. *Int J Environ Res Public Health* 2023; 20(12):6109. doi: 10.3390/ijerph20126109.
- Dipela MP. Evaluating the effectiveness of an employee assistance programme within South African police services in the Waterberg District, Limpopo Province (dissertation). Polokwane: University of Limpopo; 2016. Available from: http://ulspace.ul.ac.za/bitstream/handle/10386/1807/dipela_mp_2016.pdf?sequence=1&isAllowed=y (accessed 7 May 2022). 

Occupational malaria: lessons for occupational health practitioners

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INTRODUCTION

An editorial in *Nature* reports Dr CJ Levy, in his inaugural thesis (*These de Paris*, No. 707; 1939), stating that “...malaria is regarded as an occupational disease, for which appropriate compensation should be made, in certain countries, particularly North America (especially the States of Wisconsin and Illinois), Brazil, Spain and Italy, where its frequency as an occupational disease has given rise to special legislation. In France, on the other hand, there are no legislative measures recognizing malaria as an occupational disease, and compensation for contracting it is allowed only in the case of soldiers, sailors and airmen”.¹ In 2009, the International Labour Organization (ILO) considered whether to add malaria as a specified biological agent to the revised list of occupational diseases.² Although a number of members of the reviewing group recommended the inclusion of malaria, the experts did not agree, since the distinction of occupational and non-occupational cases was difficult to determine. However, proven occupational malaria is covered, in Section 1.3.9. of the ILO list, as a disease “caused by other biological agents at work not mentioned in the preceding items where a direct link is established scientifically, or determined by methods appropriate to national conditions and practice, between the exposure to these biological agents arising from work activities and the disease(s) contracted by workers”.²

Although there has been progress to eliminate malaria, the World Health Organization (WHO) reports that more than 600 000 people still die of malaria every year, and that increasing vector resistance to insecticides and parasite resistance to anti-malarial drug regimens remain a major concern.³ Occupational medical practitioners, including those in non-endemic countries and, particularly, those who provide services to occupational travellers, should be aware of the exposure to malaria, and the symptoms, diagnosis and treatment of the disease.

Malaria is caused by protozoan parasites of the genus *Plasmodium*, naturally transmitted by various species of female *Anopheles* mosquitoes to humans and animals. Human malaria is most commonly caused by *Plasmodium falciparum*, and less frequently by *Plasmodium vivax*, *Plasmodium ovale*, and *Plasmodium malariae*. A zoonotic species, *Plasmodium knowlesi*, has emerged as the

predominant species of malaria in some areas of south-east Asia and, rarely, some other non-human primate malaria species are able to infect humans.⁴ A classification of types of malaria transmission distinguishes between mosquito- and non-mosquito-transmitted malaria. The former includes locally acquired (indigenous to a region; or introduced by imported cases and transmitted by local mosquitoes) or odyssean (from imported infected mosquitoes, as discussed below). The latter is mechanical transmission via blood transfusion or needlestick; understandably, healthcare and laboratory workers are particularly at risk with this form.^{5,6} Congenitally acquired malaria is also non-mosquito transmitted.

The WHO produces an annual, detailed World Malaria Report³ that estimates the distribution of malaria-endemic areas within affected countries, using the *P. falciparum* parasite rate for high-transmission countries in west, central and east Africa, while the rate of confirmed malaria cases per 1 000 population is used for countries with low transmission in east and southern Africa, Central and South America, the eastern Mediterranean region, south-east Asia, and the western Pacific region. The WHO malaria report also shows the trends in annual cases diagnosed since 2000 for each country, and raises contemporary issues such as the geographic spread in Africa of *Anopheles stephensi* – an Asian vector species adapted to urban environments – and new vector control technologies.³

OCCUPATIONAL RISK OF MALARIA

The epidemiology of occupational malaria differs between endemic and non-endemic regions: in endemic malaria areas, the rate of transmission in local residents versus workers may not be clearly associated with occupation.⁷

Surveillance systems and surveys do not necessarily distinguish between occupationally and residentially acquired malaria, although some non-endemic countries report the number and percentage of cases, and the occupational categories affected.⁸⁻¹¹

In a high transmission area of Cambodia, travel to forest sites and forest work were significant risk factors for both *P. falciparum* and *P. vivax*, with prevalence of malaria infection ranging from 0.6% outside the forest to 40.4% inside.¹¹ The risk of workers acquiring

malaria in endemic malaria areas is higher for those involved with farming of crops requiring intensive irrigation, such as rice.¹² A study in Brunei, where *P. knowlesi* infection is the most common type of malaria, indicated that occupational cases accounted for 59% of the total number of *P. knowlesi* malaria cases diagnosed (21% were definitely work related, and 38% were classified as probably work related). A wide range of workers was infected in the tropical forests, and included border patrol officers, armed forces and security personnel, Department of Forestry officers, boatmen, and researchers.¹³

Of malaria cases confirmed in 2018 in the USA, where endemic malaria was eliminated in the 1940s, the majority originated in Africa and were caused by *P. falciparum*, with 2.1% occurring among USA military personnel.¹⁰ Malaria continues to be a major vector-borne disease of concern for the military worldwide.¹⁴ In the 1990s, Jaremin and colleagues reported that malaria is classified as an occupational disease in Polish citizens who work in endemic areas; the workers most commonly affected include seafarers, fishermen, priests, and missionaries – predominantly those who call at tropical ports or who work in rural areas or in the regions of military conflict, and who disregard malaria prevention and chemoprophylaxis.^{8,9} In their 1990s study of morbidity of malaria on board Croatian shipping vessels, Nikolić and colleagues concluded that the cases of malaria among seafarers indicated lack of relevant pre-travel and onboard healthcare.¹⁵ An historic review of risks due to infectious disease in British merchant seamen emphasised the substantial (58.2-fold) relative risk of malaria in comparison with the general population.¹⁶ More recently, an evaluation of malaria chemoprophylaxis and case reporting for Croatian seafarers revealed that none of them had malaria recognised as an occupational disease under Croatian law, and the majority (68%) of those who developed malaria had not taken chemoprophylaxis, while the other 32% took medication without following instructions.¹⁷ A number of fatal cases of malaria in seamen on foreign-registered ships in South African waters (most recently in May 2023) highlighted deficiencies in health policies and practices of shipping companies with regard to malaria (personal communication, SA Port Health Service).

In an analysis of more than 12 000 returning business travellers recorded on the GeoSentinel Surveillance Network of travel and tropical medicine clinics, mainly in western Europe or North America, Chen and colleagues (2018) reported that 9% presented with malaria, predominantly *P. falciparum* infections acquired in sub-Saharan Africa; of those who provided information, 92% took no or incomplete chemoprophylaxis.¹⁸ They concluded that business travellers need pre-travel advice, which is currently lacking or needs improvement.

Table 1. Odyssean malaria cases in South Africa in which occupation may have been a risk factor²⁶

Date	Putative occupational exposure
Jan 2013	Work at police station involved illegal immigrants
May 2014	Truck mechanic in a town on a busy national road
Mar 2015	Worker at a long-haul truck depot
Mar 2015	Worker involved with rail and road trailers
Nov 2015	Game lodge workers (n = 4)
Jan 2016	Mine hostel resident
Mar 2016	Mine employee
Oct 2016	Retail electrical worker
Sep 2017	Worker at import-export business

Expatriates deployed in low- to middle-income endemic countries should be counselled by occupational health practitioners about the risk, prevention, symptoms, and early diagnosis to minimise the potential impact of malaria,¹⁹ as well as the more general issue of adequate health insurance cover in the event that evacuation is necessary. Occupational malaria accounts for a notable proportion of reasons for emergency air evacuation in Africa. In a study of infectious disease-related evacuations of French soldiers (2003–2013), falciparum malaria was the top diagnosis (30/125, 24%), followed by fever of unknown origin (15/125, 12%).²⁰ An earlier study (1994–1995) of UN High Commission for Refugees field employees showed that, of 28 infectious disease-related evacuations, six (21%) were for malaria.²¹ In both these studies, more than 60% of all evacuations involved patients working in Africa.

In addition to acquiring malaria through visiting or living for work in malaria-endemic areas, workers in non-endemic regions may be infected through nosocomial exposure, or mosquito-borne (odyssean) transmission. While an imported infected mosquito is capable of transmitting infection to any person it encounters, the mode of mosquito transport may put certain workers at high risk. The entity was first recognised in workers and nearby residents at airports in Europe, and the description 'airport malaria' was applied, on the reasonable assumption that international flights had delivered the mosquitoes.^{22–24} A number of variants of the name have been used, depending on the putative mode of mosquito transport, e.g. 'taxi rank', 'minibus', 'baggage', 'luggage', or 'suitcase' malaria. To unify the concept under one name, the term 'odyssean malaria' was coined, referring to the dangerous journey that the mosquito would experience on the way to her final destination, culminating in parasite transmission to one or more persons.²⁵ In South Africa, Gauteng province has been the site of most recognised cases, probably because its position as the economic hub of the country makes it the destination of large traffic volumes from malaria-endemic areas, both within and outside national borders.²⁶ Since 1996, 166 odyssean malaria cases have been recorded, with 25 deaths (15% case fatality rate, reflecting frequent delays in diagnosis and treatment); some cases are undoubtedly undiagnosed.²⁶ Table 1 shows the subset of known cases over this period where possible occupational exposure was involved.

DISCUSSION

Clinicians in non-endemic countries frequently lack familiarity with malaria in returning travellers, including those travelling for work. In addition, there is some evidence that only a small percentage of travellers who have previously had malaria report taking chemoprophylaxis.²⁷ Odyssean malaria, by its nature, is always unusual and unexpected, with resulting delays in diagnosis and treatment, leading to often fatal outcomes. Ideally, occupational health services at airports should be sensitised to the entity. Regarding the risk to healthcare and laboratory workers, malaria is only one of several blood-borne diseases that are due to well-known occupational biological hazards, and personal protective measures should always be available and utilised. Policies and procedures should be in place to ensure the appropriate response in cases of accidental exposure.

It is important for occupational health practitioners not only to provide appropriate advice about anti-vector protection and relevant antimalarials to exposed workers, but also to pre-empt common reasons for non-adherence.¹⁰ A common misconception among people brought up in endemic areas, or who have experienced malaria previously, is that they remain immune when

they return to an endemic environment. Thus, it is imperative that occupational health practitioners provide advice on malaria prevention to such workers.

CONCLUSION

Surveillance and research findings indicate that malaria prevention and management are frequently not given sufficient attention in the workplace, and relevant occupational healthcare is lacking. Encouraging worker adherence to recommended malaria prevention strategies would reduce the number of malaria cases in people returning to non-endemic areas.

REFERENCES

1. Editorial. Malaria as an Occupational Disease. *Nature*. 1940; 3683:853. doi: 10.1038/145853c0.
2. International Labour Organization. Diagnostic and exposure criteria for occupational diseases. Guidance notes for diagnosis and prevention of the diseases in the ILO List of Occupational Diseases (revised 2010). Geneva: ILO; 2022. Available from: https://www.ilo.org/wcmsp5/groups/public/-ed_dialogue/---lab_admin/documents/publication/wcms_836362.pdf (accessed 16 August 2023).
3. World Health Organization. World Malaria Report 2022. Geneva: WHO; 2022. Available from: <https://www.who.int/teams/global-malaria-programme/reports/world-malaria-report-2022> (accessed 14 August 2023).
4. Ashley EA, Pyae Phyo A, Woodrow CJ. Malaria. *Lancet*. 2018; 391(10130):1608-1621. doi: 10.1016/S0140-6736(18)30324-6.
5. Tarantola AP, Rachline AC, Konto C, Houzé S, Lariven S, Fichelle A, et al. *Group d'Etude des Risques d'Exposition des Soignants aux agents infectieux*. Occupational malaria following needlestick injury. *Emerg Infect Dis*. 2004; 10(10):1878-1780. doi: 10.3201/eid1010.040277.
6. Herwaldt BL. Laboratory-acquired parasitic infections from accidental exposures. *Clin Microbiol Rev*. 2001; 14(4):659-688. doi: 10.1128/CMR.14.3.659-688.2001.
7. Nwaloze R, Onosakponome EO, Nnokam BA, Lawson SD. Study on the association between malaria and occupation among Covid-19 subjects. *Journal of Applied Health Sciences and Medicine*. 2023; 3(4):22-30. doi: 10.586 14/jahsm343.
8. Jaremin B, Nahorski W, Goljan J, Felczak-Korzybska I, Górski J, Myjak P, et al. Malaria as an occupational disease. *Bull Inst Marit Trop Med Gdynia*. 1993-1994; 44-45(1-4):43-50. Available from: <https://pubmed.ncbi.nlm.nih.gov/7580349/> (accessed 15 August 2023).
9. Jaremin B, Nahorski W, Goljan J, Felczak-Korzybska I, Górski J, Myjak P, et al. Malaria as an Occupational Disease in Polish Citizens. *J Travel Med*. 1996; 3(1):22-26. doi: 10.1111/j.1708-8305.1996.tb00691.x.
10. Mace KE, Lucchi NW, Tan KR. Malaria surveillance – United States, 2018. *MMWR Surveill Summ*. 2022; 71(8):1-35. doi: 10.15585/mmwr.ss7108a1.
11. Sandfort M, Vantaux A, Kim S, Obadia T, Pepey A, Gardais S, et al. Forest malaria in Cambodia: the occupational and spatial clustering of *Plasmodium vivax* and *Plasmodium falciparum* infection risk in a cross-sectional survey in Mondulakiri province, Cambodia. *Malar J*. 2020; 19:413. doi: 10.1186/s12936-020-03482-4.
12. Henry MC, Rogier C, Nzeyimana I, Assi SB, Dossou-Yovo J, Audibert M, et al. Inland valley rice production systems and malaria infection and disease in the savannah of Côte d'Ivoire. *Trop Med Int Health*. 2003; 8: 449-458. doi: 10.1046/j.1365-3156.2003.01053.x.
13. Koh GJ, Ismail PK, Koh D. Occupationally acquired *Plasmodium knowlesi* malaria in Brunei Darussalam. *Saf Health Work*. 2019; 10(1):122-124. doi: 10.1016/j.shaw.2018.09.002.
14. Leggat PA. Tropical diseases of military importance: a centennial perspective. *Journal of Military and Veterans' Health*. 2010; 18(4):25-30. Available from: https://jmvh.org/wp-content/uploads/2012/12/JMVHVol18-No-4_Oct2010_TropicalDiseases.pdf (accessed 16 August 2023).
15. Nikolić N, Poljak I, Troselj-Vukic B. Malaria, a travel health problem in the maritime community. *Journal of Travel Medicine*. 2000 Nov-Dec; 7(6):309-313. doi: 10.2310/7060.2000.00084.
16. Roberts SE, Carter T. British merchant seafarers 1900-2010: a history of extreme risks of mortality from infectious disease. *Travel Med Infect Dis*. 2016; 14(5):499-504. doi: 10.1016/j.tmaid.2016.06.009.
17. Žunić-Pedisić F, Knežević B. Malaria among Croatian seafarers between 2004 and 2014: evaluation of chemoprophylaxis use and occupational disease reporting. *Arh Hig Rada Toksikol*. 2021; 72(4):295-298. doi: 10.2478/aiht-2021-72-3597.
18. Chen LH, Leder K, Barbre KA, Schlagenhauf P, Libman M, Keystone J, et al. GeoSentinel Surveillance Network. Business travel-associated illness: a GeoSentinel analysis. *J Travel Med*. 2018; 25(1). doi: 10.1093/jtm/tax097.
19. Kitro A, Ngamprasertchai T, Srithanaviboonchai K. Infectious diseases and predominant travel-related syndromes among long-term expatriates living in low-and middle-income countries: a scoping review. *Trop Dis Travel Med Vaccines*. 2022; 8(1):11. doi: 10.1186/s40794-022-00168-4.
20. Rapp C, Aoun O, Ficko C, Andriamanantena D, Flateau C. Infectious diseases related aeromedical evacuation of French soldiers in a level 4 military treatment facility: a ten year retrospective analysis. *Travel Med Infect Dis*. 2014; 12(4):355-359. doi: 10.1016/j.tmaid.2014.03.005.
21. Peytremann I, Baduraux M, O'Donovan S, Loutan L. Medical evacuations and fatalities of United Nations High Commissioner for Refugees field employees. *J Travel Med*. 2001; 8(3):117-121. doi: 10.2310/7060.2001.24438.
22. Isaacs M. Airport malaria: a review. *Bull World Health Organ*. 1989; 67(6):737-743. Available from: <https://apps.who.int/iris/handle/10665/264723> (accessed 19 August 2023).
23. Van den Ende J, Lynen L, Elsen P, Colebunders R, Demey H, Depraetere K, et al. A cluster of airport malaria in Belgium in 1995. *Acta Clin Belg*. 1998; 53(4):259-263. doi: 10.1080/17843286.1998.11772033.
24. Van Bortel W, Van den Poel B, Hermans G, Vanden Driessche M, Molzahn H, Deblauwe I, et al. Two fatal autochthonous cases of airport malaria, Belgium, 2020. *Euro Surveill*. 2022; 27(16):2100724. doi: 10.2807/1560-7917.ES.2022.27.16.2100724.
25. Isaacs M, Frean JA. African malaria vectors in European aircraft. *Lancet*. 2001; 357(9251):235. doi: 10.1016/S0140-6736(05)71340-4.
26. Frean J, Brooke B, Thomas J, Blumberg L. Odyssean malaria outbreaks in Gauteng Province, South Africa, 2007-2013. *S Afr Med J*. 2014; 104(5):335-358. doi: 10.7196/samj.7684.
27. Akselrod H, Swierzbinski MJ, Zheng Z, Keiser J, Parenti DM, Simon GL. Characteristics and severity of disease among 100 cases of imported malaria seen at a U.S. university hospital, 2000-2017. *Am J Trop Med Hyg*. 2018; 99(6):1511-1517. doi: 10.4269/ajtmh.18-0608. 



