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Exploring prioritization of wellbeing and health impacts for mining communities during the mining life cycle within the sub-Saharan Africa context: a systematic review

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Abstract

Introduction Sub-Saharan African countries possess rich mineral resources that offer socio-economic development opportunities for mining communities. However, the prioritization of health and wellbeing impacts during the mining life cycle remains unclear. This review examines the focus on health and wellbeing in mining communities within the sub-Saharan African context.

Methods An online literature search was conducted across four databases (Scopus, PubMed, ProQuest, Web of Science) using the PICOS framework for eligibility criteria. The Rayyan tool was used for screening and data extraction.

Results 45 studies were included (20 qualitative, 25 quantitative, including mixed methods). Most studies were from South Africa. Health impacts identified included: (a) HIV/AIDS, (b) Tuberculosis (TB), (c) Hypertension, and (d) Health Impact Assessment (HIA). The study also explored the mining life cycle stages—Exploration, Development, Production, and Closure—focusing on health and wellbeing prioritization.

Conclusions While mining offers socio-economic benefits, health and wellbeing impacts are not prioritized, especially in the exploration stage. Tools like HIAs provide valuable insights, but mining communities continue to face health challenges, both positive and negative.

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Keywords Prioritization, Wellbeing and health impacts, Mining communities, sub-Saharan Africa

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Introduction

The mining industry in sub-Saharan Africa, particularly in nations like the Democratic Republic of Congo, South Africa, Botswana, and Gabon, significantly impacts local communities, especially in rural areas. Mining is closely aligned with the United Nations Sustainable Development Goals (SDGs), which aim to promote global sustainability and equality by 2030 [1]. These goals emphasize addressing global challenges like poverty, health, education, and environmental sustainability, and mining plays a complex role in both advancing and hindering these objectives.

In rural sub-Saharan Africa, communities affected by mining fall into three categories: durable-agrarian (farming-focused), resource-extraction (mining and timber-focused), and suburbanizing (urban sprawl without dominant economic activities) [2]. While mining provides economic opportunities, it also brings social and environmental challenges, impacting community health and wellbeing.

The International Council on Mining and Metals (ICMM) outlines a five-stage mining lifecycle: exploration, development, production, production & closure, and closure.

Each phase influences community health and wellbeing, yet there is limited focus on prioritizing these impacts throughout the process [3]. Mining activities can lead to health issues among mine workers, such as respiratory diseases (e.g., silicosis) from dust exposure, as well as tuberculosis and HIV due to living conditions and commuting challenges [4]. Wellbeing and health are defined as states of complete physical, social, and mental well-being.

Tools like Health Impact Assessments (HIA) help maximize benefits and minimize health risks. However, mining regions in sub-Saharan Africa still experience low health satisfaction, with respiratory illnesses common near mines [5]. Studies show that elderly individuals living within two kilometres of mines suffer higher rates of chronic respiratory diseases.

Additionally, non-communicable diseases (NCDs) like diabetes and hypertension are poorly managed in these rural communities, contrasting with mine employees who undergo regular health checks [6]. Prioritizing health and wellbeing in the mining life cycle aligns with SDG 3 (health targets) and fosters community development [7]. By incorporating community perspectives on health impacts, mining practices can improve, ultimately contributing to sustainable development in the region.

This study aims to investigate how health and wellbeing impacts are prioritized in mining communities across sub-Saharan Africa. By identifying existing practices, gaps, and improvement areas, this study seeks to inform strategies that place community health and wellbeing at the core of mining activities, aligning with the goals of sustainable development and improved quality of life for affected communities.

Methods

This systematic review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to examine how wellbeing and health impacts are prioritized for mining communities in sub-Saharan Africa, assessing relevant studies and reports across each stage of the mining lifecycle [8]. This systematic review protocol is registered with the International Prospective Register of Systematic Reviews (PROSPERO): PROSPERO 2023 CRD42023474494. The detailed protocol, including the objectives, methods, and planned analyses, is available at https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42023474494.

Inclusion and exclusion criteria

The included, studies had to (i) examine wellbeing and health impacts, (ii) include mining communities, (iii) access current research in this area, published post-2013, (iv) report specific results only in sub-Saharan countries, (v) have accessible full-length articles, (vi) published in English, and (vii) were peer-reviewed and of any study design (qualitative, quantitative or mixed methods). Exclusion criteria were the direct opposite of these inclusion criteria.

Search strategy

The search strategy was developed in collaboration with a professional librarian to ensure thorough and precise coverage of relevant literature. Full details of the strategy are provided in the Appendix 1. The systematic review took into consideration the sub-Saharan Africa mining context hence, the screening questions were developed using the Population, Intervention, Comparator, Outcome, and Study design (PICOS) to formulate eligibility criteria [9]. The PRISMA guideline [10] was used, as a flow diagram (see Fig. 1) is presented to explain the different phases of the article selection as described in the PRISMA guideline [8]. An initial pool of articles was built searching several bibliographic databases: PubMed; Scopus, ProQuest Central, and Web of Science. Furthermore, PROSPERO was searched for a broader range of results to check whether a similar systematic review is registered [11].

The following combination of keywords and their synonyms was developed and applied in the search; Prioritization, Wellbeing and Health impacts, Mining communities, sub-Saharan Africa.

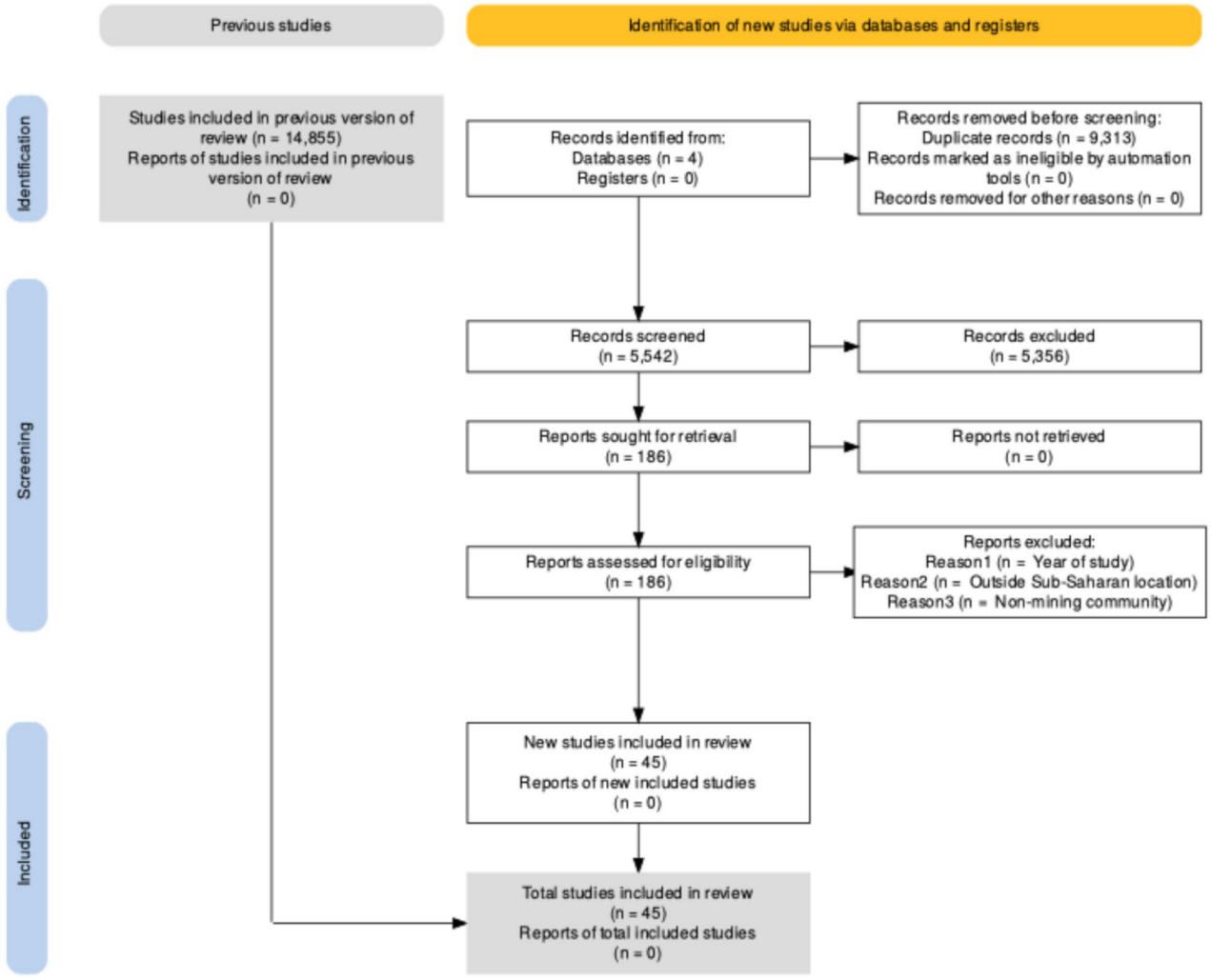

Fig. 1 PRISMA flow diagram

Screening

The screening was conducted using predefined inclusion and exclusion criteria to ensure relevance to the study objectives, articles were screened by two (JNP and NSN) different reviewers independently. To ensure the quality and reliability of the screening process, the use of systematic review management software, Rayyan was used [12]. This tool assisted in the initial screening of titles and abstracts, as well as the subsequent full-text screening, helping to streamline the selection of studies for inclusion in the review.

Furthermore, the two reviewers envisaged to agree on which articles to include during the screening process linking back to the inclusion criteria of the study. Any disagreements were discussed with a more experienced reviewer (SN), as part of resolving the conflicts.

Data extraction

Forty-five studies were assessed and confirmed by two different independent reviewers. An Excel-based data extraction tool was used in the study. The Excel extraction tool focused on fields such as Author, Year, Title, Source, Keywords, Abstract, Citation, and Method. Key characteristics of the studies were highlighted as indicated in Table 1: The lead author conducted the data extraction and the quality assessment, which was independently validated by the second author.

Quality appraisal

For the quality appraisal of all 45 articles, the CASP Checklist for qualitative studies was utilized, whilst for the quantitative and mixed methods, a combination of the STROBE a similar checklist used for systematic reviews, and CASP Checklist was utilized. Appendixes 2 and 3 showcase the summary of the quality assessment criteria for the qualitative and quantitative studies.

Table 1 Key characteristics of included articles

Author	Setting	Methodology	Sample size
(Leunberger et al., 2021)	Burkina Faso; Ghana Mozambique Tanzania	Quantitative Qualitative Mixed methods	791 participants 385 men 406 women
(Abeid et al., 2022)	Tanzania	Quantitative	144,707 people
(Akpalu & Normanyo, 2017)	Ghana	Quantitative - Questionnaires Qualitative – Interviews	558 households
(Knoblauch et al., 2020)	Zambia	Quantitative - Cross sectional	11,638 individuals
(Anaf et al., 2019)	South Africa Namibia	Qualitative – Interviews	11 interviews
(Bester, 2023)	South Africa	Qualitative - Interviews Observations	21 participants,
(Cossas et al., 2022)	Angola; Burkina Faso Burundi; Congo Democratic Republic; Ghana; Guinea; Kenya Liberia Lesotho; Mali, Madagascar; Nigeria Mozambique; Senegal Namibia; Sierra Leone Tanzania, South Africa; Zambia, Zimbabwe	Quantitative Quasi-experimental	90,951 children
(Cronje et al., 2013)	South Africa	Quantitative – surveys Qualitative interviews	12 Focus groups
(Stuckler et al., 2020)	South Africa	Qualitative	No samples
(Dietler et al., 2020)	Ghana Burkina Faso Mozambique; Tanzania Malawi; Democratic Republic of Congo	Qualitative case studies	569 mining projects 35 ministries
(Farnham et al., 2020)	Burkina Faso Ghana Mozambique Tanzania	Quantitative Mixed methods concurrent triangulation Qualitative interviews	36 focus groups, 74 interviews. 74 focus groups, 64 interviews. 75 focus groups, 103 interviews. 36 focus groups, 84 interviews.
(Focus et al., 2021)	Tanzania	Qualitative	74 soil samples
(Knoblauch et al., 2017)	Zambia	Quantitative - Cross sectional	11,638 community members 5564 workers
(Koen et al., 2017)	South Africa	Qualitative– Explorative Descriptive	22 community Caregivers
(Kourouma et al., 2022)	Zambia	Mixed methods Quantitative cross sectional Qualitative Interviews	500 households
(Lekwadu & Lekganyane, 2022)	South Africa	Qualitative - Case study	13 participants
(Leonard, 2017)	South Africa	Qualitative – Interviews	16 interviews
(Leuenberger, Cambaco, et al., 2021)	Burkina Faso Mozambique Tanzania	Qualitative – Interviews	791 participants
(Leuenberger, Dietler, et al., 2021)	All sub-Saharan countries	Mixed methods Quantitative Qualitative Interviews	200 000 households
(Leuenberger, Kihwele, et al., 2021)	Tanzania	Qualitative – Interviews	16 focus group discussions

Table 1 (continued)