Health effects of silica dust exposure — what do we need to do?

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On 28 March 2023, a satellite workshop, as part of the South Africa Sweden University Forum (SASUF) Research and Innovation Week 2023, was held at the University of the Witwatersrand School of Public Health. Ninety-five participants attended online from South Africa and several countries, and 28 attended in person. Prof. Tobias Chirwa, Head of the School of Public Health, welcomed all attendees. The workshop presentations and issues raised are summarised under the four themes of the workshop.

THEME 1: WHAT ARE THE SILICA-RELATED DISEASES AND WHY ARE THEY IMPORTANT?

Chaired by Dr Spo Kgalamono, Executive Director: National Institute for Occupational Health, National Health Laboratory Service, South Africa

Prof. Gill Nelson from the Wits School of Public Health set the scene with a short presentation about silica dust and silica-related health effects.

Overview of silica-related health effects and magnitude of the problem

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Millions of people are exposed to silica dust, worldwide, from a variety of industries, and silicosis rates remain high. The risk of developing silicosis is life long and continues after exposure has ceased. Silicosis data are available for some large industries but not for smaller businesses (usually unregulated), and artisanal and informal workers, which include women and children.

Quartz is the most common form of crystalline silica and the most common mineral in the earth's crust, so it is a component of most sand and rocks. Workers in many industries are exposed to silica dust. Aside from the well-known occupations, such as gold mining, construction, and artificial stone manufacture, those involved in tunnelling, denim jean production, jewellery production, hydraulic fracking, agriculture, and paint manufacturing (to name a few) are also potentially exposed to silica dust.

In the mining industry, silica dust is most prevalent in gold and coal mining, oil and gas mining, and shale and diatomaceous earth mining. Most affected are miners, drillers and crushing machine operators. In the construction industry, workers are exposed to silica dust from concrete, brick, granite, and tiles. Road working and stone working are also hazardous occupations. Exposure to silica flour is also a risk for silicosis as it comprises very fine grains of silica used in grouting, metal polish, abrasive cleaners, sandpaper, and

toothpaste. Silica nanoparticles are produced on an industrial scale as additives to cosmetics, drugs, printer toners, varnishes, and food, and are being developed for biomedical and biotechnological applications such as cancer therapy, and drug delivery. Long-term toxicity due to accumulation of these nanoparticles is under investigation.

Although silicosis and silica-associated tuberculosis (TB) are the most common occupational lung diseases associated with silica worldwide, exposure also plays a role in connective tissue diseases, lung cancer, chronic obstructive pulmonary disease, and some types of pulmonary fibrosis and systemic diseases. All are preventable.

Challenges

- For some diseases, there is a clear dose-response relationship (e.g. simple silicosis). For others, the dose-response relationship is less clear (e.g. auto-immune diseases).
- All of the diseases, apart from silicosis, are associated with other exposures, e.g. chronic obstructive pulmonary disease (COPD) and cigarette smoking, TB, and HIV.
- For these other diseases, the association with silica dust exposure is often overlooked, e.g. chronic renal disease and rheumatoid arthritis.
- There are diagnostic challenges, particularly in distinguishing silicosis and TB.
- Many questions remain, e.g. what is the interactive effect of smoking and silica dust exposure on COPD and lung cancer?

Prof. Emeritus Rodney Ehrlich, from the University of Cape Town, joined online to discuss the interaction of silica dust exposure and tuberculosis, and addressed some pertinent questions.

Silicosis and tuberculosis – unanswered questions and research needs

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Although silicosis and tuberculosis were identified as closely related but distinct entities in the early 20th century, there are still many unanswered questions about their relationship and combined management. This brief overview is based on experience with gold miners from the South African mines, although the questions have global application.

What is the silica dust concentration threshold for increased risk of TB?

We do not know whether control of silicosis will also control the excess risk of TB due to silica.¹ Cohort studies are needed, which control for radiological silicosis, measure silica exposure accurately, and control for other confounders.

What is needed to better distinguish radiologically between silicosis, TB, and combined disease in individuals from populations with a high risk of both diseases?

Training on the International Labour Organization (ILO) Pneumoconiosis Classification is necessary but not sufficient. Training is needed on taking an informed occupational history and on the radiological appearances of post-TB (fibrosis, nodulation, cystic changes/bronchiectasis, lung distortion, pleural sequelae) and of active TB.² Development of training materials for involved clinicians and evaluation of such training are needed.

What is the optimal TB treatment regimen for active TB combined with silicosis?

Cohort studies have found a two-to-three times worse clinical outcome for silicotuberculosis than for TB alone.^{3,4} Past clinical trials offer conflicting evidence on the optimal regimen and period of treatment (e.g. five to nine months).^{5,6} Updated research using the latest regimens is needed.

Is TB preventive treatment (TPT) of individuals with silicosis realistic in low-resource settings?

There is limited and mixed evidence of the effectiveness of TPT in silicosis and the period of treatment.^{7,8} South African national guidelines recommend TPT for persons with silicosis for three months (weekly rifapentine and isoniazid) or 12 months (daily isoniazid).⁹ The extent of local implementation is unknown and questions regarding regimen, acceptability, feasibility, and coverage remain, particularly among ex-miners. Updated research using the latest shorter regimens is needed.

How frequently should individuals be examined for silicosis and silicotuberculosis?

Currently, active miners in South Africa are required by law to be examined annually while the Occupational Diseases in Mines and Work Act provides for ex-miners to be examined every two years. This latter provision has historically hardly been implemented in the case of black miners, many of whom do not live in South Africa.¹⁰ Even with

these limitations of access, the Medical Bureau for Occupational Diseases (MBOD), the state agency responsible for certifying occupational lung disease in miners, has struggled with large backlogs in recent years.¹¹ This raises the question of what frequency of examination of ex-miners is feasible, taking into account the need to determine eligibility for compensation in an impoverished population and to identify TB given a very high risk of active disease.

In populations with high burdens of silicosis and TB, what is the role of sputum examination using GeneXpert or equivalent?

Individuals with silicosis have four times the risk of TB than those with TB alone.¹ In populations with both disease burdens, the diagnosis of active TB is confounded by chest X-ray (CXR) abnormalities and chronic respiratory symptoms attributable to silicosis and post-TB. On the other hand, half of individuals with active TB may have no symptoms.^{12,13} Xpert (and Xpert Ultra) have been shown to attain high sensitivity and specificity against TB culture.¹⁴ Protocols are needed for the threshold for sputum examination when examining individuals from such populations, and for rational empirical treatment in the case of negative sputum tests.^{2,14}

Can use of computer-aided detection systems for reading CXRs increase the ability to conduct such surveillance?

Computer-aided detection (CAD) is recommended by the World Health Organization (WHO) for CXR screening for active TB in high-risk groups, which includes workers exposed to silica dust.¹⁵ Independently, CAD has been shown to achieve high performance metrics for identification of silicosis in miners.¹⁶ Acceptability, feasibility, and costing studies of application of CAD for TB and silicosis in low-resource settings are needed.¹⁷

REFERENCES

1. Ehrlich R, Akugizibwe P, Siegfried N, Rees D. Silica exposure, silicosis and tuberculosis – a systematic review. *BMC Public Health*. 2021; 21:953. doi: 10.1186/s12889-021-10711-1.
2. Maboso B, Rees D, teWater Naude J, Goodman H, Ehrlich R. Difficulties in distinguishing silicosis and pulmonary tuberculosis in silica exposed gold miners – a report of four cases. *Am J Ind Med*. 2023; 66(4):339-348.
3. Escreet BC, Langton ME, Cowie RL. Short-course chemotherapy for silicotuberculosis. *S Afr Med J*. 1984; 66(9):327-330.
4. Hong Kong Chest Service/tuberculosis Research Centre, Madras/British Medical Research Council. A controlled clinical comparison of 6 and 8 months of anti-tuberculosis chemotherapy in the treatment of patients with silicotuberculosis in Hong Kong. *Am J Respir Med*. 1991; 143(2):262-267.
5. Churchyard GJ, Kleinschmidt I, Corbett EL, Murray J, Smit J, De Cock KM. Factors associated with an increased case-fatality rate in HIV-infected and non-infected South African gold miners with pulmonary tuberculosis. *Int J Tuberc Lung Dis*. 2000; 4:705-712.
6. Rupani MP. A mixed-methods study on impact of silicosis on tuberculosis treatment outcomes and need for TB-silicosis collaborative activities in India. *Sci Rep*. 2023; 13(1):2785. doi: 10.1038/s41598-023-30012-4.
7. Hong Kong Chest Service/Tuberculosis Research Centre, Madras/British Medical Research Council. A double-blind placebo-controlled clinical trial of three anti-tuberculosis chemoprophylaxis regimens in patients with silicosis in Hong Kong. *Clinical Trial*. *Am Rev Respir Dis*. 1992; 145(1):36-41.



8. Cowie RL. Short course chemoprophylaxis with rifampicin, isoniazid and pyrazinamide for tuberculosis evaluated in gold miners with chronic silicosis: a double-blind placebo controlled trial. *Tuber Lung Dis.* 1996; 77:239-243.
9. South Africa. Department of Health. National Guidelines on the Treatment of Tuberculosis Infection. Undated (issued 2023). Available from: https://sahivsoc.org/Files/Health_Latent%20TB%20Infection_2023_web.pdf (accessed 18 May 2023).
10. Ehrlich R, Barker S, Tsang V, Kistnasamy B, Yassi A. Access of migrant gold miners to workers' compensation for occupational lung disease: quantifying a legacy of injustice. *J Migration Health.* 2021; 4:100065. doi: 10.1016/j.jmh.2021.100065.
11. Kistnasamy B, Yassi A, Yu J, Spiegel SJ, Fourie A, Barker S, et al. Tackling injustices of occupational lung disease acquired in South African mines: recent developments and ongoing challenges. *Global Health.* 2018; 14(1):60. doi: 10.1186/s12992-018-0376-3.
12. Maboso BM, Moyo DM, Muteba KM, Govender VG, Barnes DF, Maama-Maime LBM, et al. Burden of disease among Basotho ex-miners in a large out-reach medical assessment programme. *Occup Health Southern Afr.* 2020; 26(4):145-152.
13. The First National TB Prevalence Survey. South Africa 2018. Short report. Available from: https://www.nicd.ac.za/wp-content/uploads/2021/02/TB-Prevalence-survey-report_A4_SA_TPS-Short_Feb-2021.pdf (accessed 18 May 2023).
14. Kendall A, Kamoga C, Kitonsa PJ, Nalutaaya A, Salvatore PP, Robsky K, et al. Empiric treatment of pulmonary TB in the Xpert era: correspondence of sputum culture, Xpert MTB/RIF, and clinical diagnoses. *PLoS ONE.* 2019; 14(7):e0220251. doi: 10.1371/journal.pone.0220251.
15. WHO Consolidated Guidelines on Tuberculosis. Module 2: Screening – Systematic Screening for Tuberculosis Disease. Geneva: World Health Organization; 2021. Licence: CC BY-NC-SA 3.0 IGO. Available from: <https://apps.who.int/iris/bitstream/handle/10665/340255/9789240022676-eng.pdf> (accessed 19 May 2023).
16. Ehrlich R, Barker S, Rees D, teWater Naude J, Kistnasamy B, Naidoo J, et al. Accuracy of computer aided detection of silicosis and pulmonary tuberculosis in ex-miners from the South African gold mines. *Int J Environ Res Public Health.* 2022; 19:12402. doi:10.3390/ijerph191912402.
17. Geric C, Qin ZZ, Denkinger CM, Kik SV, Marais B, et al. The rise of artificial intelligence reading of chest X-rays for enhanced TB diagnosis and elimination. *Int J Tuberc Lung Dis.* 2023; 27(5):367-372.

The topic of 'Silica dust exposure and lung cancer' was presented by Prof. Jill Murray (honorary associate professor in the Wits School of Public Health), with assistance from Dr Deepna Lakhoo from the National Institute for Occupational Health and the Wits School of Pathology.

Silica-associated lung cancer

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Worldwide, lung cancer is one of the most commonly diagnosed malignancies and is the leading cause of cancer mortality; for example, in the USA, it comprises 21% of all cancer deaths.¹ In the general population, tobacco smoke is the main risk for lung cancer and there is evolving evidence of increased risks due to smoking combined with other lung carcinogens. However, what is less well appreciated, both by the medical profession and the general public, is the contribution of occupational factors. The population attributable fraction of occupational lung cancer is reported to be as high as 15%.² Of the occupational exposures, asbestos is the most common, but there are many other workplace carcinogens, including arsenic, radon, polycyclic aromatic hydrocarbons, and silica.

In 1997, the International Agency for Research on Cancer (IARC) designated silica as a carcinogen³ but, at that time, the carcinogenicity was questioned because of the absence of dose-response findings in studies, and the concern that confounding variables, in particular smoking, had not been adequately addressed.⁴

In 2012, the IARC performed an updated meta-analysis, which confirmed the carcinogenicity of silica and clearly demonstrated a positive exposure-response relationship.⁵ These findings greatly contributed to the lowering of the occupational exposure limit (OEL) to 0.05 by the Occupational Health and Safety Administration (OHSA) in 2016.⁶ However, a number of uncertainties remained, with

implications for medical screening, prevention, setting of OELs, and lung cancer treatments. Is the presence of silicosis a necessary pre-requisite to attribute lung cancer in an individual to silica exposure? What is the combined effect of silica and smoking? Is there a silica exposure threshold below which lung cancer will not occur? Is there an association with specific histological subtypes?

Subsequent research has shed light on these uncertainties. First, the risk of lung cancer is elevated in both those with and without radiological signs of silicosis,⁷ and the effect of smoking is likely multiplicative⁸ (see Figure 1). With regard to histological type, some studies have suggested an increased risk of all types of lung cancer,⁸ while others have reported a strong association with small and squamous cell carcinomas⁹ – subtypes that are less responsive to therapy than adenocarcinomas.¹⁰

As a result of relatively recent advances in lung cancer management, the outlook has shifted from one of nihilism to cautious optimism.¹ Subsequent to research conducted in the USA that showed that screening with low-dose computed tomography (LDCT) substantially reduced lung cancer mortality,¹¹ programmes targeted at current and former smokers have been widely instituted in well-resourced settings. There are no official screening programmes for lung cancer in South Africa. However, the South African Thoracic Society made broadly similar recommendations in 2019 with pointers to guide interpretation,¹² given the high local prevalence of tuberculosis. With regard to treatment, molecular profiling of tumours, undertaken in sophisticated pathology laboratories, is resulting in targeted, individually tailored therapy.¹⁰

There are several important implications for the management of silica-exposed populations in South Africa. Chest radiographs are the most widely used modality for silicosis diagnosis – but they not only miss half the cases of pulmonary silicosis using autopsy as the gold standard,¹³ but also do not meet the requirements for lung cancer screening.⁴ Studies are necessary to clarify the efficacy

of LDCT screening in populations in which silicotuberculosis is not infrequent. Research directed at treatment should include a focus on the cells and genes activated by silica exposure to identify potential therapeutic targets. Primary prevention should aim not only to reduce exposure to silica, but also carcinogens, particular tobacco smoke. For workers with lung cancer, clear criteria for compensation need to be established. Finally, research is needed to evaluate the burden of silica-associated lung cancer in both mining and non-mining populations.