Author	Setting	Methodology	Sample size
(Leuenberger et al., 2022)	Burkina Faso Ghana; Mozambique Tanzania	Qualitative – Interviews	24 focus groups, 24 focus groups 35 focus groups 24 focus groups
(Mafulul et al., 2022)	Nigeria	Quantitative	Soil, pondwater plant crops
(Magidi & Hlungwani, 2023)	Zimbabwe	Qualitative - Interviews Case studies	28 respondents
(Marcantonio et al., 2021)	Sierra Leone	Quantitative– Statistical analysis	72 interviews, 11 focus groups 230 participants
(Maseki et al. 2017)	South Africa	Quantitative	5 bulk samples
(Mbuya et al., 2023)	Tanzania	Quantitative– Cross sectional	660 participants
(Mensah et al., 2020)	Ghana	Quantitative	51 samples
(Mhlongo & Akintola, 2021)	South Africa	Qualitative informal - Discussions / fieldwork	12 abandoned mine sites
(Moeng, 2019)	South Africa	Quantitative Qualitative interviews	56 households
(Nkosi et al., 2020)	South Africa	Quantitative - Cross sectional	2397 elderly
(Nkosi et al., 2021)	South Africa	Quantitative - Cross sectional	2397 elderly
(Nkosi et al., 2016)	South Africa	Quantitative - Cross sectional	2 397 elderly
(Ntema et al., 2020)	South Africa	Qualitative - Interviews	200 households
(Oke et al., 2020)	Nigeria	Quantitative	20 soil samples
(Olajide-Ibiejugba et al., 2022)	South Africa	Qualitative – Exploratory	5611 Adolescents
(Ondayo et al., 2023)	Kenya	Quantitative	121 topsoil samples
(Pretty & Odeku, 2017)	South Africa	Qualitative	No sample
(Ramadan et al., 2022)	Egypt	Quantitative	47 samples
(Rice et al., 2022)	South Africa	Mixed methods Quantitative; Qualitative – Interviews	407 people
(Long et al., 2015)	Ghana	Qualitative - Interviews	114 Participants
(Iyaloo et al., 2020)	South Africa	Qualitative - Interviews	310 participants
(Ohene et al., 2020)	Ghana	Quantitative - Cross sectional	10,441 people
(Seloa & Ngole-Jeme, 2022)	South Africa	Qualitative – Interviews	250 participants
(Siyongwana & Shabalala, 2019)	South Africa	Qualitative - Case study	54 local communities
(Veckranges, 2023)	South Africa	Qualitative - Case study	4 796 individuals

The first author applied the checklist to all studies, whereas the second author independently reviewed selected studies using the same checklist for quality control purposes. The authors assessed the quality of evidence and robustness of the synthesis. Where there were conflicts the experienced third author resolved the conflicts.

The qualitative studies were assessed based on the sixteen questions from the CASP checklist for qualitative studies. Whilst the quantitative and mixed methods studies were assessed based on the following ten key criteria: study validity; methodology; results; confounding factors; ethical consideration and conclusion.

The studies reviewed demonstrated significant heterogeneity in terms of methodology, sample sizes, geographic settings, and focus areas. This diversity reflects the varying research objectives, from small-scale qualitative studies offering in-depth insights to large-scale quantitative surveys providing generalizable data. Mixed-methods studies bridged these approaches but highlighted challenges in integrating findings.

Results

Article selection process and summary of included studies

The search of the databases provided 14,855 articles, after resolving the duplicates, 5542 articles remained. After reviewing the abstracts and titles 5356 articles were excluded. The full text of 186 articles were assessed for the inclusion criteria, and 45 articles met those criteria. (***see*** Fig. 2***).*** A summary and narrative synthesis of the 45 included studies are provided in Table 2.

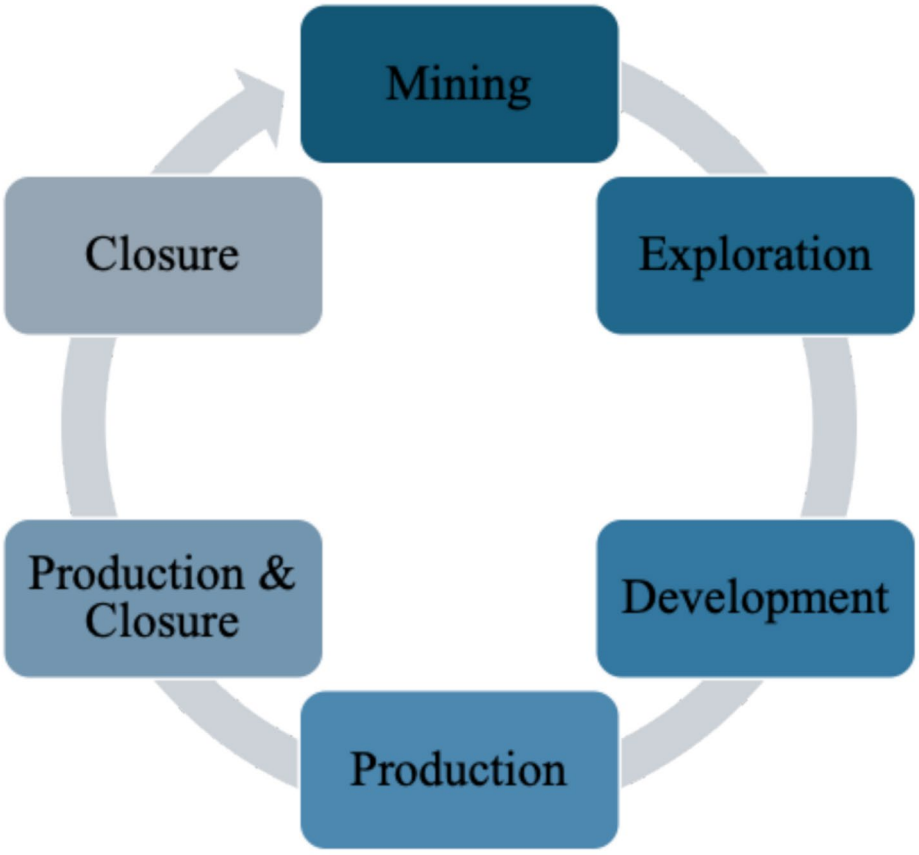

Fig. 2 Stages of a mining life cycle

Table 2 Prioritization of health impact assessments (HIAs) across different mining stages

Mining Stage	Health Impact Prioritization Focus	Description
Exploration Stage	Limited Focus on Health and Wellbeing	Only two studies focused on health and wellbeing impacts during the exploration phase. Limited prioritization of HIAs in this early stage may lead to unaddressed health risks, particularly as communities face potential environmental and social impacts from preliminary mining activities [58, 60].
Development Stage	Emerging Importance of HIAs	Two studies identified the development stage as critical but often lacked detailed focus on wellbeing and health impacts. Emphasis on HIAs at this stage could enhance proactive health planning, helping communities manage the social and environmental impacts linked to infrastructure establishment [19, 50].
Production Stage	High Priority for HIAs and Detailed Health Metrics	HIAs were a focus in twenty-six studies primarily in the production stage, addressing health risks such as respiratory illnesses and safety concerns [1, 13–18, 22, 28, 30, 32–34, 36, 39–41, 43, 44, 46, 47, 50, 53, 54, 56, 57]. Studies found HIAs can lead to a 10–20% improvement in specific health metrics (e.g., reduced respiratory illnesses) and provide data-driven decision-making for health interventions [52].
Production & Closure Transition	Identifying Health Impacts Before Closure	HIAs during this stage help in transitioning communities as mining operations wind down, addressing potential socio-economic and health challenges [61]. Studies suggest this stage benefits from monitoring and evaluation of health outcomes, using cumulative impact analysis to understand long-term effects [61].
Closure Stage	Long-Term Health and Wellbeing Focus	Eleven studies highlighted the need for post-closure HIAs to manage health risks such as arsenic and other pollutants from abandoned mines [20, 21, 23–27, 29, 31, 50, 62]. Ongoing HIAs in this phase can protect community health by monitoring and addressing contamination and health risks linked to closed mining sites [4].
Across Stages: Community Involvement	Prioritizing Community Participation in HIAs	Effective HIAs involve community input, as shown by studies where participation improved tailored interventions by up to 25% [53]. Community involvement was essential to ensure HIAs address specific local health concerns, fostering more sustainable health outcomes in all mining phases [53].
Gendered Health Impacts	Importance of Addressing Gender-Specific Health Needs	One study in Tanzania highlighted the importance of recognizing gender differences in health impacts, especially for women [38]. Gendered HIAs across mining stages allow for more equitable health interventions, focusing on strategic needs and improving health outcomes for vulnerable groups [53].

Geographic distribution of studies across sub-Saharan Africa

The sample size of the 45 studies, were conducted across 36 sub-Saharan African countries. Studies from South Africa (21) [1, 13–32], Tanzania (8) [33–40], Burkina Faso (6) [34, 37, 39, 41–43], Ghana (6) [34, 39, 44–47], Mozambique (5) [34, 43, 48, 49], Zambia (3) [35, 50, 51], Namibia (2) [13, 35], and 1 each in Angola, Burundi, Congo (DRC), Guinea, Kenya, Liberia, Lesotho, Mali, Madagascar, Nigeria, Senegal, Sierra Leone, Zimbabwe, Malawi, and Egypt.

Eight of these studies were in multiple sub-Saharan countries [13, 34, 35, 37, 41–43, 48].

Distribution of research methods

Twenty studies used qualitative methods, twenty-one studies used quantitative, whilst four used a mixed methods approach. The results will be presented by examining the role of HIAs in mining contexts, highlighting specific health issues like respiratory illnesses, tuberculosis, HIV/AIDS, and hypertension in mining communities, and exploring the prioritization of wellbeing and health impacts at various stages of the mining lifecycle, including exploration, production, and closure.

Health impact assessments

Health Impact Assessments (HIAs) are recognized as valuable tools for informed decision-making in the mining sector. They are particularly beneficial in identifying health determinants and assessing the socio-economic and health impacts of mining activities on local communities [38]. For example, a large-scale copper mining project in Zambia demonstrated how HIAs could trigger long-term monitoring of health determinants and outcomes among nearby communities [50].

Several studies report the effectiveness of HIAs in improving specific health metrics, showing a 10–20% reduction in health issues like obesity and respiratory illnesses when HIAs were applied [39]. Moreover, engaging communities in HIAs has been shown to enhance health outcomes by up to 25%, as community involvement helps tailor interventions to local needs [39]. A focus on HIAs during the production stage of mining has been common, with twenty-seven studies examining how these assessments aid in identifying and mitigating health impacts before active mining begins [1, 13–18, 22, 28, 30, 32–34, 36, 39, 41, 43, 44, 46, 47, 51–57].

Beyond production, HIAs serve as essential data collection tools, incorporating methods such as health determinants analysis, stakeholder engagement, and cumulative impact assessments, which were the focus of sixteen studies [14, 18–20, 22, 26, 27, 30, 32, 38, 39, 42, 53, 54, 56, 58]. Five studies further highlight the importance of using both primary community data and secondary data from reports to gain a comprehensive understanding of health impacts [1, 34, 39, 42, 51]. In three studies, HIAs coupled with environmental assessments effectively utilized available community and health service data, enhancing the depth of health impact analyses [38, 41, 52].

Specific needs, such as gender differences in health impacts, also underscore the importance of HIAs. A study in Tanzania used gender-separated focus groups to address women's strategic health needs, underscoring how HIAs can support planning for socio-economic impacts and improve community wellbeing [38]. Additionally, some studies advocate for HIAs to go beyond regulatory compliance, incorporating local perceptions and health data to create a holistic understanding of community wellbeing [13, 34, 58].

Early-stage application of HIAs in mining is crucial to pre-emptively address health concerns, especially in artisanal mining. One study highlighted the need for systematic health assessments that are both sustainable and responsive to broader socio-economic needs, particularly during the closure stage [41]. Incorporating community perspectives has been strongly recommended in three studies, as it prioritizes the health needs of vulnerable populations, leading to more equitable health outcomes and better-aligned interventions [17, 39, 59].

Health impact of mining

The review revealed that mining communities encounter both real and perceived health risks due to their proximity to mining operations. These studies provided valuable insights into the diverse ways mining activities influence the health and wellbeing of nearby communities.

HIV / AIDS / STIs

In remote mining communities, HIV/AIDS and other sexually transmitted infections (STIs) remain pervasive, deeply affecting miners and their families [17]. This issue was documented across nine studies that consistently highlighted HIV/AIDS/STIs as a significant health impact within these communities [1, 15–17, 37, 40, 41, 50, 57].

In a study analysing the impact of new mine openings on HIV infection rates, data from a large sample of 33,086 individuals across 39 mine sites was examined [49]. The findings revealed that these new openings nearly doubled the odds of HIV infection (odds ratio: 1.93) [49].

Additionally, individuals in mining communities showed a trend toward lower HIV knowledge (odds ratio: 0.81), with new mine openings associated with an increase in risky sexual behaviours [49]. In one study, the active involvement of local NGOs, through collaboration and a proactive strategy, was found to play a crucial role in helping mining communities effectively combat HIV/AIDS [33].

Hard-to-reach communities were found to have high rates of TB and HIV, highlighting the need for mines to prioritize these communities in their health initiatives [33]. One study showed that the HIV positivity rate in the community rose from 3.0% in 2012 to 3.4% in 2015, while the positivity rate among the workforce decreased from 5.2% in 2013 to 4.3% in 2015 [52].

Tuberculosis

Seven studies identified various respiratory diseases as a primary health impact for communities living near mines, particularly during the closure stage [21, 29, 33–35, 47, 63]. Three studies in the review highlighted that respiratory diseases were primarily prioritized during the production stage of mining [4, 21, 64]. Additionally, one study provided further detail on respiratory diseases occurring during the exploration stage of mining [35].

Further results have also found an association between respiratory symptoms—such as high levels of current wheeze and rhino-conjunctivitis among communities living near gold mine dumps in South Africa [4]. Respiratory diseases, whether real or perceived as mining-related, were commonly recognized as a health concern in mining communities but were primarily prioritized during the production stage [29].

Three studies highlighted the complex interplay between social and environmental factors that lead to health crises in mining communities, especially in remote areas with limited healthcare access and high TB rates [17, 33, 49]. Integrating TB services in these communities is essential to improve case detection and care, as mining activities significantly increase TB risk due to poor living conditions, environmental degradation, and exposure to harmful dust [4].