REFERENCES

1. Siegel RL, Miller KD, Wagle NS, Jemal A. Cancer statistics, 2023. *CA Cancer J Clin.* 2023 Jan; 73(1):17-48. doi: 10.3322/caac.21763. doi: 10.3322/caac.21763.
2. Cocco P. Lung cancer and occupation. In: Feary J, Suojalehto H, Cullinan P, eds. *Occupational and Environmental Lung Disease (ERS Monograph)*. Sheffield: European Respiratory Society; 2020. pp. 252–265.
3. International Agency for Research on Cancer. IARC monographs on the evaluation of carcinogenic risks to humans. Vol 68. Silica, some silicates, coal dust and para-aramid fibrils. Lyon: IARC; 1997. Available from: <https://monographs.iarc.fr/wp-content/uploads/2018/06/mono68.pdf> (accessed 7 August 2023).
4. Sato T, Shimosato T, Klinman DM. Silicosis and lung cancer: current perspectives. *Lung Cancer (Auckl)*. 2018; 9:91-101. doi: 10.2147/LCTT.S156376.
5. IARC Working Group on the Evaluation of Carcinogenic Risks to Humans. Arsenic, metals, fibres, and dusts. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. 2012; 100(Pt C):11-465. Available from: <https://europepmc.org/article/NBK/nbk304375>.
6. United States. Occupational Health and Safety Administration. Occupational Exposure to Respirable Crystalline Silica; Final Rule. FR Doc No: 2016-04800. Federal Register. 2016; 81(58):16285-16890. Available from: <https://www.govinfo.gov/content/pkg/FR-2016-03-25/pdf/2016-04800.pdf> (accessed 7 August 2023).
7. Poinen-Rughooputh S, Rughooputh MS, Guo Y, Rong Y, Chen W. Occupational exposure to silica dust and risk of lung cancer: an updated meta-analysis of epidemiological studies. *BMC Public Health.* 2016; 16(1):1137. doi: 10.1186/s12889-016-3791-5.
8. Ge C, Peters S, Olsson A, Portengen L, Schüz J, Almansa J, et al. Respirable crystalline silica exposure, smoking, and lung cancer subtype risks. A pooled analysis of case-control studies. *Am J Respir Crit Care Med.* 2020;

Risk is elevated in both silicotics and non-silicotics⁷

	SMR	95% CI
Silicotics	2.32	1.91–2.81
Non-silicotics	1.78	1.07–2.96

For the same silica dose, the cancer risk is higher in individuals with radiological silicosis.

Risk of smoking is at least additive and likely multiplicative⁸

Exposure status	OR ⁷	95% CI
Never smoker and never silica	1.00	
Never smoker and ever silica	1.02	0.87–1.19
Ever smoker and never silica	6.37	5.91–6.87
Ever smoker and ever silica	8.72	8.00–9.52

Figure 1. Silica dust exposure risks for lung cancer

- 202(3):412-421. doi: 10.1164/rccm.201910-1926OC.
9. Zhou Y, Zhang W, Wu D, Fan Y. The effect of silica exposure on the risk of lung cancer: A meta-analysis. *J Biochem Mol Toxicol.* 2023; 37(4):e23287. doi: 10.1002/jbt.23287.
10. Lindeman NI, Cagle PT, Aisner DL, Arcila ME, Beasley MB, Bernicker EH, et al. Updated molecular testing guideline for the selection of lung cancer patients for treatment with targeted tyrosine kinase inhibitors: guideline from the College of American Pathologists, the International Association for the Study of Lung Cancer, and the Association for Molecular Pathology. *Arch Pathol Lab Med.* 2018; 142(3):321-346. doi: 10.5858/arpa.2017-0388-CP.
11. National Lung Screening Trial Research Team. Reduced lung-cancer mortality with low-dose computed tomographic screening. *N Engl J Med.* 2011; 365:395-409. doi: 10.1056/NEJMoa1102873.
12. Koegelenberg CFN, Dorfman S, Schewitz I, Richards GA, Maasdorp S, Smith C, et al. South African Thoracic Society. Recommendations for lung cancer screening in Southern Africa. *J Thorac Dis.* 2019; 11(9):3696-3703. doi: 10.21037/jtd.2019.08.66.
13. Hnizdo E, Murray J, Klempman S. Lung cancer in relation to exposure to silica dust, silicosis and uranium production in South African gold miners. *Thorax.* 1997; 52(3):271-275. doi: 10.1136/thx.52.3.271.

THEME 2: SILICOSIS ELIMINATION PROGRAMMES

Chaired by Dr Vanessa Govender, Director: Masakhane Health, South Africa

Dr Meckie Achayo from MKUTA in Tanzania [A Response to Fight TB and HIV/AIDS in Tanzania], who is a Wits graduate, provided data about 'Silicosis elimination programmes in the non-mining industry – a global context'; he joined virtually from Dar es Salaam, Tanzania.

Silicosis elimination programmes in the non-mining sector: a global context

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Background

Elimination of silicosis has been on the global agenda since the 1930s. In 1995, the ILO/WHO Joint Committee on Occupational Health recommended countries to place elimination of silicosis high on their priority lists.¹ In the same year, the Global

Programme for the Elimination of Silicosis (GPES) was initiated. Following this, countries such as Brazil, China, Chile, India, Thailand, Vietnam, and South Africa joined the programme and formed their own National Programmes for the Elimination of Silicosis (NPESs).¹

Methods

A scoping review was conducted to explore silicosis elimination programmes in the non-mining industry, globally, through an extensive search for both scientific and grey literature



published from 1995 to 2021. Of the 1 277 articles identified, 10 met the eligibility criteria (two journal papers, three reports, four presentations, and one fact sheet). Eight countries were represented: the Americas (Brazil, Chile, Peru), Asia (Vietnam, Thailand, China), Africa (South Africa), and Europe (Turkey).

Findings

Countries used four key strategies to implement their NPES activities:

1. Intra- and inter-national collaborations
2. Capacity building through training
3. Policies, guidelines, and silicosis prevention measures
4. Occupational health surveillance and prevalence studies

Intranational collaborations were initiated among government ministries as well as with occupational health and safety-related organisations. The Americas Silicosis Initiative (initiated in 2005) and the Work and Health in Southern Africa (WAHSA) programmes are good examples of regional collaborations.^{2,3} In countries such as Brazil, Chile, and Peru, training was conducted on dust control technologies (control banding) and diagnosis of silicosis using the ILO's International Classification of Radiographs of Pneumoconioses.²

To ensure that prevention measures were adhered to, countries developed policies through their NPES. For example, Brazil banned the use of sand as a blasting agent and dry finishing of ornamental stones.⁴ Chile developed a risk assessment guidance tool, the 'Qualitative Evaluation of the Risk of Exposure to Silica', for assessment and control of silica exposures in four high-risk industries: aggregate crushing, ceramics, tile making, and dental laboratories.⁵ Surveillance and prevalence studies were identified as essential for the monitoring of trends of several indicators (e.g. the proportion of workers using protective personal equipment (PPE)).^{6,7}

Challenges

Several challenges hindered progress of NPES activities across different countries. Some of these included:¹

1. Insufficient political will
2. Insufficient access to information and knowledge
3. Shortage and/or inadequacy of human resources
4. Legislation shortcomings:
 - a. Poor enforcement
 - b. More focus on fact finding than problem solving
5. Shortage or inadequate allocation or re-allocation of financial resources
6. Insufficient primary prevention measures

Insights

There is a gap in reporting progress of the NPES and GPES, which may indicate a loss of momentum of global efforts to eliminate silicosis. While experiences from Switzerland, Germany, Finland, and France indicate that silicosis incidence can be reduced, there has been a resurgence in some countries e.g. Australia and Sweden.⁸ Vigilance through surveillance is therefore needed to respond to new exposures and epidemics.

Food for thought

- Is the WHO and ILO target to eliminate silicosis by 2030 achievable?
- What are the best silicosis elimination strategies for the African non-mining industry, including the informal sector?
- What lessons can the non-mining industry draw from the mining industry?
- How can we translate strategies/experiences from countries such as Belgium and Switzerland to suit the southern African context?

Acknowledgements

Ntombizodwa Ndlovu, Thireshni Chetty, Nelisiwe Fakudze, Taile Kgoete, and Lebogang Mogongoa (School of Public Health, University of the Witwatersrand); Edward Sepirwa and Odette Volmink (National Institute for Occupational Health); and the Department of Employment and Labour (South Africa).

REFERENCES

1. World Health Organization. The Global Occupational Health Network: Elimination of Silicosis; 2007:1-20. Available from: <https://studylib.net/doc/13783560/gohnet-the-global-occupational-health-network> (accessed 8 August 2023).
2. Pan American Health Organization. Fact sheet – Elimination of Silicosis: Americas Initiative; 2009. Available from: <https://www.paho.org/en/documents/fact-sheet-elimination-silicosis-americas-initiative> (accessed 8 August 2023).
3. Hogstedt C, Elgstrand K, Ryan A, Naidoo RN, Rees D, Chitambo A, et al. The Work and Health in Southern Africa (WAHSA) Programme – overall experiences and the way forward. *Occup Health Southern Afr*. 2009;15(6a–WAHSA Special Issue):2-6. Available from: <http://occhealth.co.za/index.php?p=issue&i=187> (accessed 8 August 2023).
4. International Labour Organization. National Programme on Elimination of Silicosis – Brazil; 2005. Available from: https://www.ilo.org/global/topics/safety-and-health-at-work/events-training/events-meetings/WCMS_110470/lang--en/index.htm (accessed 8 August 2023).
5. National Institute for Occupational Safety and Health, Finnish Institute of Occupational Health. Improving workers' health across the globe: advancing the global plan of action for workers' health. Cincinnati, OH: Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH). Publication No. 2016-118; 2016. Available from: <https://www.cdc.gov/niosh/docs/2016-118/default.html> (accessed 8 August 2023).
6. International Labour Organization. Silicosis Elimination Program in Thailand; 2005. Available from: https://www.ilo.org/wcmsp5/groups/public/---ed_protect/---protrav/---safework/documents/presentation/wcms_110488.pdf (accessed 8 August 2023).
7. International Labour Organization. Evaluation on five years of implementing the silicosis prevention project in Vietnam (1999-2003); 2005. Available from: https://www.ilo.org/safework/info/WCMS_110490/lang--en/index.htm (accessed 8 August 2023).
8. Fedotov IA. The ILO/WHO Global Programme for the Elimination of Silicosis (GPES). *African Newsletter on Occupational Health and Safety*; 2005; 15(3):56-58.

Moving abroad, Prof. Anna-Carin Olin (University of Gothenburg), who was visiting South Africa for the SASUF Research and Innovation Week, described the current situation with regard to silica dust exposure in Sweden.

Silica exposure in Sweden – past and current perspectives

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The exposure pattern to silica dust has changed dramatically in Sweden during the last decade. The mining sector has changed from having more than 1 000 small mines back in history; the number is now down to 15. Quarrying also used to be a big industry, employing more than 7 000 workers, but has decreased in size and currently employs around 1 200 workers. Much of the stonework is now exported, mainly to China, where poor working conditions have been described. Initiatives have been taken to strengthen procurements to include standards for the work environment for imported stone, but many anomalies still probably exist.

During the 1960s, there was a large campaign to reduce exposure to quartz in Swedish mines. This was as a result of analysis of data from the national silicosis register, which revealed that more than 4 500 workers – mainly employed in quarrying – had developed silicosis. The campaign was successful: exposure levels were dramatically reduced and morbidity decreased. Subsequently, there has been a gradual reduction in Sweden's preventive measures. The silicosis register was stopped in 1988, and legislation prescribing obligatory quartz measurements in specified workplaces was abandoned in 2019. This has resulted in a lack of knowledge about the current exposure situation in Swedish workplaces and an ignorance of the problems associated with silica exposure. Sectors where exposure to silica dust still seems to be a problem are construction and concrete manufacturing, which employ many workers.

Strong initiatives, from researchers in occupational and environmental departments in Sweden, have been taken to lower the current OEL for quartz from 0.1 to 0.05 or 0.025 mg/m³, but efforts have been fruitless so far.

Moving back to South Africa, Jabulile Mhlophe (Department of Employment and Labour) gave an update on the silica dust and silicosis milestones.

South Africa's National Programme for the Elimination of Silicosis – where are we?

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In 2004, the Department of Employment and Labour initiated the National Programme for the Elimination of Silicosis. Two years later, in 2006, the National Working Group (NWG) and Provincial Working Groups (PWGs) were established to manage the programme, but lack of baseline data on the prevalence of silicosis in South Africa made it difficult for the working groups to achieve their mandates.

In 2009, the Council for Scientific and Industrial Research (CSIR) was commissioned to conduct a literature review on silica dust exposures of workers in the non-mining industry, especially in South Africa. The review revealed that there was no information regarding the most frequently recorded occupations where silicosis was listed as a contributory cause of death in the South African non-mining sector, although, from 1999 to 2004, the Occupational Medicine Clinic at the National Institute for Occupational Health (NIOH) diagnosed silicosis in workers from foundries and potteries, and from the refractory, engineering, stone crushing, construction, chemical, and glass industries.¹ The authors also stated that “*Lack of a comprehensive programme on worker exposure to silica dust and a commitment from the management on this type of programme is a problem in the non-mining industries*.”¹ The same group collected 300 personal dust samples, using gravimetric dust sampling in six non-mining industries in Gauteng province. Silica dust exposures in the sandstone, ceramics, refractory, and foundry exceeded the OEL of 0.1 mg/m³.²

In the same year (2010), the Department of Employment and Labour embarked on an inspection of 208 silica dust producing companies in all the provinces to determine compliance with silica dust levels in terms of the Occupational Health and Safety Act of

1993. Only 54 companies (26%) were found to be compliant.³

In October 2020, the CSIR and the Wits Health Consortium were funded by the Department of Employment and Labour to conduct a study on the prevalence of silicosis in the non-mining sectors in South Africa, which is underway. The objectives of the study are:

1. To determine the prevalence of (and the number of workers diagnosed with) silicosis across industries from 2012 to 2018
2. To establish trends in the number of deaths from silica-related diseases per industry from 2012 to 2018
3. To develop a strategy and occupational health programmes that should be put in place to reduce exposure to respirable silica dust and to eliminate silicosis in South Africa by 2030

REFERENCES

1. Khoza NN, Grové T, Moraba M, Schutte PC. Level of exposure of workers to silica dust in the non-mining sectors in South Africa. Literature review. Centre for Mining Innovation, CSIR; 2009. Available from: <https://www.labour.gov.za/DocumentCenter/Research%20Documents/SEIAS%20Reports/Level%20of%20exposure%20of%20workers%20to%20Silica%20dust%20in%20the%20non%20mining%20sectors%20in%20South%20Africa.pdf> (accessed 21 August 2023).
2. Khoza N, Grové T. Determining the extent of exposure to silica dust of the workers in the non-mining sectors in South Africa: an exploratory study. Centre for Mining Innovation, CSIR; 2010. Available from: <https://www.labour.gov.za/DocumentCenter/Research%20Documents/SEIAS%20Reports/Determining%20the%20extent%20of%20exposure%20to%20silica%20dust%20of%20workers%20in%20the%20non%20mining%20sectors%20in%20South%20Africa.pdf> (accessed 21 August 2023).
3. Annual Report of the Department of Labour. Section 2. Information on predetermined objectives. Dept. of Labour; 2011. Available from: https://www.labour.gov.za/DocumentCenter/Reports/Annual%20Reports/Departmental%20Annual%20Reports/2011/PFMA%20Report_2011part2.pdf (accessed 22 August 2023).



Jabulile Mphlope was followed by Dr Thuthula Balfour (Minerals Council South Africa), who brought the audience up to date on the mining industry's progress on silicosis elimination.

Silicosis elimination in the South African mining industry

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The elimination of silicosis remains a priority in the South African mining industry as evidenced by the number of cases that are still reported annually. Although cases of silicosis declined by 86.5% from 2008 to 2021, there were still 240 cases reported in 2021. This is a significantly high number.

It is ironic that the first international conference on silicosis was convened by the ILO and the Transvaal Chamber of Mines, and paved the way to the adoption of a 1934 ILO convention that recognised silicosis as an occupational disease.

Over the years, South Africa has led research on silicosis. In a seminal study conducted in 2004, Gavin Churchyard et al. found an 18.3–19.9% prevalence of silicosis in 520 gold miners with mean service of 21.8 years, at quartz levels of 0.053 mg/m³. With this and other evidence, better performance regarding the elimination of silicosis in the country would have been expected.

This irony is well articulated by Jock McCulloch in his book, *South Africa's Gold Mines and the Politics of Silicosis*, in which he states: "The history of silicosis in South Africa is filled with paradoxes. The Rand mines were the first in the world to invest heavily in dust extraction technologies and instruments, such as the konimeter, to reduce risk. South Africa was the first state to recognise silicosis and tuberculosis as occupational diseases, and the gold mines were the first to use radiography to screen workers. Yet South Africa was unsuccessful in making the mines safe or in providing adequate compensation. The major paradox is between the intensity of public debate about silicosis and the invisibility of the disease burden."¹

There have been concerted industry initiatives from both the Mine Health and Safety Council (MHSC) and the Minerals Council South Africa to eliminate silicosis and other pneumoconioses. In 2003, through the

MHSC, the industry adopted milestones, which were re-emphasised in 2013:²

- By December 2024, 95% of all exposure measurement results will be below the milestone level for respirable crystalline silica (RCS) of 0.05 mg/m³.
- By December 2024, 95% of all exposure measurement results will be below the milestone level for coal dust respirable particulate of 1.5 mg/m³ (< 5% crystalline silica).
- Using current diagnostic techniques, no new cases of silicosis, pneumoconiosis, or coal worker's pneumoconiosis will occur amongst previously unexposed individuals who joined the industry in 2009.

In 2007, the Minerals Council developed the Mining Occupational Safety and Health (MOSH) leading practice adoption system and rolled out several leading practices in mines, such as the fogger dust suppression system, footwall and sidewall treatment, scraper winch covers, multistage filtration system, and continuous real-time monitoring of airborne pollutants. The Minerals Council also established a milestone reporting system in 2015 to monitor progress towards achieving the milestones.

Consequently, the mining industry is on target to meet the milestone on RCS. In 2022, 6.3% of exposures were higher than 0.05 mg/m³, lower than the aspirational target of 7%. A few cases of silicosis have, however, been diagnosed in novices who joined the industry after 2009. This is a cause for concern as it indicates previous high levels of exposures.

In conclusion, South Africa has the knowledge and ability to eliminate silicosis and all efforts should be directed at this task.

REFERENCES

1. McCulloch J. *South Africa's Gold Mines and the Politics of Silicosis*. Martlesham, Suffolk: Boydell & Brewer; 2012. Available from: <https://www.jstor.org/stable/10.7722/j.ctt1x736n> (accessed 14 August 2023).
2. South African Government. Mineral Resources on Occupational Health and Safety summit; 2016. Available from: <https://www.gov.za/speeches/mine-health-and-safety-19-nov-2016-0000> (accessed 14 August 2023).

THEME 3: OCCUPATIONAL EXPOSURE LIMITS

Chaired by Prof. Cas Badenhorst, Anglo American and North-West University, South Africa

More technical presentations followed, starting with an online discussion by Prof. Derk Brouwer (University of the Witwatersrand), who pertinently asked the question: "Should the current statutory OEL for silica be reduced to 0.05 mg/m³?" This question was further debated by Prof. Cas Badenhorst (North-West University) as he explained the challenges in reducing the statutory RCS OEL in the SA mining industry.

Will reducing the statutory OEL for silica to 0.05 mg/m³ prevent new silicosis cases?

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OELs aim to protect workers from developing diseases due to a working lifetime of exposure to hazardous substances. Such limit values can be derived from toxicological animal studies where an outcome or point

of departure is used as a starting point for extrapolation to human exposure, or from epidemiological studies. The first type of OEL assumes a 'standard worker and scenario', such as a 70 kg male performing light activities for 40 years for 40 hours per week. The second type of OEL uses (aggregated lifetime) exposure-disease outcome relationships to calculate a cut-off point as a limit value concentration. However, there is always a residual risk – partly due to the uncertainties associated with the methods. This means that exposure to the substance at the OEL

concentration will never protect all workers from adverse health effects. For example, for RCS dust, the US Occupational Safety and Health Agency (OSHA) states that the residual risk for silicosis at an OEL of 0.05 mg/m³ ranges from 0.7% to 4.3%.¹ Similarly, the EU Scientific Committee on Occupational Exposure Limits (SCOEL) assumes a silicosis prevalence of < 5% at that OEL concentration.²

In addition to the actual value of the OEL, there are statistical considerations regarding compliance testing. Presently, it is not feasible to measure exposures for every worker each day. In practice, the time-weighted average concentration over eight hours (TWA-8h) of a 'sample' of workers is measured periodically. This dataset is used to make inferences about the total population of workers. Consensus exists that a lognormal distribution can best describe the variation in concentrations of pollutants in workplaces. Moreover, the current approach uses the 95th percentile of the estimated distribution of concentrations for the 'population' as a test criterion. Taking this into account, it is essential to know how, in actual workplace practice, compliance with the OEL can ensure that the RCS TWA-8h concentrations for all of the workers does not exceed 0.05 mg/m³. For a hypothetical dataset, 21 TWA-8h concentrations range from 0.023 to 0.05 mg/m³ with a geometric mean (GM) of 0.035 mg/m³ and a relatively low geometric standard deviation (GSD) of 1.27. For this dataset (with no data point exceeding 0.05 mg/m³), the point estimate of the 95th percentile of the population from which

this sample is drawn is 0.054 mg/m³, and the probability of exceedance of 0.05 mg/m³ is 81.7%.

In conclusion, the risk of developing silicosis will never be reduced to zero, due to the inherent variability of exposure and the uncertainty associated with both the OEL and its compliance testing (95th percentile of a sample). A 5% exceedance of an OEL is accepted, whereas an RCS OEL of 0.05 mg/m³ implicitly accepts a 'residual' risk. Therefore, silicosis cannot be eliminated by a statutory OEL of 0.05 mg/m³ (or even a lower value). However, the prevalence can be reduced to a societal 'accepted risk level', although this will only work (as long as every worker is not equipped with a real-time monitor every day) if the 95th percentile of the TWA-8h concentration distribution of each measurement campaign (sample) is below this threshold limit value.

REFERENCES

1. United States. Occupational Safety and Health Administration, Department of Labor. Occupational exposure to respirable crystalline silica – Literature review and preliminary risk assessment, OSHA 2010-0034; 2010. Available from: <https://www.federalregister.gov/documents/2016/03/25/2016-04800/occupational-exposure-to-respirable-crystalline-silica> (accessed 9 August 2023).
2. Recommendations from the Scientific Committee on Occupational Exposure Limits for Silica, Crystalline (respirable dust). SCOEL/SUM/94. European Commission; 2003.

Challenges in reducing the statutory RCS OEL in the SA mining industry

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OELs play a crucial role in assessing workplace exposures and their potential health risks. Ever since Kobert introduced the table of acute exposure limits in 1912,¹ numerous organisations worldwide

have contributed to the global effort of establishing OELs. These limits serve as invaluable tools in understanding and managing occupational hazards.

The widespread adoption of OELs has led to a complex landscape of guidelines, influenced by various factors and organisations. The process of developing and setting OELs involves evaluating scientific data on health impacts, which can differ between bodies and jurisdictions. One significant factor contributing to variations in OELs is the consideration of feasibility, with health-based OELs being more

Table 1. Early history of institutional OEL development *

Decade first published	Type of OEL
1910s	US and South African limits (for crystalline silica/quartz only)
1920s	US Bureau of Mines exposure limits International Critical Tables
1930s	German exposure limits USSR Ministry of Labour MACs
1940s	American Conference of Governmental Industrial Hygienists (ACGIH) maximum allowable concentrations of atmospheric contaminants (preceding threshold limit values) American National Standards Institute standards
1950s	People's Republic of China's Provisional Hygienic Standards for the Design of Industrial Premises
1970s	US Occupational Safety and Health Administration (OSHA) permissible exposure limits (PELs) National Institute for Occupational Safety and Health (NIOSH) recommended exposure limits (RELs) Nordic Expert Group (NEG) for Criteria Documentation of Health Risks from Chemicals <i>Deutsche Forschungsgemeinschaft (DFG) Maximale Arbeitsplatz-Konzentration (MAKs)</i>
1980s	American Industrial Hygiene Association (AIHA) workplace environmental exposure limits (WEELs)
1990s	European Scientific Experts Group (now Scientific Committee on Occupational Exposure Limits [SCOEL]) binding occupational exposure limit values (BOELVs) and indicative occupational exposure limit values (IOELVs)

*Source: Deveau et al. 2015²



precautionary and regulatory-adjusted OELs incorporating non-health factors such as economics and technical feasibility.

These differences in OELs are seen not only between health-based and regulatory-adjusted values but also across jurisdictions with varying socioeconomic contexts and technological capabilities. The economic feasibility of reducing OELs for substances such as silica includes benefits for governments and employers. Governments can experience lower costs in medical treatment and tests, reduced insurance payments, and fewer incident investigations. Employers benefit from reduced costs associated with illnesses, fatalities, insurance payments, replacement workers, and training.

The economic feasibility of reducing OELs also considers costs associated with implementing engineering and administrative controls, conducting more frequent incident investigations, adopting new equipment and technologies, and complying with changes in codes of practice.³ Additionally, there may be indirect costs related to productivity loss due to process elimination or substitution techniques, as well as the potential for complete work stoppages.

Overall, the economic feasibility of reducing OELs requires a comprehensive assessment of costs and benefits, considering the specific context and capabilities of each jurisdiction.

REFERENCES

1. Kobert R. The smallest amounts of noxious industrial gases which are toxic and the amounts which may perhaps be endured. *Comp Pract Toxicol.* 1912; 5:45.
2. Deveau M, Chen CP, Johanson G, Krewski D, Maier A, Niven KJ, et al. The global landscape of occupational exposure limits – implementation of harmonization principles to guide limit selection. *J Occup Environ Hyg.* 2015; 12 (sup1):S127-S144. doi: 10.1080/15459624.2015.1060327.
3. Claassen N, Du Plessis JL, Van der Walt J, Preis E, Girdler-Brown B, Ker-Fox J, et al. Review of the current airborne exposure limits as listed in Schedule 22.9(A). CoE 180607. Johannesburg: Mine Health and Safety Council; 2021. Available from: https://mhsc.org.za/wp-content/uploads/2022/05/CoE-180607-Milestone-5-Integrated-Report_Final.pdf (accessed 25 August 2023).

Mr Vijay Nundlall (Sibanye-Stillwater) expanded on Prof. Badenhorst's talk, by discussing current practices to reduce silica dust exposure in the South African mining industry.

Current practices to reduce dust exposure in the South African mining industry

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Vijay Nundlall focused on current practices in the South African gold mining industry to reduce exposure to silica dust. He described the processes that generate silica dust, and how the transportation of the broken rock influences where silica settles and how it is transported via the mine ventilation system. Some of the key interventions discussed were footwall treatment to keep dust trapped on the footwall, and dust filtration systems to remove silica from the

ambient air and during rock tipping (transportation) processes. Watering down and the tools available, including automated spray systems, were also elaborated upon. The use of real-time dust monitors for trouble shooting problem areas, and for re-engineering work processes, was highlighted. Vijay emphasised the importance of awareness and education of employees about the dangers of silica dust, the control measures in place, and what employees can individually do to reduce their exposure to silica dust. He concluded with a description of internal dust management awards – created to influence behaviour – and the trends in silica dust exposure reduction over time with all interventions in place.

Staying in the mining industry, Dr Dipalesa Mokoboto (Department of Mineral Resources and Energy) asked, and responded to the question: "Have the silicosis milestones for SA mining been achieved?"

Summary on achievement of silicosis milestone in the South African mining industry

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The Mine Health and Safety Inspectorate (MHSI), and Mine Health and Safety Council (MHSC) – an entity of the MHSI – were both established in terms of the Mine Health and Safety Act (MHSA) No. 29 of 1996 as amended. Occupational lung diseases (OLDs) such as silicosis and tuberculosis are reported to the MHSI in line with the requirements of the MHSA. The MHSC, on the other hand, is responsible for setting milestones through its tripartite structures, during summits. Milestones on elimination of OLDs were set at a health and safety summit in 2014. The MHSC is responsible for monitoring and reporting on progress made on the milestones.

The milestones covered occupational hygiene and occupational medicine:¹

1. By December 2024, 95% of all exposure measurement results will be below the milestone level for RCS of 0.05 mg/m³ (these results are individual readings and not average results).
2. Using present diagnostic techniques, no new cases of silicosis, pneumoconiosis, or coal worker's pneumoconiosis will occur amongst previously unexposed individuals ('previously unexposed individuals' were regarded as those unexposed to mining dust prior to December 2008, i.e. persons entering the industry in 2009).

In terms of monitoring the occupational hygiene milestone to determine if 95% of the RCS measurements were below 0.05 mg/m³, there was an improvement from 82.75% in 2014 to 91.1% in 2020. Thus, the milestone has not yet been reached; however, it is anticipated that 95% of all RCS measurements will be below 0.05 mg/m³ by 2024.

For the occupational medicine milestone, six cases of silicosis were reported to the MHSI, which were confirmed as novice workers. The Medical Bureau for Occupational Diseases (MBOD) certified two of the cases as silicosis. Two additional cases were further investigated by the Minerals Council South Africa and silicosis was excluded in both. One was found to have miliary TB and the other had community acquired pneumonia.

A holistic review of the remaining two novice cases needs to be conducted to verify the diagnosis of silicosis. The validity of the diagnosis is

influenced by the experience of the reader of the CXR, and the results of other examinations. Although the silicosis milestones for the South African mining industry have not yet been met, great achievements have been made.

REFERENCE

1. Mine Health and Safety Council. 2014 Occupational Health and Safety Summit Milestones. Available from: https://mhsc.org.za/sites/default/files/public/research_documents/2014%20OHS%20Summit%20Milestones.pdf (accessed 14 August 2023).

THEME 4: DETECTION AND MONITORING OF SILICA-RELATED DISEASES

Chaired by Dr Thuthula Balfour, Minerals Council South Africa

Three presentations were delivered under this theme. Dr Zodwa Ndlovu discussed the challenges and opportunities of the national silicosis surveillance programme. Prof. Emeritus David Rees from the Wits School of Public Health and Prof. Anna-Carin Olin from the University of Gothenburg spoke about the use of biomarkers in the diagnosis of lung fibrosis and silicosis.

National surveillance of silica-exposed workers – challenges and opportunities

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The concept of surveillance is well established. It is a systematic and ongoing process – not a once-off event. Occupational surveillance systems collect data on exposure measurements, disease, and demographic and occupational characteristics. Nowadays, these data are usually available in computerised, administrative databases. The data are analysed, interpreted, and disseminated to stakeholders for the prevention and control of adverse exposures and occupational diseases. Occupational disease surveillance is useful for the detection of exposures and disease, the monitoring of trends, the identification of workers who are at risk of developing disease, the provision of alerts or warnings of high risk, the provision of information to evaluate or monitor the effects on interventions, and for stimulating research.

The use of routine, administrative, compensation data for surveillance was illustrated using the example of the National Institute for Occupational Health's (NIOH's) Pathology Automation System database (PATHAUT). The database contains diagnoses of OLDs, including silicosis and TB, in deceased South African miners. Although the data are collected for autopsy compensation, they are used for OLD surveillance. The PATHAUT database is the only source of long-term data for OLD surveillance in South African mine workers. The surveillance information is contained in annual

reports dating back to 1975, which are available on the NIOH website (<https://www.nioh.ac.za/pathology-division-surveillance-reports/>). The PATHAUT data have also been used extensively for research. Studies have described the magnitude and factors associated with silicosis trends^{1,2} and alerted the industry to the risk of silicosis in platinum miners and female gold miners.^{3,4}

There are other institutions that collect silicosis disease and silica exposure data that could be used to establish a national silicosis surveillance system for both the mining and non-mining industries. This will require collaboration among the relevant stakeholders. However, experience has shown that sustained commitment determines the success or failure of a surveillance system. Therefore, long-term commitment to provide adequate human and financial resources is key to the development of a sustainable national surveillance system.