Eleven studies focused on TB, with one conducted in Tanzania from 2017 to 2020 demonstrating the impact of community-based active case finding: 144,707 people were screened, resulting in 1,499 TB and 1,273 HIV diagnoses, showing the effectiveness of connecting marginalized groups to TB/HIV services [4, 16, 21, 25, 31, 33–36, 40, 47].

One study highlighted both direct and indirect health risks posed by mining, such as silicosis and other respiratory issues, with these health outcomes especially common among individuals involved in artisanal or small-scale mining [16]. In Mererani, Tanzania, TB prevalence among miners was particularly concerning, ranging from 3,000 to 7,000 cases per 100,000 individuals—significantly higher than the general population [40]. The high rates of TB/HIV in mining communities may be linked to their marginalization [33].

Screening within this population underscored the need for greater support focused on TB-related health and wellbeing in these communities [40]. Collectively, these studies emphasized the critical importance of integrating TB services in mining areas to improve case detection and care, especially for vulnerable and marginalized groups.

Hypertension

The review noted that only two studies focused on hypertension as a health and wellbeing impact [17, 24]. One study, conducted near five pre-selected mine dumps in Gauteng and North West provinces, South Africa, found that high blood pressure was more prevalent among individuals living close to these dumps (1–2 km) at 57.51%, compared to those living 5 km or more away at 46.66% [24].

There was a significant association between residing in exposed areas and having high blood pressure (AOR = 3.04, 95% CI: 2.41–3.83, $P < 0.001$). The second study, conducted in the Bekkersdal mining community, revealed that 36% of participants self-reported being diagnosed with hypertension [17].

Sustainable mining

Exploration and production stage

Despite the critical importance of the exploration phase in mining, this stage frequently overlooks the health and wellbeing of surrounding communities, with only two studies specifically addressing these concerns [58, 60]. These studies indicated that health and wellbeing impacts are generally not prioritized during exploration [58, 60]. Although this phase often raises hopes for economic growth within communities, it can also introduce potential health threats through environmental degradation and rapid urbanization [60].

While two studies reviewed the exploration phase, only one prioritized health and well-being, contributing to a lower risk of child mortality in these communities [60]. Another study examined the environmental and health impacts of both exploration and production phases, highlighting benefits and risks [58]. For instance, uranium mining in Sinai, Egypt, demonstrated significant environmental impacts, especially on vital resources like water [58].

Development and production stage

This review identified two studies that emphasize the development stage as a pivotal phase in the mining project lifecycle, noting that these were the only studies specifically addressing well-being and health impacts during this critical phase [19, 50]. 70% of mining community members were concerned about the transparency and fairness of EIA procedures, while 50% felt government monitoring of mining development is inadequate [19].

Communities expressed a focus on providing special support to vulnerable groups, including the poorest

households during the mining development stage of a project [50]. However, these studies did not elaborate on why health and wellbeing were prioritized at this stage.

Conversely, the Environmental Impact Assessment (EIA) process focuses on mining development but lacks depth regarding health and wellbeing impacts. While the EIA underscores the broader impacts of mining development on communities, its limited scope constrains a comprehensive understanding of these issues [19].

Closure

Even after mine closures, communities continue to face health risks [45]. Studies indicate that abandoned mines pose lingering threats to community health, with arsenic contamination and other pollutants from gold mining being notable concerns [21].

Eleven studies unpacked the socio-economic impacts during mine closure, highlighting that while these analyses were positive undertakings, the lack of focus on health and well-being impacts was a limitation [4, 20, 21, 23, 24, 26, 27, 31, 45, 62, 63]. Mine closure is inherently different, with unique health risks, especially in rural communities affected by abandoned mines [62].

Most studies emphasized the health risks faced by communities near mines, with this exploration allowing for targeted interventions [20]. Eleven studies specifically addressed well-being and health impacts during the closure stage, underscoring the importance of mining's impact on communities [4, 20, 21, 23–27, 31, 45, 62].

However, they did not fully explore the prioritization of wellbeing and health impacts in this stage. One study noted that post-evaluation of health impacts was crucial during the closure phase, emphasizing the need for comprehensive assessments at this stage of mining [29].

Discussion

This systematic review highlighted the significant role of HIAs in reducing health risks in mining communities, looking particularly at the prioritization of wellbeing and health impact across the mining life cycle [41].

However, the review also points out that chronic diseases, like hypertension, remain underexplored in the context of mining, despite evidence linking environmental exposures to these conditions. A notable finding from the review is that HIAs are often applied reactively, with most studies focusing on the production stage of mining operations, whilst early-stage health assessments are often sidelined in favour of economic feasibility studies [59].

The review emphasized, that early-stage HIAs can significantly mitigate long-term wellbeing and health impacts by integrating health considerations from the outset of a mining project.

The review further underscored the importance of considering the health needs of vulnerable populations, particularly women and marginalized groups, who face disproportionate health risks in mining communities [38]. The examination of several health-specific impacts of mining, including the relationship between mining activities and infectious diseases like HIV/AIDS, TB, and Hypertension stood out in the review [33].

The review clearly emphasized that a mixed-methods approach, which integrates both qualitative and quantitative data, is crucial for capturing the complex and multidimensional health impacts in mining communities. This integrated approach would improve the accuracy of health risk assessments and make interventions more targeted and effective.

Regional differences in HIA reflect variations in resource availability, infrastructure, and health priorities shaped by local contexts and mining activities. The prioritization of health impacts varied significantly by country. For instance, South Africa's focus on TB and respiratory illnesses is driven by its proximity to gold mines, while Zambia emphasizes long-term community health monitoring due to copper mining projects [59].

In contrast, Tanzania employs community-based approaches, highlighting localized health interventions, whereas Ghana relies more on quantitative data for mining impacts [38]. The prioritization of health impacts varied significantly by country. For instance, South Africa's focus on TB and respiratory illnesses is driven by its proximity to gold mines, while Zambia emphasizes long-term community health monitoring due to copper mining projects [4].

To fully realize their potential, the review suggests that HIAs should be incorporated into the legal and regulatory frameworks that govern the mining sector throughout the entire mining lifecycle.

HIAs are economically advantageous. For example, Zambia's copper mining projects reduced healthcare costs by addressing health risks proactively. Similarly, Tanzania's community-based TB screenings not only improved health outcomes but also minimized long-term treatment expenses [65].

The review also identified several gaps in the current research on HIAs in mining. One key limitation is the insufficient focus on early-stage health assessments and the need to expand the scope of HIAs to address chronic diseases more comprehensively. The review advocates for future research to be more inclusive and sensitive to the diverse needs of mining communities, throughout the mining life cycle.

Early-stage HIAs should be prioritized to proactively address health risks, integrate community engagement for vulnerable groups, and expand to include chronic diseases like hypertension. Incorporating HIAs

into regulatory frameworks and using mixed-methods approaches can ensure effective, evidence-based interventions tailored to local needs [39].