REFERENCES

1. Nelson G, Girdler-Brown B, Ndlovu N, Murray J. Three decades of silicosis: disease trends at autopsy in South African gold miners. *Environ Health Perspect.* 2010; 118:421-426.
2. Nelson G, Murray J. Silicosis at autopsy in platinum mine workers. *Occup Med (Lond).* 2013; 63:196-202.
3. Ndlovu N, Nelson G, Vorajee N, Murray J. 38 years of autopsy findings in South African mine workers. *Am J Ind Med.* 2016; 59:307-314.
4. Ndlovu N, Richards G, Vorajee N, Murray J. Silicosis and pulmonary tuberculosis in female South African miners. *Occup Med (Lond).* 2019; 69:272-278.

Biomarkers for the detection of pathophysiological responses to silica

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Medical surveillance of workers for silicosis – fibrosis of the lung due to RCS – is typically done using CXRs. This method is imperfect because subradiological silicosis (disease

unapparent on the X-ray) is common and, once apparent, shows incurable and established disease. Consequently, markers of pathophysiological responses to silica using methods other than CXRs have been of interest for decades.¹ These markers are broadly termed biomarkers or screening tests; meaning indicators of excessive exposure or the body's negative reaction to the exposure, or tests that provide a presumptive diagnosis of disease.



Some of the potential benefits of these tests are:

1. Biomonitoring to identify harmful RCS exposure

Measuring RCS is expensive and requires sophisticated equipment. An affordable biomarker that directs RCS measurement to worksites or jobs with potential over-exposure would be useful.

2. Screening for silicosis

CXRs and the competence to read them are limited in some countries with large numbers of RCS-exposed individuals. A simple screening test that identified individuals who require more sophisticated evaluation would reserve scarce resources for those needing them.

3. Diagnosis of silicosis

Subradiological silicosis, including early disease, would be diagnosable if a sensitive and specific test for the pneumoconiosis was available.

4. Triage for further investigation

A test that excluded silicosis (high negative predictive value) among exposed individuals would enable selection of only those with a risk of the disease to undergo chest imaging. In resource-scarce settings (informal mining, for instance) this targeting would be beneficial.

5. Identifying susceptible individuals

Only a proportion RCS-exposed people develop silicosis. Identifying those susceptible might stimulate interventions to prevent disease development.

All biomarkers and screening tests investigated so far have flaws² and there are reservations about their use. Nevertheless, their potential benefits are substantial and the search for reliable tests should continue.

REFERENCES

1. Gulumian M, Borm PJA, Vallyathan, Castranova V, Donaldson K, Nelson G, et al. Mechanistically identified suitable biomarkers of exposure, effect, and susceptibility for silicosis and coal-worker's pneumoconiosis: a comprehensive review. *J Toxicol Environ Health*. 2006; Part B 9: 357-395. doi: 10.1080/15287390500196537.
2. Austin EK, James C, Tessier J. Early detection methods for silicosis in Australia and internationally: a review of the literature. *Int J Environ Res Public Health*. 2021; 18:8123. doi: 10.3390/ijerph18158123.

Can we detect early adverse effects of inhaled respirable silica?

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Silica dust exposure is deposited in the very distal part of the small airways (i.e. airways < 2 mm in diameter). Here, silica induces a low-grade inflammatory response as the normal defence system cannot handle the long quartz structures. Long-standing inflammatory changes may slowly develop into silicosis in susceptible individuals, or into cancer.

The small airways have long been known as 'the silent zone of the lung'. This is based on the fact that early pathological changes are asymptomatic and, moreover, are not detected by routine clinical measures such as spirometry or CXRs. This explains why silicosis often goes undiagnosed, as shown in several studies, including those using mine workers' autopsy data in South Africa.¹

This illustrates the need for better methods to identify early silicosis, i.e. secondary prevention. This need must, however, not detract focus from actions to reduce exposure and thus prevent the disease.

A method has been developed and validated in which a small amount of fluid is retrieved from the airway linings in the lung, in exhaled air: the PEXA methodTM (particles in exhaled air: www.pexa.se). Pathological processes in the small airways of the lung have been shown to alter the composition of the lining fluid. Hence, the sample provides a valid source of biomarkers for diseases affecting the small airways. Using the PEXA method, a number of protein biomarkers have been identified for smoking-induced lung disease and, in post-COVID-19 patients, a profile of surfactant lipids has been identified that is suggestive of the development of lung fibrosis. More recently, preliminary findings in tunnel workers exposed to silica dust show that their lipid profiles in PEXA samples are altered, proposing a 'pro-fibrotic' profile. As the PEXA method is non-invasive, it is suitable for screening for the detection of early disease.

REFERENCE

1. Field N, Murray J, Wong ML, Dowdeswell R, Dudumayo N, Rametsi L, et al. Missed opportunities in TB diagnosis: a TB process-based performance review tool to evaluate and improve clinical care. *BMC Public Health*. 2011; 11:127. doi: 10.1186/1471-2458-11-127.

KEY POINTS FROM THE WORKSHOP

1. Silicosis is a problem in the mining industry in South Africa and is diagnosed in workers from other industries.
2. Although good progress has been made in reducing silica dust exposures in the gold mines, silica dust-related diseases persist.
3. Silica dust levels have been reduced in the South African gold mining industry, with the help of dust suppression and other controls, but not completely.
4. The silicosis milestones, set in 2014, have not yet been met.
5. There is need for comprehensive silicosis surveillance to monitor the trends and distribution of new cases in South Africa – in both workers and former workers – to assess progress towards silicosis elimination targets.
6. The target 0.05 mg/m³ silica dust concentration is unlikely to provide complete protection against the development of silicosis, which means that the milestone of zero cases of silicosis will not be met.
7. Real-time monitoring of silica dust exposure is needed.
8. The setting of OELs is complicated and lowering the current OEL to 0.05 mg/m³ will introduce complexities that need to be considered.
9. In Sweden, current silica dust exposure levels are unknown due to changes in legislation, which inhibit the measurement of silica concentrations in occupational settings; silicosis rates are probably underestimated.
10. South Africa is 'ahead of the game' by performing autopsies on deceased current and ex-mine workers; Sweden has no such programme.
11. New biomarkers for the early detection of pathological effects and disease need to be investigated.

Unanswered questions

1. Is there is a need for medical surveillance in the stone and sand industries?
2. What is the relevance of tuberculin skin testing in silica-exposed individuals? Is tuberculosis preventive treatment effective for silicosis in southern Africa?
3. What RCS OEL is protective against increased tuberculosis risk?
4. Should we spend resources on lung cancer surveillance and research in silica-exposed workers?
5. How can we address silica dust exposure and silicosis in artisanal and illegal mine workers?

Quotes from the workshop

1. *"We are all swimming in the same pool. Can we learn to be life savers and prevent exposed workers from developing silicosis?"*
– Jabulile Mhlophe, Department of Employment and Labour
2. *"240 cases of silicosis are 240 too many."* – Thuthula Balfour, Minerals Council South Africa
3. *"We have known about silicosis for more than 150 years... let us not take another 150 years to eliminate it."* – Gill Nelson, Wits School of Public Health
4. *"Silicosis is not the only disease caused by silica dust exposure, and the lungs are not the only organs affected."* – Gill Nelson, Wits School of Public Health

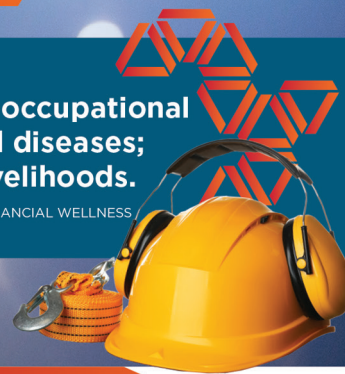
Acknowledgements

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Integrated environmental, corporate, and business risk management approaches in regional and national developmental projects

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BACKGROUND

The Southern African Tuberculosis and Health Systems Support (SATBHSS) project has resulted in some exclusive and important achievements, and lessons. The project improved several corporate, environmental, and occupational procedures to protect workers, communities, the environment, and businesses. Southern African Development Community (SADC) member states have realised direct and indirect benefits in the past seven years. Some achievements and spillover benefits include reviewing and developing occupational health and safety laws, occupational health standards, environmental laws, and public health laws, including their regulations, standards, and procedures. This was in parallel with intensive training of practitioners such as occupational hygiene professionals and inspectors, and occupational health doctors, radiologists, and nurses. Recognition of complementary programmatic approaches, when undertaken holistically, make the project members realise economies of scale. Ideally, this should include, amongst others, the recognition and implementation of occupational and environmental health and safety (OEHS) systems; environmental and social management systems (ESMSs); employee wellness programmes (EWPs); and infection prevention and control (IPC). These are all necessary programmes; however, running them in parallel but disjointedly can waste resources. Working together is beneficial for the projects in terms of the incorporation of multidisciplinary expertise.

I recently lost my brother (Mr Elvis Khoza) who worked in the South African coal mines for more than three decades. During his years of service, inductions and training on health and safety in the mines were offered. One of the important things he did was to sign a consent form, whereby he agreed that an autopsy could be performed on his body. He passed away on the evening of Friday, 16 June 2023. On the following Monday, we approached the mine to perform a post-mortem, but were informed that the post-mortem examination could not be done on the Wednesday of the same week because *“the request was submitted late”*. Our reaction was that, if Monday was considered late, then the process is self-defeating. In South Africa, especially Mpumalanga, where my brother came from, burial usually occurs in the same week in which the person died, unless the event occurred late in the week. This is to reduce the cost of the funeral and the family trauma, amongst other things, and fast-track the healing process. The inability to perform the autopsy on my brother is a symptom of an unharmonised system that concerns many stakeholders, including the community.

There are many missed opportunities for families, the community, and the country to collect data that can assist in changing workplace policies – not only in South Africa, but the entire continent and beyond.

Fortunately, with the assistance of Dr Spo Kgalamono (Executive Director, National Institute for Occupational Health (NIOH)), and the Pathology Division (NIOH), the post-mortem was performed. From this experience, my suggestion is to develop an electronic notification

system that requires mines to report deaths of miners to the NIOH and other relevant stakeholders (trade unions, Medical Bureau for Occupational Diseases (MBOD), and next of kin). In addition, the mines should follow or develop appropriate standard operating procedures for organ removal that apply irrespective of the day of the week.

CHALLENGES AND OPPORTUNITIES

Communication

Employees, communities, and other stakeholders such as contractors and management, lack awareness about complaints and grievances procedures. A collaborative approach requires a comprehensive understanding and communication with key stakeholders. There is a need to promote a single grievance procedure for infection and prevention control (IPC), occupational health and safety (OHS), waste management, land use, air and water pollution, etc. A diverse target group's cultural and language barriers may hinder accessibility to grievance reporting. It may be necessary to provide translation services or to modify grievance mechanisms to accommodate cultural contexts.

Limited resources

Often, the project implementers invest resources in the challenges that the project is developed to solve. Establishing and implementing comprehensive health and safety, and environmental grievance mechanisms require investments in resources, time, technology, and training, some or all of which are often overlooked. There is a need to prioritise and accommodate grievance procedures for sustainable and inclusive growth.

Trust and transparency

Any health and safety, and environmental grievance mechanisms and/or complaints management and procedures must be trusted and transparent, and must function within reasonable turn-around times. Stakeholders must be assured that their safety concerns will be taken seriously and addressed promptly. If the organisation causing the problem is also handling the grievance mechanism, there might be some trust issues, in which case the process should be handled by an independent third party.

The complexity of investigation

Grievance or complaints procedures are complex and challenging to navigate, especially in a large project that is implemented in multiple geographical areas or countries. This complexity can discourage organisations from investing in internal resources to adequately resolve lodged complaints or grievances. Issues related to indigenous and vulnerable populations, and environmental noise or chemical exposures, require comprehensive investigation skills and technology if they are to be identified and addressed.

Legislative and enforcement setting

The availability (or absence) of regulatory and enforcement capacity often discourages stakeholders from reporting grievances, particularly if no action is taken after a complaint has been lodged. Workers and communities might not report complaints if they know that there will be no consequences. In addition, inspectors need to have legal backing to enforce sanctions due to non-compliance. Fragmentation of processes is also problematic; issues related to OHS are often taken more seriously than those regarding the environment or indigenous people.

Harmonisation of business and corporate/workplace risk assessment ratings

The operational and business risk assessment rankings are typically inconsistent. For example, operational and business risk experts may rate fire dangers similarly. However, the risk to employees exposed to noise or dust, with a long latency period before disease manifests, will be rated low by business risk experts because workers' exposure to noise and dust will not stop production, or result in loss of money for the company. Workers, families and communities bear the cost of worker exposure to noise and dust, through sicknesses and deaths that leave widows and orphans without breadwinners or reliable source of income.

Workplace technological advancements

Mines and other infrastructure development projects have become increasingly mechanised due to technology. This has increased complexity and introduced new and re-emerging threats, such as nanotechnology and exposure to nanomaterials, and pandemics. More advanced technologies, occupational hygiene, epidemiology, and toxicology knowledge and skills are needed to address these issues. Regulatory agencies, organisations, and stakeholders must adopt real-time environmental technologies to monitor and control occupational and environmental hazards and mitigate complaints.

Project management has become increasingly difficult due to cultural, human rights, and gender challenges. Developing and promoting harmonised safety, health, and environmental policies and guidelines across all disciplines is necessary to address these complexities.

CONCLUSION

The African Union Agenda 2063¹ shows that development is best realised when the entire ecosystem benefits. Aspirations 1, 2, and 3 of the Agenda advocate for a prosperous Africa based on inclusive growth and sustainable development; an integrated continent, politically united and based on the ideals of Pan-Africanism and the vision of Africa's Renaissance; and an Africa that has good governance, democracy, respect for human rights, justice, and the rule of law.¹ The SADC heads of state acknowledge that mine workers contribute

significantly to the region's wealth – at the cost of their lives, families, and communities.² Integrated workplace safety, health, and the environment can help with sustainable investment and development, which can help to achieve Sustainable Development Goal (SDG) 3 of the United Nations 2030 Agenda for Sustainable Development,³ i.e. to ensure healthy lives and promote wellbeing for all at all ages. SDG 8 is to "Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all"; Target 8.8 is to "Protect labour rights and promote safe and secure working environments for all workers, including migrant workers, in particular women migrants, and those in precarious employment".⁴

Business and operational risk assessments should look beyond economic cost. There is an intangible cost of the endless human suffering triggered by occupational accidents and work-related diseases, which are not fully recognised in many business risk assessment figures. This is unfortunate because many of them are preventable. Promoting an integrated workplace health, safety, and environment approach is key during the project design and implementation, and sustainability after the project has closed. Promotion of the autopsy service is important for compensation of occupational lung diseases. The annual pathology reports⁵ provide comprehensive information about diseases diagnosed in deceased miners.

ACKNOWLEDGEMENTS

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REFERENCES

1. Agenda 2063: The Africa We Want. African Union; 2015. Available from: https://au.int/sites/default/files/documents/33126-doc-framework_document_book.pdf (accessed 31 August 2023).
2. SADC. Declaration on Tuberculosis in the Mining Sector [Internet]. Gaborone: SADC; 2012. p. 9. Available from: www.sadc.int.
3. United Nations. Department of Economic and Social Affairs Sustainable Development. Transforming our World: The 2030 Agenda for Sustainable Development. United Nations; 2015. Available from: <https://sdgs.un.org/2030agenda> (accessed 31 August 2023).
4. United Nations. Department of Economic and Social Affairs. Sustainable Development Goals. SDG Indicators. United Nations; undated. Available from: <https://unstats.un.org/sdgs/metadata/?Text=&Goal=8&Target=8.8> (accessed 31 August 2023).
5. National Institute for Occupational Health, National Health Laboratory Service. Pathology Division Surveillance Reports. Available from: <https://www.nioh.ac.za/pathology-division-surveillance-reports/> (accessed 31 August 2023). 

Workplace rehabilitation makes sense for both employee and employer

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Rehabilitation is a multidisciplinary team intervention designed to optimise functioning and reduce disability of an individual with a health condition. While rehabilitation cannot reverse or undo the damage caused by trauma, it does restore the individual to optimal health, functioning, and wellbeing.

Rand Mutual Assurance (RMA) is a social assurer that has been compensating injured mine and metal workers for almost 130 years. The company has also come face to face with the eventual social outcomes of its beneficiaries, which are not encouraging for either the disabled workers or their families, despite adequate compensation.

Some of the psycho-social outcomes following compensation are:

- Isolation of the newly disabled worker is common because our societies tend not to 'include' people living with disabilities.
- Anger and depression in the disabled worker can lead to substance abuse (drugs and alcohol).
- Dysfunctional family relationships and high divorce rates are the result of inadequately prepared wives, husbands, or partners.
- Reduced chances of re-entry into the job market result in the deterioration of socio-economic status of the household, with resultant perpetuation of poverty and no chance of educating children of the affected family.
- The ultimate demise of an injured ex-miner is seldom a direct result of the injury; the deterioration of health, poor socio-economics, and neglect are known to be major contributors.

When the total ecosystem of rehabilitation fails to anticipate the psycho-social effects of living with a disability or impairment, families and communities are left with the burden of caregiving with little training, and no capacity to contain the anger or depression of the disabled worker.

Even though rehabilitation makes sense for all individuals concerned, 50% of known disabled workers never receive the rehabilitation they require.¹

IMPLICATIONS OF DISRUPTED REHABILITATION FOR THE EMPLOYER, EMPLOYEE, AND FUNDER

The employer: some employers have been known to terminate injured workers without allowing an opportunity for rehabilitation or accommodation in work. The experience of carrying long-term absenteeism, with no progress or positive outcomes, tends to frustrate both the employer and employee.

The employee: most employees come into big towns or to the mines to seek job opportunities. When they get injured, their rehabilitation is disrupted when they are discharged to go home to their villages. No access to rehabilitation and loss of contact with the employer result, ultimately, in loss of benefits of early intervention mechanisms. Some employees who have access to intensive rehabilitation refuse it, driven by either ignorance of the benefits or mistrust in the compensation system.

The funder: claims administered tend to utilise most resources while the claimant is in hospital only. There is a population that tends to be lost to follow-up once they are discharged, or if they are lucky to reach a rehabilitation professional, they only receive a portion of the rehabilitation benefit. The funder, in most cases, is given no comfort as to whether medical benefits are in line with rehabilitation standards or not.

THE REGULATORY ENVIRONMENT

Albeit fragmented, there is sufficient legal framework in South Africa to support the maturation of the existing rehabilitation ecosystem. Chapter VIIA in the Compensation for Occupational Injuries and Diseases (COID) Amendment Act, covering rehabilitation, re-integration and return to work (RTW), informs an approach to rehabilitation and drives return to work of employees.

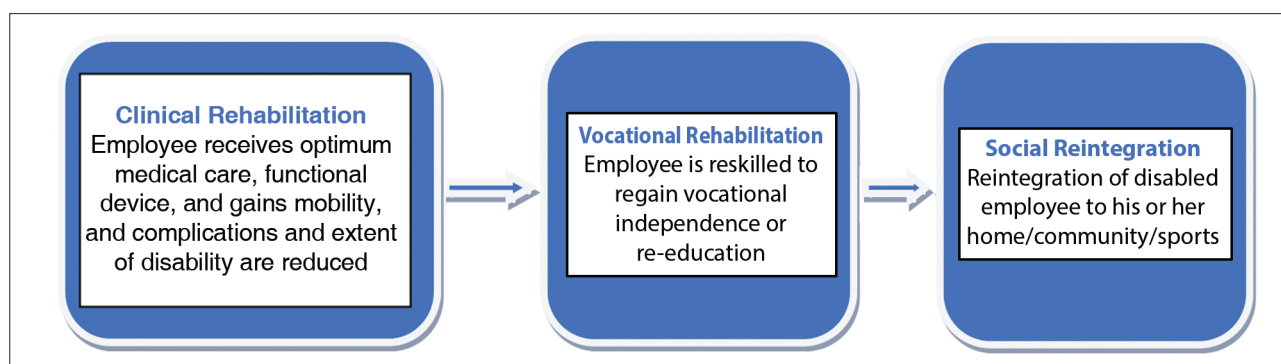


Figure 1. Rehabilitation pillars model

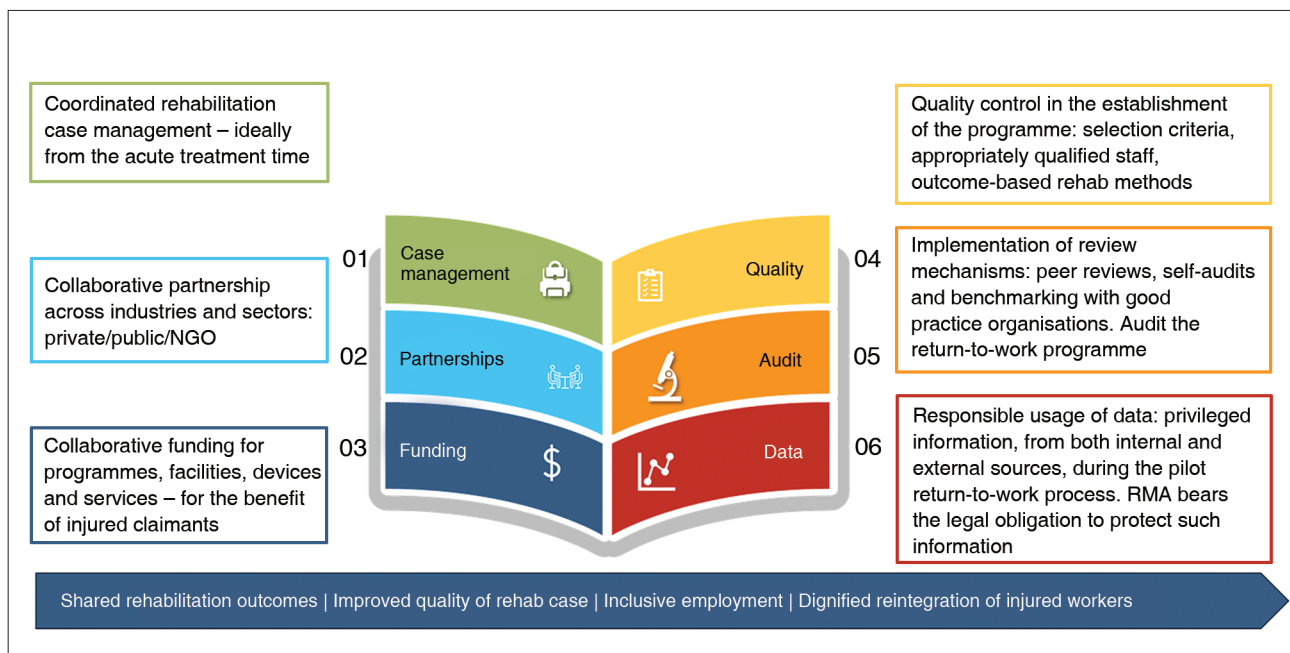


Figure 2. Coordinated case management

The regulation is complemented by many other regulatory frameworks:

- The South African Constitution (recognises specific rights for people living with disabilities)
- The Labour Relations Act
- Employment Equity Act (Code of Good Practice on Employment of Persons with Disabilities)
- National Health Insurance (pending)

RMA PILOT REHABILITATION PROGRAMME

As a social insurer, RMA has committed to rolling out a pilot rehabilitation programme ahead of the promulgation of the COIDA Amendment Act of 2020. The programme is anchored by the ‘three pillars’ of rehabilitation model, as depicted in Figure 1.

RTW and workplace rehabilitation remain contentious matters for many employers, because the art and expertise of rehabilitation does not reside inside a mine or a factory. Most employers do not have the training or capacity to extend or explore ‘inclusion’ mechanisms for a disabled employee.

RMA has launched its pilot rehabilitation programme to address these capacity limitations, by implementing the three rehabilitation pillars model with mining members. Figure 2 shows how case management will be coordinated in the programme.

Coordinated rehabilitation models are employed and applied in both developed and developing countries. Most of them require an inclusive and creative approach from the stakeholders. It has been found in most cases that pooling of resources matures the rehabilitation ecosystem, with little or no monetary investment.

SUMMARY: KEY FACTORS IN WORKPLACE REHABILITATION AND RE-INTEGRATION

- Rehabilitation is a multidisciplinary team intervention designed to optimise functioning.
- Coordinated rehabilitation case management reduces frustration and eventual perceived ‘neglect’.

- Timely access to appropriate medical treatment and vocational rehabilitation is critical to self-sustainability of the injured, ill, or disabled worker.
- For the employer, it is necessary to shift the focus from deficits and incapacity towards ability.
- The benefits are compelling when focused stakeholders are committed to RTW.
- Worker commitment to wellness is the fulcrum of rehabilitation.
- Pooled resources, that make both vocational rehabilitation and social reintegration possible, tend to yield the best outcomes. Models exist in which intergovernmental collaborations, with NGOs and insurance funders, have created collaborative funding tools and resources focused on vocational reskilling of injured workers. Such collaborations create easy access to services/jobs/tools for reintegration.

CONCLUSION

RMA’s pilot rehabilitation programme aims to inspire discussion and motivate action towards collaborative rehabilitation and reintegration of injured workers. Rehabilitation is not just the right thing to do; it also restores a moral right of the injured worker to dignity.

REFERENCE

- 1 South Africa. 2023. Draft Rehabilitation, Reintegration and Return to Work Regulations. Compensation of Occupational Injuries and Diseases Act, 1993 (Act No. 130 of 1993). Available from: <https://gpwonline.sharepoint.com/sites/gpw-web/Shared%20Documents/Forms/AllItems.aspx?ga=1&id=%2Fsites%2Fgpw%2Dweb%2FShared%20Documents%2FGovernment%2F48787%2015%2D6%20NationalRegulation%2Epdf&parent=%2Fsites%2Fgpw%2Dweb%2FShared%20Documents%2FGovernment>.

No more skirting around the health and safety concerns of women in mining wearing PPE designed for men

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The Chief Inspector of Mines has issued an updated guideline outlining considerations that mines should incorporate into Mandatory Codes of Practice to tackle the health and safety concerns that women have faced from using PPE designed for men.

On 28 July 2023, the Chief Inspector of Mines introduced a new Guideline for a Mandatory Code of Practice (COP) for the Selection and Provision of Personal Protective Equipment (PPE) for Women in the South African Mining Industry (2023 Guideline).¹ While the 2023 Guideline retains the core elements of the version first published in 2015 under section 49(6) of the Mine Health and Safety Act (MHSA), the new Guideline seeks to address the very real body issues faced by women in mining (WIM). In previously male-centric work environments, the impact that PPE has on menstrual health as well as women's dignity is a much-skirted topic. The 2023 Guideline recognises the importance of addressing women's unique health and safety concerns around work attire, particularly ill-fitting PPE designed for male proportions, which can impact their comfort, mobility, and wellbeing in the mining industry.

The objective of the Guideline is to provide a framework within which all South African mines must compile and implement a mandatory code of practice (COP) addressing the provision of PPE for WIM. It should take into account the unique health and safety concerns faced by women in various work roles, from underground miners to engineers and managers. The 2023 Guideline expands the scope beyond the provision of PPE and now provides guidelines on the selection of PPE as well.

The 2023 Guideline introduces an important emphasis on the establishment of WIM structures at mine sites. These structures must reflect technical, professional, and managerial demographics, ensuring that women in various roles are included. This will foster a more inclusive approach to addressing gender-related issues related to occupational health and safety and PPE.

A significant addition in the 2023 Guideline is a summary of the SIMRAC Research Project SIM 100904, which identified safety concerns related to PPE use for WIM.² The research project revealed that female mine workers have often encountered challenges related to using the bathroom or changing their sanitary products while wearing standard-issue PPE. Ill-fitting PPE, such as overalls designed to male proportions, can be cumbersome to remove, making it difficult for women to address their sanitary needs. The research project found that this resulted in many women avoiding going to the bathroom or drinking water while on site. The health risks associated with dehydration (especially in high-heat environments), ignoring the urge to urinate, and prolonged gaps between changing sanitary products can drastically affect the health, safety, and comfort of WIM.

Building on the findings of the SIMRAC research, the 2023 Guideline emphasises the need for greater consultation with female employees before selecting and procuring PPE to ensure that the selected protective equipment is suitable for WIM, considering their anatomical and physiological attributes. For example, it may be appropriate to give women the option to wear a two-piece overall, depending on the working environment. There is also a possible link between certain types of PPE used by women and an increased

vulnerability to skin conditions such as contact dermatitis, chafing, rashes, and infections. The research highlighted the health and safety risks associated with the coping mechanisms that women developed in response to wearing ill-fitting PPE designed and sized for men, such as lesions from wearing thick woollen socks to improve the fit of large safety boots.

The SIMRAC research places significant emphasis on the need for adequate sanitary amenities at mine sites. Historically, mining facilities lacked separate toilet facilities for women. However, the increased presence of women in mining has highlighted the importance of dedicated and private female toilets, not only to attend to women's sanitary needs but also to guard against gender-based harassment and associated safety concerns.

The updated guideline recommends providing additional separate toilets per work section to ensure privacy, protection, and dignity for female mine workers. Such toilets should be equipped with sanitary bins that are regularly emptied to dispose of sanitary products. Proper waste management in these facilities ensures hygiene and reduces health risks for WIM. In addition, facilities should be equipped with toilet paper and hand-washing facilities. Access to clean water is crucial in reducing the risk of infections, particularly for those who are menstruating. Well-lit areas surrounding toilets ensure safety for women users, especially during night shifts or in underground environments.

To improve the provision of appropriate PPE for WIM, the 2023 Guideline advocates an approach towards selecting and providing PPE that considers ergonomics and comfort, taking into account the dimensions and individual attributes of female workers. A woman's body should not be a barrier to her career in mining. Sourcing PPE from manufacturers that accommodate sizes and designs better suited to the female anatomy, is best done in consultation with WIM.

Employers in the mining sector should review their COPs for the provision of PPE for women to update them with the more detailed framework provided in the 2023 Guideline. By addressing the challenges identified during the implementation of the 2015 Guideline, this updated version represents a positive step towards progress and gender equality in the industry, fostering a safer and more inclusive work environment for WIM.

REFERENCES

1. South Africa. Mine Health and Safety Act, 1996 (Act No. 29 of 1996). Guideline for a mandatory code of practice for the selection and provision of personal protective equipment for women in the South African mining industry. Government Gazette No. 49046; 2023 July 28 (published under Government Notice 3734). Available from: https://www.gov.za/sites/default/files/gcis_document/202307/49046gon3734.pdf (accessed 15 August 2023).
2. Zungu LI. Personal protective equipment for women in the South African mining industry. SIM 100904. Johannesburg: Mine Health and Safety Council; 2012. 

SASOM news

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REPORT ON THE ICOH MID-TERM MEETING: ANGERS, FRANCE, 15–17 MAY 2023

Founded in 1906 in Milan, Italy, as the Permanent Commission on Occupational Health, today the International Commission on Occupational Health (ICOH) is the world's leading international scientific society in the field of occupational health, with a membership of approximately 2 000 professionals from 105 countries (www.icohweb.org). ICOH's main objective is to foster the scientific progress, knowledge, and development of occupational health and safety in all its aspects. The flagship of the ICOH activities is the triennial World Congress on Occupational Health, usually attended by approximately 2 000 to 3 000 participants. ICOH has 38 Scientific Committees (SCs) and various Working Groups (WGs) and Task Groups (TGs), most of which hold their own symposia, conferences, and workshops, produce scientific monographs, and review abstracts that are submitted to the international congresses. Mid-term meetings are held in the periods between the ICOH congresses, and these are attended by the ICOH Officers, Board members, and the Chairs or Secretaries of the SCs and WGs, with the aim of discussing the ongoing activities of ICOH, and the progress made in terms of the ICOH work plan for the specific triennium.

The ICOH mid-term meeting for the current triennium (2022–2024) was held in hybrid mode from 15 to 17 May 2023, in Angers, France. For the first time, selected ICOH National Secretaries (NSs) were invited to participate (one from each region), including Prof. Daan Kocks, ICOH NS for South Africa (and representative of the African region) and Chair of the South African Society of Occupational Medicine (SASOM), who participated virtually and presented his NS report on the second day of the meeting. Claudina Nogueira, ICOH Vice President for SCs and ExCo member of SASOM, attended in person. Another South African occupational safety and health (OSH) professional, Dr Karen Michell, now based in the UK, attended in person in her capacity of Chair of the ICOH SC on Accident Prevention. The meeting was held at the Angers Congress Centre and graciously hosted by the University of Angers, with the very kind support of Prof. Alexis Descatha (ICOH Board member) in terms of organisational and logistics arrangements on the ground. The ICOH Officers meeting took place on 14 May 2023, in the same venue.

Angers and Anjou – the Loire Valley's best kept secrets...