Many reviewed studies identified correlations between mining activities and health outcomes, such as increased HIV prevalence near new mining sites [16, 33, 49]. However, causation was often not established. Future longitudinal studies are needed to better understand these causal relationships, as longitudinal studies can deepen understanding of causality.

Conclusions

While HIAs have the potential to significantly improve health outcomes in mining communities, their application must be strengthened, as they provide a broader perspective on wellbeing and address risks beyond specific mining projects. Prioritizing health and wellbeing throughout the mining lifecycle can reduce health risks and promote more sustainable practices that benefit vulnerable populations.

It is crucial to prioritize health and wellbeing impacts throughout the entire mining life cycle, rather than focusing solely on the production stage. Continuous research, policy reforms, and the adoption of comprehensive methodologies are essential to enhance the effectiveness of HIAs and ensure lasting improvements in community health and wellbeing.

Policymakers should prioritize integrating public health and environmental protections into mining regulations, as mining impacts local economies, disrupts lifestyles, causes displacement, and can lead to social tensions.

This review underscores the need for a holistic approach to health impact assessments in mining, advocating for their early and consistent application to maximize benefits for affected communities.

Abbreviations

AIDS	Acquired Immunodeficiency Syndrome
CASP	Critical Appraisal Skills Programme
EIA	Environmental Impact Assessment
HIA	Health Impact Assessment
HIV	Human Immunodeficiency Virus
ICMM	International Council on Mining and Metals
NCDs	Non-Communicable Diseases
PICOS	Population, Intervention, Comparator, Outcome, Study Design
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PROSPERO	International Prospective Register of Systematic Reviews
SDGs	Sustainable Development Goals
STIs	Sexually Transmitted Infections
TB	Tuberculosis
WHO	World Health Organization

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Author contributions

Screening was conducted by JNP and NSN, whilst SN resolved the conflicts. Manuscript was authored by JNP with inputs from NSN and SN. Data extraction was assessed and confirmed by JNP and NSN. Quality appraisal was conducted by JNP on all selected articles, with NSN independently reviewing selected articles. Conflicts were resolved by SN. All authors read and approved the final manuscript.

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Data availability

Data is provided within the manuscript or supplementary information files. The sources of data were publicly available published studies identified through electronic databases. No primary data were collected.

Declarations

Ethics approval and consent to participate

Ethical approval was not required for this study, as it is a systematic review of previously published literature. No new data were collected from human participants. All studies included in the review were assessed to ensure that they had received appropriate ethical approval in their original research.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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References

1. Rice B et al. Health and wellbeing needs and priorities in mining host communities in South Africa: a mixed-methods approach for identifying key SDG3 targets, *BMC PUBLIC HEALTH*, vol. 22, no. 1, 2022-1-11 2022, doi: https://doi.org/10.1186/s12889-021-12348-6
2. Howley CB, Howley A. Poverty and School Achievement in Rural Communities: A Social-Class Interpretation, *Rural Education for the Twenty-first Century: Identity, Place, and Community in a Globalizing World*, p. 34, 2010.
3. Sethi SP, Emelianova O. International Council on mining and metals sustainable development framework (ICMM), *Globalization and Self-Regulation: the crucial role that corporate codes of conduct play in global business*, p. 161, 2016.
4. Iyaloo S, Kootbodien T, Naicker N, Kgalamono S, Wilson K, Rees D. Respiratory health in a community living in close proximity to gold mine waste dumps, Johannesburg, South Africa. Int J Environ Res Public Health Vol. 2020;17(7):2020–4. https://doi.org/10.3390/ijerph17072240.
5. Leuenberger A. Investigating health impacts and equity in communities surrounding large natural resource extraction projects in sub-Saharan Africa: a contribution to sustainable development.
6. Singh U, et al. The Met and unmet health needs for HIV, hypertension, and diabetes in rural KwaZulu-Natal. South Africa: analysis of a cross-sectional multimorbidity survey; 2023.
7. Eckermann E. SDG 3: A missed opportunity to transform Understandings and monitoring of health, Well-Being and development?? Appl Res Qual Life. 2018;13(2):261–72.
8. Page MJ et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews, *bmj*, vol. 372, 2021.
9. Amir-Behghadami M, Janati A. Population, intervention, comparison, outcomes and study (PICOS) design as a framework to formulate eligibility criteria in systematic reviews. Emerg Med J, 2020.
10. Moher D, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. Syst Reviews. 2015;4:1–9.
11. Booth A, et al. The nuts and bolts of PROSPERO: an international prospective register of systematic reviews. Syst Reviews. 2012;1(1):2.
12. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan—a web and mobile app for systematic reviews. Syst Reviews. 2016;5:1–10.

13. Anaf J, Baum F, Fisher M, London L. The health impacts of extractive industry transnational corporations: a study of Rio Tinto in Australia and Southern Africa, *Globalization and Health* vol. 15, 2019-2-19 2019, doi: https://doi.org/10.1186/s12992-019-0453-2
14. Bester V. Towards a sustainable artisanal gold mining sector in South Africa: Proposed developmental initiatives, *Journal of Rural Studies*, vol. 97, pp. 375–384, 2023 2023, doi: https://doi.org/10.1016/j.jrurstud.2022.12.029
15. Cronje F, Reyneke S, Van Wyk D. Local communities and health disaster management in the mining sector, *Jamba: Journal of Disaster Risk Studies*, vol. 5, no. 2, 2013 2013, doi: https://doi.org/10.4102/jamba.v5i2.78
16. Stuckler D, Steele S, Lurie M, Basu S. Introduction: 'dying for gold': the effects of mineral miningon HIV, tuberculosis, silicosis, and occupational diseases in southern Africa, (in eng), *International journal of health services: planning, administration, evaluation*, vol. 43, no. 4, pp. 639– 49, 2013 2013, doi: https://doi.org/10.2190/HS.43.4.c
17. Koen V, Ryke EH, Watson MJ, Van Eeden ES. Community caregivers' perspectives of community well-being in a mining community, *Health SA Gesondheid*, vol. 22, pp. 316–324, 2017 2017, doi: https://doi.org/10.1016/j.hsag.2017.05.002
18. Lekwadu MI, Lekganyane MR. The Experiences and Challenges of Women Who Reside in Driekop Mining Community of the Limpopo Province *Social Work (South Africa)*, vol. 58, no. 3, pp. 272–294, 2022 2022, doi: https://doi.org/10.15270/58-3-1057
19. Leonard L. Examining Environmental Impact Assessments and Participation: The Case of Mining Development in Dullstroom, Mpumalanga, South Africa, *Journal of Environmental Assessment Policy and Management*, vol. 19, no. 1, 2017 2017, doi: https://doi.org/10.1142/S1464333217500028
20. Maseki J, Annegarn HJ, Spiers G. Health risk posed by enriched heavy metals (As, Cd, and Cr) in airborne particles from Witwatersrand gold tailings, *Journal of the Southern African Institute of Mining and Metallurgy*, vol. 117, no. 7, pp. 663–669, 2017 2017, doi: https://doi.org/10.17159/2411-9717/2017/v117n7a8
21. Mhlongo SE, Akintola GO. Artisanal and small-scale mining activities as post-mining land use in abandoned mine sites: a case of Giyani and Musina areas, Limpopo Province of South Africa, (in English), *Journal of Degraded and Mining Lands Management*, vol. 8, no. 3, pp. 2815–2827, 2021 2021, doi: https://doi.org/10.15243/jdmlm.2021.083.2815
22. Moeng K. Community perceptions on the health risks of acid mine drainage: the environmental justice struggles of communities near mining fields, *Environment, Development and Sustainability*, vol. 21, no. 6, pp. 2619–2640, 2019 2019, doi: https://doi.org/10.1007/s10668-018-0149-4
23. Nkosi V, Rathogwa-Takalani F, Voyi K. Non-allergic rhinitis and associated risk factors among the elderly in communities close to gold mine dumps in Gauteng and North West provinces in South Africa: a cross-sectional study. Int Archives Occup Environ Health Vol. 2020–8 2020;93(6):715–21. https://doi.org/10.1007/s00420-020-01526-5.
24. Nkosi V, Shirinde J, Rathogwa-Takalani F, Voyi K. High blood pressure and exposure to dust from gold mine dumps among the elderly in South Africa: A cross-sectional study. Public Health Pract. 2021;2:2021. https://doi.org/10.1016/j.puhip.2021.100146.
25. Nkosi V, Wichmann J, Voyi K. Chronic respiratory disease among the elderly in South Africa: Any association with proximity to mine dumps? *Environmental Health: A Global Access Science Source*, vol. 14, no. 1, 2015 2015, doi: https://doi.org/10.1186/s12940-015-0018-7
26. Ntema J, Marais L, Cloete J, Lenka M. Mine closure in Matjhabeng in the free state goldfields, South Africa: implications for households. Extractive Industries Soc. 2023;14:2023. https://doi.org/10.1016/j.exis.2023.101257.
27. Olajide-Ibiejugba A et al. Allergy and Household Living Conditions among Adolescents Living near Gold Mine Tailing Dumps in the Gauteng and North West Provinces of South Africa, *International Journal of Environmental Research and Public Health*, vol. 19, no. 1, 2022-1 2022, doi: https://doi.org/10.3390/ijerph19010122
28. Pretty MM, Odeku KO. Harmful mining activities, environmental impacts and effects in the mining communities in South Africa: a critical perspective, (in English), *Environmental Economics*, vol. 8, no. 4, pp. 14–24, 2017 2017, doi: https://doi.org/10.21511/ee.08(4).2017.02
29. Iyaloo S, Kootbodien T, Naicker N, Kgalamono S, Wilson K, Rees D. Respiratory health in a community living in close proximity to gold mine waste dumps, Johannesburg, South Africa, *International Journal of Environmental Research and Public Health*, vol. 17, no. 7, 2020 2020, doi: https://doi.org/10.3390/ijerph17072240
30. Seloa P, Ngole-Jeme V. Community Perceptions on Environmental and Social Impacts of Mining in Limpopo South Africa and the Implications on Corporate Social Responsibility, *Journal of Integrative Environmental Sciences*, vol. 19, no. 1, pp. 189–207, 2022 2022, doi: https://doi.org/10.1080/1943815X.2022.2131827
31. Siyongwana PQ, Shabalala A. The socio-economic impacts of mine closure on local communities: evidence from Mpumalanga Province in South Africa, *GeoJournal*, vol. 84, no. 2, pp. 367–380, 2019 2019, doi: https://doi.org/10.1007/s10708-018-9864-5
32. Veckranges L. Estimating the impact of large-scale mining on local communities in sub-Saharan Africa, *Development Southern Africa*, vol. 40, no. 5, pp. 1067–1085, 2023 2023, doi: https://doi.org/10.1080/0376835X.2023.2171966
33. Abeid R et al. Increasing TB/HIV Case Notification through an Active Case-Finding Approach among Rural and Mining Communities in Northwest Tanzania, *Journal of Tropical Medicine*, vol. 2022, 2022 2022, doi: https://doi.org/10.1155/2022/4716151
34. Farnham A et al. Investigating Health Impacts of Natural Resource Extraction Projects in Burkina Faso, Ghana, Mozambique, and Tanzania: Protocol for a Mixed Methods Study, (in English), *JMIR Research Protocols*, vol. 9, no. 4, 2020-4 2020, doi: https://doi.org/10.2196/17138
35. Cossa H, Dietler D, Macete E, Munguambe K, Winkler MS, Fink G. Assessing the effects of mining projects on child health in sub-Saharan Africa: a multi-country analysis, (in English), *Globalization and Health*, vol. 18, pp. 1–16, 2022 2022, doi: https://doi.org/10.1186/s12992-022-00797-6
36. Focus E, Rwiza MJ, Mohammed NK, Banzi FP. Health Risk Assessment of Trace Elements in Soil for People Living and Working in a Mining Area, *Journal of Environmental and Public Health*, vol. 2021, 2021 2021, doi: https://doi.org/10.1155/2021/9976048
37. Leuenberger A, et al. It is like we are living in a different world: health inequity in communities surrounding industrial mining sites in Burkina Faso, Mozambique, and Tanzania, (in English). Int J Environ Res Public Health. 2021 2021;18(21):11015. https://doi.org/10.3390/ijerph182111015.
38. Leuenberger A et al. Gendered health impacts of industrial gold mining in northwestern Tanzania: perceptions of local communities, *Impact Assessment and Project Appraisal*, vol. 39, no. 3, pp. 183–195, 2021 2021, doi: https://doi.org/10.1080/14615517.2021.1904697
39. Leuenberger A, et al. Incorporating community perspectives in health impact assessment: A toolbox. Environ Impact Assess Rev. 2022;95(2022–7). https://doi.org/10.1016/j.eiar.2022.106788.
40. Mbuya A, Mboya I, Semvua H, Mamuya S, Msuya S. Prevalence and factors associated with tuberculosis among the mining communities in Mererani, Tanzania, *PLOS ONE*, vol. 18, no. 3, 2023-3-15 2023, doi: https://doi.org/10.1371/journal.pone.0280396
41. Dietler D et al. Inclusion of Health in Impact Assessment: A Review of Current Practice in Sub-Saharan Africa, (in English), *International Journal of Environmental Research and Public Health*, vol. 17, no. 11, p. 4155, 2020 2020, doi: https://doi.org/10.3390/ijerph17114155
42. Leuenberger A et al. Water and health in mining settings in sub-saharan africa: A mixed methods geospatial visualization, *Geospatial Health*, vol. 16, no. 1, 2021 2021, doi: https://doi.org/10.4081/gh.2021.965
43. Leuenberger A et al. Health impacts of industrial mining on surrounding communities: Local perspectives from three sub-Saharan African countries, *PLoS ONE*, vol. 16, no. 6, 2021 2021, doi: https://doi.org/10.1371/journal.pone.0252433
44. Akpalu W, Normanyo A. Gold mining pollution and the cost of private healthcare: the case of Ghana. Ecol Econ, 142, pp. 104–12, 2017-12 2017, doi: https://doi.org/10.1016/j.ecolecon.2017.06.025
45. Mensah AK, Marschner B, Shaheen SM, Wang J, Wang S-L, Rinklebe J. Arsenic contamination in abandoned and active gold mine spoils in Ghana: geochemical fractionation, speciation, and assessment of the potential human health risk. Environ Pollut. 2020;261:2020. https://doi.org/10.1016/j.envpol.2020.114116.
46. Long R, Renne E, Basu N. Understanding the Social Context of the ASGM Sector in Ghana: A Qualitative Description of the Demographic, Health, and Nutritional Characteristics of a Small-Scale Gold Mining Community in Ghana, (in eng), *International journal of environmental research and public health*, vol. 12, no. 10, pp. 12679-96, 2015-10-12 2015, doi: https://doi.org/10.3390/ijerph121012679
47. Ohene S, Bonsu F, Adusi-Poku Y, Dzata F, Bakker M. Case finding of tuberculosis among mining communities in Ghana, (in eng), *PloS one*, vol. 16, no. 3, p. e0248718, 2021 2021, doi: https://doi.org/10.1371/journal.pone.0248718