Just 90 minutes from Paris by high-speed train and 90 minutes from the Atlantic Ocean, the region of Anjou is one of France's hidden gems and a must-visit location in the Loire Valley, famous for its winelands. In Anjou, the wild and impetuous Loire River, classified as a UNESCO World Heritage site, and many other rivers – Maine, Mayenne, Oudon, Sarthe and Thouet – criss-cross the region, offering visitors a myriad of cruising, sailing, boating, and canoeing

opportunities. The region is also known as the 'Valley of the Kings' with more than 1 200 châteaux (castles) and manors, most of which are still used as homes. Anjou is the third winemaking region in France – the main grape varieties being Cabernet Franc for red wines and Chenin for white wines. With six routes traversing majestic vineyards and quaint villages, and covering around 90 km, the region produces close to 180 million bottles of wine annually, 17% of which are exported – mainly to Germany, Belgium, and America.

The city of Angers is the capital of Anjou and lies along the Maine River, 8 km above the latter's junction with the Loire River. The city's massive, moated *Château d'Angers*, with 17 towers from 40 to 58 metres high, was built in 1230 on the site of earlier castles, and is the largest fortress in the Loire Valley. The Château is home to the late 14th-century Apocalypse series of tapestries known as *Tenture d'Apocalypse*, the most important medieval tapestry in the world (104 m long) that has survived many centuries. The tapestries were woven by Nicolas Bataille for Louis I, the Duke of Anjou. The *Chant du Monde* (Song of the World), a contemporary version of the tapestry designed by Jean Lurçat, is displayed in the 12th-century *Hôpital Saint Jean* (St. John's Hospital), known today as the Jean Lurçat and Contemporary Wall Hangings Museum (established in 1986).

Despite the damage of past wars, particularly World War II, Angers is still rich in medieval architecture. The 12th- to 13th-century Cathedral of Saint Maurice retains its original stained glass. The 15th-century Barrault House contains the public library, an art museum, and the complete works of the sculptor Pierre Jean David d'Angers, who was born in the city. The prefecture is in the former Saint Aubin Abbey, dating back to the 11th-century, which has Roman arcades. Angers has evolved around the Château, creating such appealing living conditions that today the city is recognised as the leading French city "*où il fait bon vivre*", or where it is good to live.

The many parks, gardens, and greenery throughout the city play a special role in creating this pleasant atmosphere. Based in Angers, the Community Plant Variety Office is a European organisation with the main mission of managing the intellectual property rights associated with valid plant varieties throughout the European Union. This is a way of supporting and guaranteeing the profitability of investments in plant research and innovation on a larger scale. Angers is the largest horticultural centre in Europe and the largest producer of hydrangeas in the world, exporting 80% of its production; the hydrangeas from Angers are famous for being robust, hardy, and developing branches with many buds. The region's Terra Botanica hosts over 300 000 visitors annually and introduces them to 275 000 plants and flowers from all continents – 27 acres of gardens, water features, and greenhouses, and 40 theme park attractions. It is the world's first 'edutainment' park to be themed on plants and gardens.

The historic centre of Angers, known as *Cité*, is like a journey back in time. Excellent gastronomy in one of the many local eateries is a definite highlight of the Angers experience.

Quernons d'Ardoise, a favourite local sweet, is a small square of nougatine (caramelised hazelnuts and almonds) wrapped in blue chocolate; and Cointreau, the orange-flavoured triple-sec liqueur, is produced exclusively in Angers. Exhibitions and events are held throughout the year all over Angers, which has a very active cultural centre. Woven into this dynamic mix are nearly 40 000 students; the city is a centre of learning, boasting two renowned universities and several specialised institutions.

Angers – the place for humans and plants, turned out to be the perfect venue to host the 2023 ICOH mid-term meeting!

Day one, Monday 15 May 2023

The mid-term meeting started with the joint meeting of the ICOH Officers, Board, and SCs, and was attended by close to 50 participants. The joint meeting opened with the report from the ICOH President, Prof. Seong-Kyu Kang, and was followed by reports on the SCs (Claudina Nogueira, ICOH Vice President), the activities on the NSs (Dr Martin Hogan, ICOH Vice President), the report by the Secretary General, Dr Diana Gagliardi, and a short presentation by Dr Won-Jun Choi, Editor-in-Chief of the *ICOH Newsletter*. The meeting participants then broke into groups for discussion and feedback on three topics, viz. i) increasing collaboration among SCs and with NSs, ii) increasing the visibility of SC work, and iii) optimisation of management for SCs. A general discussion on the way forward for SCs followed, emanating from the ideas that emerged.

Prof. Abdeljalil El Kholti, President of the ICOH2024 Congress in Marrakesh, Morocco, and Prof. Kamal Wifaq, Chair of the National Scientific Committee, shared updates on the organisation of the event, which will be hosted by the Moroccan Occupational Health Association (MOHA), in collaboration with The Occupational Health Department of the Faculty of Medicine and Pharmacy, Hassan II University of Casablanca. The second announcement was disseminated at the end of March 2023, with information on plenary speakers, fees, grants, and awards, the congress venue and accommodation options, and the topics for Free Paper Sessions, to which abstracts could be submitted for consideration as oral or poster presentations, until the extended deadline of 20 August 2023. The scientific programme is being developed with the participation and suggestions of the ICOH SCs and WGs, the

National Organising Committee, and other entities.

The day ended with a guided tour of highlights of the city of Angers, followed by a social dinner at the meeting venue.

Day two, Tuesday 16 May 2023

International Scientific Event on 'Translational Epidemiology in Occupational Health'

The half-day event in hybrid format and co-organised by ICOH and the University of Angers and Hospital, was held at the meeting venue. The international scientific event was partly funded by Pays de la Loire Région and Angers Loire Métropole.

Epidemiology constitutes a crucial aspect of occupational health, involving research and evaluation with the ultimate aim of generating evidence-based recommendations. Translational aspects of epidemiology aim to transfer scientific responses studied by researchers to field practitioners for workers and decision-makers, to be adapted to a wide range of workplaces. The international scientific event gathered high-profile presenters who shared their expertise and experience on a wide range of topics. The first session, titled 'Translational Epidemiological Centre on Occupational Health, Toxicology and Preparedness', included presentations related to a specific project on translational epidemiology to illustrate some examples of tools that can be used (e.g. job exposure matrices, systematic reviews, cohort studies, etc.). In the second session, titled 'Occupational health around the world', selected ICOH Board members and other professionals shared their knowledge on current issues in occupational health, presenting on different aspects of occupational risk management in various countries, thus illustrating the importance that ICOH gives to improving working conditions for all. The presentation topics of the second session were:

- The spatial-temporal distribution of musculoskeletal disorders: results of the 'Global Burden of Disease' in 204 countries and 21 sub-regions from 1990 to 2019
- Biological risks in relation to other occupational risks
- Controlling workplace health hazards in the chemical industry – a case study from India
- Psychosocial risk management and the promotion of health, safety, and wellbeing in the future of work
- Landscape and legal frameworks of basic occupational health services in southern Africa



View of the Angers *Cité* and Château, with the Maine River in the foreground Photograph: ICOH Secretariat



The long arm of the 'selfie' – ICOH Board members and the VP for SCs enjoy some leisure time out in the Angers Cité and Château.
L to R: Akizumi Tsutsumi (Japan), Riitta Sauni (Finland), Frida Marina Fischer (Brazil), Claudina Nogueira (South Africa), Alexis Descatha (France – meeting host and 'king of the bow-tie'), and Shyam Pingle (India) Photograph: Dr Shyam Pingle

First ICOH Board meeting

The first ICOH Board meeting followed the international scientific event in the afternoon. The final contract between the National Organising Committee of the ICOH2027 Congress and ICOH was formally signed before the beginning of the meeting. The ICOH2027 Congress will be hosted by the Indian Association of Occupational Health (IAOH) in Mumbai, India, with the theme *Sustainable Occupational Health in the Era of Globalization*.

The programme for the afternoon included reports from the task groups on membership and information and communication. The following ICOH WGs also reported on their activities: Future of Decent Work; Demographic Changes and Occupational Health; Implementation of the Global Strategy of Occupational Health for All, with special reference to the global ban of asbestos; Occupational Cancer; Implementation of ICOH Guidelines on Congress Organisation; and Inequalities in Occupational Health.



In-person and virtual gathering of OSH professionals – around 50 participants attended the 2023 ICOH mid-term meeting in Angers, France, in mid-May 2023, including the ICOH Officers, Board members, selected National Secretaries, representatives of Scientific Committees and Working Groups, and other invited guests Photograph: ICOH Secretariat

Day three, Wednesday 17 May 2023

Second ICOH Board meeting

The following reports were presented on the final day, from 09:00 to 13:00: ICOH Finance Committee; ICOH Budget; and TG on Constitution, and Bylaws and Guidelines. There was a session dedicated to election procedures for the next triennium (2024–2027), as well as a discussion around the bidding process for the ICOH2030 Congress, which is open for submissions until the end of October 2023. The remainder of the meeting time was dedicated to discussions on the following topics: relationships between ICOH and the international organisations, the International Labour Organization (ILO) and the World Health Organization (WHO); a proposal for the appointment of ICOH honorary members; and the current ICOH strategy and future developments.

The meeting adjourned with the ICOH President thanking all attendees for their valuable contributions and active participation during the three days. A special vote of thanks and appreciation was extended to the ICOH Secretariat staff for their tireless work in organising the ICOH mid-term meeting, and their support and able assistance to the ICOH Officers, Board members and Chairs of the SCs and WGs.

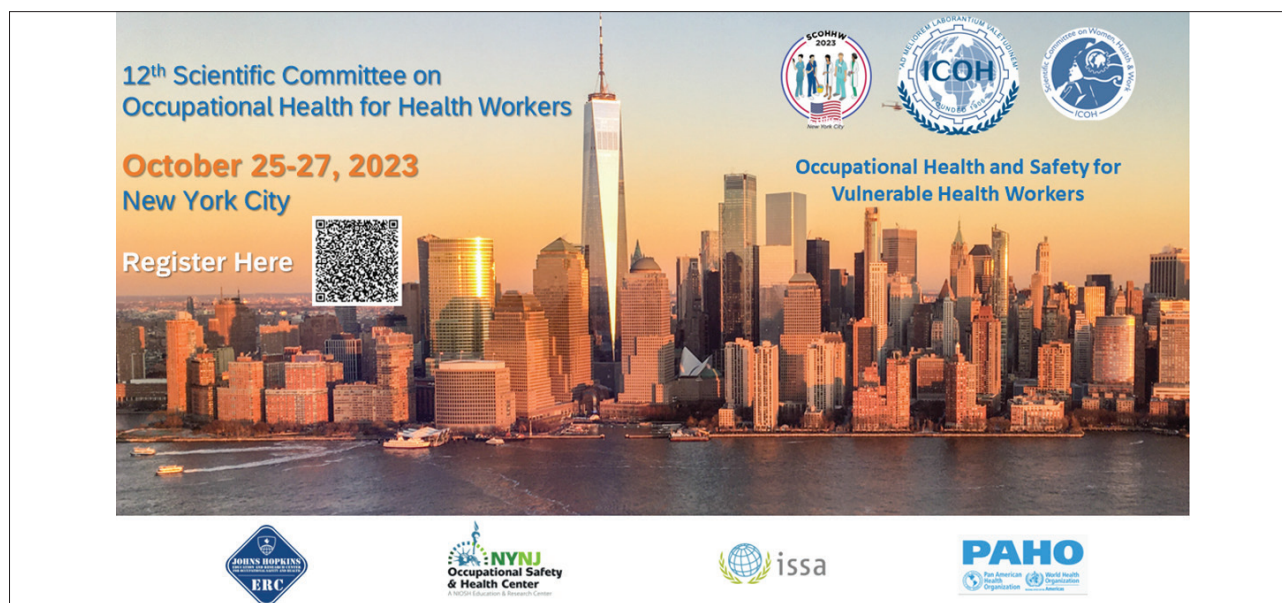
UPCOMING ICOH EVENTS FOR 2023

Please refer to the Events page of *Occupational Health Southern Africa* (<http://www.occhealth.co.za/index.php?p=events>) and the ICOH website (<https://www.icohweb.org/site/events.asp>) for more information on upcoming ICOH events until the end of 2023.

NEWS FROM THE SASOM NATIONAL OFFICE

SASOM is once again holding its Annual Congress in a virtual format in 2023. Four sessions will be held on the last Fridays of the months of June, July, August, and September, with the overarching theme being *Occupational Health Practice in 2023 – Shining a light on the shadows of medicine*. SASOM will report on all four sessions of the Annual Congress in the next issue of *Occupational Health Southern Africa*.

SASOM is represented on the organising committee of the upcoming conference of the ICOH SC on the History of the Prevention of Occupational and Environmental Diseases – 7th International Conference on the History of Occupational and Environmental Health – to be held at the University of KwaZulu-Natal, from 15 to 17 November 2023. SASOM will present a poster on the history of the Society and deliver an oral presentation on the history of occupational health in South Africa. For more information, please access the official congress website: <https://icohhistory.ukzn.ac.za> 



12th Scientific Committee on Occupational Health for Health Workers

October 25-27, 2023
New York City

Register Here 

Occupational Health and Safety for Vulnerable Health Workers

Logos: SCOHHCW 2023, ICOH, Occupational Safety & Health Center, NYNJ, issa, PAHO, WHO, ILO, IOM, AfforHealth, SASOM



Global Perspective on Occupational Health for Health Workers Workshops

October 24, 2023
New York City

National Programmes for Occupational Health and Safety for Health Workers
Guideline for Preventing Violence and Harassment at Work
Global Research and Data Landscape at the Nexus of Precarious Work, Migration and Occupational Health

jhsph.edu/erc/icoh-scohhcw2023

Logos: ICOH, World Health Organization, International Labour Organization, IOM, AfforHealth, SCOHHCW 2023, SASOM

SAIOH news

As part of our service to members, in this newsletter we provide feedback on the latest developments within the Southern African Institute for Occupational Hygiene (SAIOH). SAIOH exists for its members and is reliant on them to continue to serve this noble profession ethically. Therefore, we invite your inputs and feedback on any matters communicated below.

THE 'INTERNET OF THINGS' DEVICE CYBER VULNERABILITIES: ADDRESSING THE RISKS AND ENHANCING SECURITY IN OCCUPATIONAL HYGIENE

Naadiya Mundy: SAIOH President

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Naadiya Mundy

Photograph: courtesy of SAIOH

In the context of industrial hygiene management, the convergence of 'hygiene' and 'the internet of things' (IoT) presents both challenges and opportunities. Occupational hygiene focuses on identifying, evaluating, and controlling workplace hazards to protect the health and wellbeing of workers. IoT, on the other hand, involves the interconnection of devices and sensors, enabling data collection, analysis, and automation in various industries. Thus, the integration of IoT devices in occupational hygiene has revolutionised workplace safety and health monitoring.

In the realm of occupational hygiene, the integration of interconnected devices offers real-time data, empowering improved risk assessment and proactive safety measures for workers' protection. Nonetheless, the swift adoption of IoT in occupational hygiene also creates cyber vulnerabilities, posing risks to the confidentiality of sensitive health data and potentially compromising worker safety. Therefore, understanding the IoT device cyber vulnerabilities specific to occupational hygiene, and devising strategies to bolster security, become imperative to ensure the wellbeing of workers and safeguard their data.²

In simple terms, the IoT, in the context of occupational hygiene, begins with data-gathering sensors and monitors. The most common and useful of these, for occupational hygiene professionals, are mobile, wearable devices, which enable real-time monitoring of workers, even from remote locations. These devices are on the forefront of 'on the worker, on the job' technology that ushers in the 'sensing era' – a new era of information technology where the digital and physical worlds converge.

Gas detection is an exemplary application of this technology, where smartphone apps and sensors work together to warn workers about exposures to toxic substances, including otherwise undetectable gases. The potential applications of the IoT in occupational hygiene are vast and diverse, revolutionising safety practices by supplying real-time data for better risk assessment and proactive

measures to protect workers' wellbeing. However, with the advantages of the IoT come inherent risks, particularly in terms of cyber vulnerabilities.