48. Leuenberger A et al. Incorporating community perspectives in health impact assessment: A toolbox, *Environmental Impact Assessment Review*, vol. 95, 2022 2022, doi: https://doi.org/10.1016/j.eiar.2022.106788
49. Dietler D, Farnham A, Lyatuu I, Fink G, Winkler MS. Industrial mining and HIV risk: Evidence from 39 mine openings across 16 countries in sub-Saharan Africa, *AIDS*, vol. 36, no. 11, pp. 1573–1581, 2022 2022, doi: https://doi.org/10.1097/QAD.0000000000003294
50. Knoblauch A, et al. Community health impacts of the Trident copper mine project in Northwestern Zambia: results from repeated Cross-Sectional surveys. Int J Environ Res Public Health. 2020;17(10):2020–5. https://doi.org/10.3390/ijerph17103633.
51. Kourouma JM, Monde C, Phiri D, Syampungani S. Community-centred approach for assessing social sustainability in mining regions: A case study of Chingola district, Zambia, *Sustainable Development*, vol. 31, no. 4, pp. 3102–3127, 2023 2023, doi: https://doi.org/10.1002/sd.2572
52. Knoblauch A et al. Experience and lessons from health impact assessment guiding prevention and control of HIV/AIDS in a copper mine project, northwestern Zambia, *Infectious Diseases of Poverty* vol. 6, 2017-7-4 2017, doi: https://doi.org/10.1186/s40249-017-0320-4
53. Magidi M, Hlungwani PM. Development or destruction? Impacts of mining on the environment and rural livelihoods at Connemara Mine, Zimbabwe, *South African Geographical Journal*, vol. 105, no. 2, pp. 157–178, 2023 2023, doi: https://doi.org/10.1080/03736245.2022.2032294
54. Marcantonio R, Field S, Sesay P, Lamberti G. Identifying human health risks from precious metal mining in Sierra Leone, *Regional Environmental Change*, vol. 21, no. 1, 2021-3 2021, doi: https://doi.org/10.1007/s10113-020-01731-5
55. Mbuya AW, Mboya IB, Semvua HH, Mamuya SH, Msuya SE. Prevalence and factors associated with tuberculosis among the mining communities in Mererani, Tanzania. PLoS ONE. 2023;18(3):2023. https://doi.org/10.1371/journal.pone.0280396.
56. Oke JA, Faromika OP, Aluko JO, Oke SR. Human health hazard of elemental concentrations in soils of Epe: an implication of gold mining in Nigeria, *International Journal of Environmental Science and Technology*, vol. 17, no. 12, pp. 4879–4894, 2020 2020, doi: https://doi.org/10.1007/s13762-020-02821-x
57. Ondayo M, Watts M, Hamilton E, Mitchell C, Mankelow J, Osano O. Artisanal gold mining in Kakamega and vihiga counties, Kenya: potential human exposure and health risk. Environ Geochem Health. 2023–8 2023;45(8):6543–65. https://doi.org/10.1007/s10653-023-01647-z.
58. Ramadan RS, Dawood YH, Yehia MM, Gad A. Environmental and health impact of current uranium mining activities in Southwestern Sinai, Egypt. Environ Earth Sci. 2022;81(7):2022. https://doi.org/10.1007/s12665-022-10341-9.
59. Leuenberger A et al. Health impacts of industrial mining on surrounding communities: Local perspectives from three sub-Saharan African countries, (in eng), *PloS one*, vol. 16, no. 6, p. e0252433, 2021 2021, doi: https://doi.org/10.1371/journal.pone.0252433
60. Cossa H, Dietler D, Macete E, Munguambe K, Winkler MS, Fink G. Assessing the effects of mining projects on child health in sub-Saharan Africa: a multi-country analysis, *Globalization and Health*, vol. 18, no. 1, 2022 2022, doi: https://doi.org/10.1186/s12992-022-00797-6
61. Leuenberger A, et al. It is like we are living in a different world: health inequity in communities surrounding industrial mining sites in Burkina Faso, Mozambique, and Tanzania. Int J Environ Res Public Health. 2021;18(21):2021. https://doi.org/10.3390/ijerph182111015.
62. Mafulul SG, Potgieter JH, Longdet IY, Okoye ZSC, Potgieter-Vermaak SS. Health Risks for a Rural Community in Bokkos, Plateau State, Nigeria, Exposed to Potentially Toxic Elements from an Abandoned Tin Mine, *Archives of Environmental Contamination and Toxicology*, vol. 83, no. 1, pp. 47–66, 2022 2022, doi: https://doi.org/10.1007/s00244-022-00936-5
63. Nkosi V, Wichmann J, Voyi K. Comorbidity of respiratory and cardiovascular diseases among the elderly residing close to mine dumps in South Africa: A cross-sectional study, *South African Medical Journal*, vol. 106, no. 3, pp. 290–297, 2016 2016, doi: https://doi.org/10.7196/SAMJ.2016.v106i3.10243
64. Nkosi V, Wichmann J, Voyi K. Chronic respiratory disease among the elderly in South Africa: any association with proximity to mine dumps? *Environmental Health*, vol. 14, 2015-4-3 2015, doi: https://doi.org/10.1186/s12940-015-0018-7
65. AM K et al. Community Health Impacts of the Trident Copper Mine Project in Northwestern Zambia: Results from Repeated Cross-Sectional Surveys, (in eng), *International journal of environmental research and public health*, vol. 17, no. 10, 2020-5-21 2020, doi: https://doi.org/10.3390/ijerph17103633

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