These potential vulnerabilities include:

1. Weak authentication and access controls: IoT devices may have weak authentication mechanisms or default credentials, making them susceptible to unauthorised access by cyber attackers.^{1,2}
2. Lack of firmware and software updates: many IoT devices lack regular firmware and software updates to address known vulnerabilities, leaving them exposed to potential exploits.
3. Insecure communication: inadequate encryption or unsecured communication channels between IoT devices and central systems can expose sensitive health data to interception.
4. Data privacy and confidentiality: the collection of real-time health data raises concerns about data privacy and confidentiality. Improper data handling or storage can lead to unauthorised access or data breaches. As IoT devices collect and send sensitive health data, including exposure levels to hazardous substances and worker health parameters, ensuring the privacy and protection of this information is paramount to keeping the trust of workers and complying with data protection regulations.
5. Insider threats: malicious insiders or employees with access to IoT devices may exploit vulnerabilities or compromise sensitive data intentionally.
6. Lack of cybersecurity awareness: workers and personnel responsible for operating IoT devices may have limited cybersecurity awareness, leading to poor security practices and potential weaknesses.²
7. Interconnected networks: IoT devices may be connected to the organisation's network, creating potential pathways for attackers to gain access to critical systems.
8. Resource constraints: small and medium-sized organisations may lack the necessary resources and abilities to implement robust cybersecurity measures for IoT devices.

Enhancing IoT device security in occupational hygiene:

1. Implementing secure communication protocols, such as encrypted data transmission and strong authentication, ensures that data collected from IoT devices remain confidential and are accessible only by authorised personnel.
2. Device manufacturers and employers should ensure that IoT devices receive regular security updates and patches to address vulnerabilities and remain resilient against emerging cyber threats.
3. Adopting a multi-layered security approach with firewalls, intrusion detection systems, and secure authentication mechanisms strengthens the overall security of the IoT infrastructure.
4. Employing physical security measures, such as access controls, to prevent unauthorised physical access to IoT devices ensures that tampering attempts are minimised or detected promptly.
5. Organisations should conduct thorough audits to assess and find potential vulnerabilities.

In summary, the adoption of IoT devices in occupational hygiene offers significant benefits in enhancing workplace safety and health. However, it is essential to recognise and address the potential cyber vulnerabilities that these devices introduce. By implementing robust security measures, regular updates, and proactive risk management

strategies, employers can mitigate the risks associated with IoT device cyber vulnerabilities in occupational hygiene. Safeguarding the integrity and confidentiality of data collected by IoT devices ensures that occupational hygiene efforts continue to drive improved worker safety and wellbeing.

REFERENCES

1. Aslan Ö, Aktuğ SS, Ozkan-Okay M, Yilmaz AA, Akin E. A comprehensive review of cyber security vulnerabilities, threats, attacks, and solutions. *Electronics*. 2023; 12(6):1333. doi: 10.3390/electronics12061333.
2. Mupila FK, Gupta H, Bhardwaj A. An empirical study on cyber-crimes and cybersecurity awareness. *Research Square*; 2023 (preprint). doi: 10.21203/rs.3.rs-3037289/v1.

NATIONAL COUNCIL FEEDBACK

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Strategic plan and objectives

The targets within SAIOH's continuously evolving five-year strategy are consistently being met by our diligent management board. A signed-off strategy plan will be circulated to all our members and launched at the annual general meeting (AGM) in October.

Ethics

SAIOH's memorandum of incorporation (Mol), drafted by legal advisors NGO Law, is in the final stages of approval. NGO Law can now concentrate on the review of the SAIOH Ethics Policy and Procedure(s), which will empower the Ethics Committee to instil uncompromisable ethical behaviour in the industry.

Note

Another Ethics PDC will be offered during the 2023 SAIOH Annual Conference.

SAIOH branch activities

The Western Cape branch hosted its second in-person meeting on 9 June 2023. Johan Coetzé discussed the use and application of Bayesian statistics in occupational hygiene. The Gauteng branch will hold its third hybrid meeting on 4 August 2023 at the National Institute for Occupational Health (NIOH) offices in Johannesburg. The Botswana branch, now registered in Botswana as the Botswana Association for Occupational Hygiene (BAOH), held its official launch on 25 May 2023 at the Debswana Training Centre in Gaborone. BAOH also signed a memorandum of understanding (MoU) with the Botswana Ministries of: Employment, Labour Productivity and Skills Development; Mineral Resources, Green Technology and Energy Securities; and Investment, Trade and Industry. Naadiya Mundy, the SAIOH President, attended this event.

International feedback

The Occupational Hygiene Training Association (OHTA) and the International Occupational Hygiene Association (IOHA) continue communicating with their members; relevant links are e-mailed to

all SAIOH members and published on the SAIOH website. IOHA has informed us that they will no longer publish their *Global Exposure Manager* (GEM) newsletter.

Coinciding with the SAIOH 2023 Annual Conference, the IOHA Board of Directors will hold its autumn meeting in Cape Town – hosted by SAIOH on 22 October 2023. SAIOH will also host a formal dinner for the IOHA Board of Directors on 23 October 2023.

Disappointing news

Garth Hunter, the SAIOH representative on the International Occupational Hygiene Association (IOHA) Board and its National Accreditation Recognition Committee (NARC), and a very prominent member of the PCC and PCC Exco, resigned earlier this month. He and his family are emigrating to Ireland in mid-August. This is a huge loss, not only to SAIOH, but also to the occupational hygiene profession in South Africa. We take this opportunity to wish Garth and his family all the best in their new country.

The SAIOH PCC will nominate a new representative(s) on the IOHA Board and the NAR Committee.

SAIOH Technical Committee feedback

Our second technical committee is developing technical procedures and a SAIOH position paper on heat stress management, enabling SAIOH to provide comprehensive and relevant proposals to strengthen the newly launched Physical Agents Regulations (PAR) – the old Environmental Regulations for Workplaces.

Annual SAIOH Scientific Conference

The hybrid SAIOH 2023 Annual Scientific Conference will take place from 23 to 26 October this year, paired with the IOHA meeting. The theme of the conference is *Real-time monitoring revolutionising occupational hygiene for safer workplaces* and will take place at the Breakwater Lodge on the Victoria and Alfred Waterfront, Cape Town.

FROM THE PROFESSIONAL CERTIFICATION COMMITTEE (PCC)

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Corlia Peens: PCC Chairperson

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Certification assessments

A summary of results from the March to June 2023 assessments is provided in Table 1, which reflects the Q1 and Q2 written assessment results and the Q1 oral assessment results.

The second quarter (Q2) PCC written assessments took place on 23 June 2023; 23 virtual oral assessments were conducted from 21 to 31 July 2023 (Q2).

Oral assessment improvements

The PCC technical teams continue to revise the PCC oral assessment format and questions in line with the occupational hygiene self-assessment tool.

Table 1. SAIOH PCC certification assessment results (March–June 2023)

Certification category	Written assessments (Q1 and Q2)				Oral assessments (Q1)			
	Assessed	Passed	Failed	Pass rate	Assessed	Passed	Failed	Pass rate
	n	n	n	%	n	n	n	%
OH assistant	74	69	5	93.2	74	69	5	93.2
OH technologist	37	21	16	56.8	8	4	4	50.0
Occupational hygienist	34	19	15	55.9	15	13	2	86.7
Total	145	109	36	75.2	97	86	11	88.7

Two PCC technical teams are working in parallel. The first is updating the SAIOH self-assessment tool and revising the PCC oral assessment format, and the second is developing questions and the required answers. Improvements in the assessment format will encompass the growing field of occupational hygiene and ensure that the assessment format and tools are relevant and current.

Occupational Hygiene Skills Forum (OHSF)

The OHSF was instrumental in coordinating the development of a series of asbestos training courses. The most recent, 'Asbestos assessments in buildings, section 1: Introduction' is now available for use by OHSF-registered training providers. The assessments are administered by SAIOH for a certain fee per candidate. Please contact Lee Doolan for more info (lee@saioh.co.za). 

UPCOMING EVENTS

OCCUPATIONALhealth
SOUTHERN AFRICA

SOUTH AFRICA

PHASA 2023 Conference

The Boardwalk Convention Centre, Gqeberha (Port Elizabeth)

10-13 September 2023

e-mail: info@nioh.ac.za

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INTERNATIONAL

Decent work beyond COVID-19

Tokyo, Japan

19-22 September 2023

Website: https://www.occhealth.co.za/pdf/ICOH-2023_fixA4.pdf

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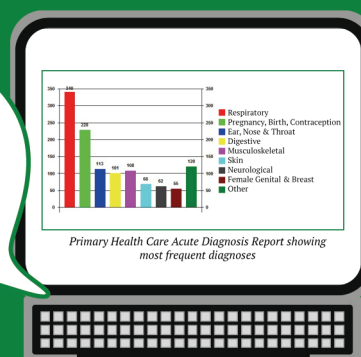
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Guideline for the compilation of a mandatory code of practice for the selection and provision of personal protective equipment for women in the South African mining industry

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BACKGROUND

The mining industry has been male dominated for years, but there has been an increase in the number of women employed. Women are now occupying jobs underground, which were, in the past, exclusively performed by men. This comes with unforeseen challenges. One is the use of personal protective equipment (PPE), which was designed for men and did not take female anthropometric measurements into consideration. Women in mining (WIM) have unique anatomical and physiological makeups, and special health and safety needs. This has led to an improvement in the provision of more suitable PPE for women.

According to the project report, SIM 100904, there is a possible association between the types of PPE used by women and increased exposure to skin conditions such as contact dermatitis, chaffing, rashes, and bacterial and fungal infections.¹ The situation is reported to be further exacerbated by the unique coping mechanisms that WIM have been compelled to use, to adjust or correct ill-fitting PPE, e.g. the use of nylon tights and thick woollen socks. These unorthodox adjustments led to increased risks for skin conditions.

Thus, it became necessary to draft a guideline on the provision of PPE for WIM in the South African mining industry. The first Guideline was promulgated in 2015. The current Guideline follows a five-year implementation period, addressing concerns that were raised after the first promulgation. The reviewed Guideline was promulgated on 28 July 2023.²

PPE selection, provision, and use in the workplace should not be based only on hazard identification and risk assessment processes, but should also incorporate ergonomic and comfort aspects to guarantee PPE efficiency for all workers. This approach will ensure that female anthropometric measurements are taken into consideration and accommodated. The hazards identified will determine the body part that is to be protected and the PPE that is required. The relevant PPE includes, but is not limited to, head, eye and face protection, hand and arm, body (torso), foot, and respiratory protection.

LEGAL STATUS OF THE GUIDELINE AND CODE OF PRACTICE (COP)

According to Section 9(2) of the Mine Health and Safety Act (MHSA), an employer must prepare and implement a COP on any matter affecting the health and safety of employees at mines, other persons who may be directly affected by activities of these mines, or when the Chief Inspector of Mines (CIoM) requires it.³ The COP must comply with any relevant guideline issued by the CIoM in accordance with Section 9(3) of the MHSA.³ Failure by the employer to do this is a breach of the MHSA. All employers are, thus, required to prepare and implement the mandatory COP of the selection and provision of PPE for women in the South African mining industry, in accordance with the 2023 Guideline.

OBJECTIVES OF THE GUIDELINE

The main objective of the Guideline is to provide guidance to the employer at every mine when compiling a mandatory COP. The COP will assist employers in providing suitable PPE for WIM where required, and to train all employees on issues relating to PPE for WIM.

ASPECTS TO BE ADDRESSED IN THE COP

The COP must cover, as a minimum requirement, the aspects set out below, unless there are no significant risks identified at the mine that affect the aspects mentioned. The COP covers the roles and responsibilities of different persons involved in the processes to ensure that suitable PPE is provided to WIM.

The roles and responsibilities include the following:

1. The employer

The employer must ensure that:

- structures are established and maintained at the mine to address occupational health and safety, and gender issues related to PPE. These structures must be representative of the technical, professional, and managerial demographics. Consideration should be given to women working in different mining environments (underground and surface), and plants;
- enough of the required and appropriate PPE for each activity performed by WIM is available. Suitable PPE provided should be considered in the risk assessments that are conducted;
- there is awareness, education, and health promotion provided to WIM on mining issues and the use of PPE;
- training is provided on the types and the correct use of suitable PPE;
- before procurement, there are engagements with manufacturers, female employees, and suppliers to meet the PPE needs of the employees;
- procedures are established and implemented, and facilities provided to ensure the proper maintenance of PPE;
- suitable facilities are provided for the storage, transportation, and cleaning of PPE;
- a documented monitoring system is established and maintained, regarding the appropriateness and effectiveness of PPE used by WIM; and
- any medical information required for the implementation of the COP remains confidential.

2. Managers and supervisors

Managers and supervisors are responsible for ensuring effective day-to-day use of PPE by the WIM falling under their supervision. This could include the management and operationalisation of the PPE standard operating procedure (SOP) for the different mine sites. They are also responsible for:

- familiarising themselves with the contents of the COP relevant to the WIM falling under their supervision, and ensuring implementation; and
- ensuring that specific risk assessments are carried out for the protection

of WIM, and providing PPE that can mitigate risks faced by WIM. These assessments are conducted to:

- ensure that WIM receive suitable and sufficient information, instruction, and training regarding PPE supplied to them; and
- ensure the proper use, storage, maintenance, cleaning, examination, repair, and replacement of PPE.

3. Women in Mining

Female employees also have the responsibility to comply with the requirements of any safe measures put in place, and must:

- ensure that the PPE provided is used and cared for as required in the MHSA, and in accordance with the training, instruction, and information received;
- return the PPE after use to the storage facilities provided. If this is not possible, they must take reasonable steps to safeguard the condition of the PPE when temporarily stored elsewhere. Employees must avoid taking the PPE home unless otherwise agreed upon by the employer based on the risk assessment;
- regularly examine the PPE and report any defect, damage, or loss to the manager or the supervisor;
- inform managers or supervisors of any medical and/or other condition(s) that may affect the ability to wear or use PPE; and
- report to the manager or supervisor any concerns regarding the equipment, and suggested improvements to SOPs, which may reduce the risks for PPE or enable improvements in the design or application thereof.

The COP should set out measures to ensure that suitable PPE for WIM is selected and provided, and that such PPE is properly maintained. These measures should include:

- Identifying all areas in which PPE for WIM may be required
- Identifying the types of PPE for WIM that would provide suitable protection against the identified hazards, including undergarments
- Ensuring that the correct PPE for WIM is issued to each female employee in terms of:
 - The size and fit, including smaller sizes, considering their ergonomics, anatomical and physiological needs
 - The workplace hazards
 - The purpose of the PPE
 - The nature of the work to be undertaken
 - Adequacy of PPE in terms of quality and quantity



Fig 1. The jacket

A ladies' cut, longer and extending below the waist with slits on the sides. The bust is darted to fit perfectly over the chest area. The zipper is metal for durability. In this case, the mine opted for a pink reflective strip for a special touch Photograph: courtesy of MMPA

- Ensuring PPE for WIM is regularly maintained to remain fully functional for its intended purpose
- Ensuring PPE for WIM is timeously replaced when no longer fully functional for its intended use
- Ensuring that the use and effectiveness of the PPE is monitored, including fit, comfort, and maximum protection from the identified hazards for WIM
- Ensuring pregnant and breast-feeding women are duly accommodated in line with the risk assessment

Training

The COP must set out measures to ensure that WIM are properly trained in the use of PPE provided to them, which should include:

- Identifying appropriate persons to provide training to WIM on the use of PPE, with the appropriate qualifications and experience
- Giving employees access to the MHSC's *Illustrative Handbook on PPE for WIM*, and including PPE training in the induction programme for employees
- Conducting training in two phases for all WIM who are required to wear PPE

CONCLUSION

Most mines have started to implement the requirements outlined in the Guideline in terms of PPE, based on the research findings reported in SIM 100904.¹ For example, women no longer prefer to wear one-piece overalls, choosing to wear two-piece PPE clothes, as depicted in Figures 1 and 2.

REFERENCES

- Zungu LI. Personal protective equipment for women in the South African mining industry. SIM 100904. Johannesburg: Mine Health and Safety Council; 2012.
- South Africa. Mine Health and Safety Act, 1996 (Act No. 29 of 1996). Guideline for a mandatory code of practice for the selection and provision of personal protective equipment for women in the South African mining industry. Government Gazette No. 49046; 2023 July 28 (published under Government Notice 3734). Available from: https://www.gov.za/sites/default/files/gcis_document/202307/49046gon3734.pdf (accessed 15 August 2023).
- South Africa. Mine Health and Safety Act, 1996 (Act No. 29 of 1996) and Regulations. Available from: <https://www.gov.za/documents/mine-health-and-safety-act> (accessed 27 August 2023). 



Figure 2. The pants

A high cut to prevent slipping and unwanted exposure when bending. There is a wider cut around the hips to ensure maximum comfort. A double layer material is inserted in the crotch area to prevent fraying Photograph: courtesy of MMPA