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Burden of Silicosis in the South African Mining Sector and its Effects on Migrant Labor from Neighboring Countries

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Abstract

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Background: Among other minerals, South Africa has an abundance of asbestos and crystalline silica. Due to dust particles from these minerals, exposure causes respiratory diseases in particular silicosis. Most researches on silicosis have largely been of a cross sectional nature with no or limited long-term patterns reported.
Objective: This review aims to analyse silicosis patterns in the gold, diamond and platinum workers over a period of 30 years, and to investigate possible causative factors for mining sector employees leading to them developing respiratory diseases associated with silica.
Methods: This review article is a product of analysis of published reports and studies from South Africa published in the last decades. The EliScholar digital platform and Google scholar were used, and the focus publications were those that related to "silicosis", "migrant workers", silica dust" and autopsy. The review also allowed articles that were generalized, not merely focusing on one mineral. Autopsy reports obtained from the National Institute for Occupational Health database on miners were used for three sub-studies that are the subject of this review.
Conclusion: The silicosis trends in miners at autopsy show a clear system failure by the mining sector in controlling and managing occupational respiratory diseases.

Keywords: *asbestos, diamond, gold, labour, migrant, miners, platinum, silicosis.*

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INTRODUCTION

South Africa has seen mining for more than 100 years and the burden of silicosis has been attendant to the country, however, not much is documented with regards to the incidence of silicosis pertaining to miners who are exposed and their response. This review has a bias on the migrant contract workers coming from neighbouring countries such as, Zimbabwe, Zambia, Botswana, and Malawi for instance, whom history shows as constituting the largest population. Most of these were employed in the mining sector which is mostly dusty with limited occupational health facilities [1, 3, 4]. Oscillating migration behaviours, dusty occupational conditions, and overcrowded housing set ups create perfect conditions to fuel the epidemic. It must be said that the government of South Africa and the mining companies themselves have taken measures to address the situation of prevention but it is also evidenced by the reviewed articles that this has not been adequate. Several epidemiological research works have established clear evidence that extended exposure to dust predisposes both serving and former miners to silicosis and even tuberculosis [5].

METHODS AND MATERIALS

Articles identified were 12 retrieved from the internet mainly from google scholar and PubMed. After screening, two articles were excluded for duplication (n=2), and the remaining (n=10) were screened first and excluded a further (n=2) for irrelevance. The remaining articles (n=8) were further assessed for eligibility and two were excluded with reasons, thus leaving six articles which were included in the review. Figure 1 below shows the flowchart of how literature was selected.

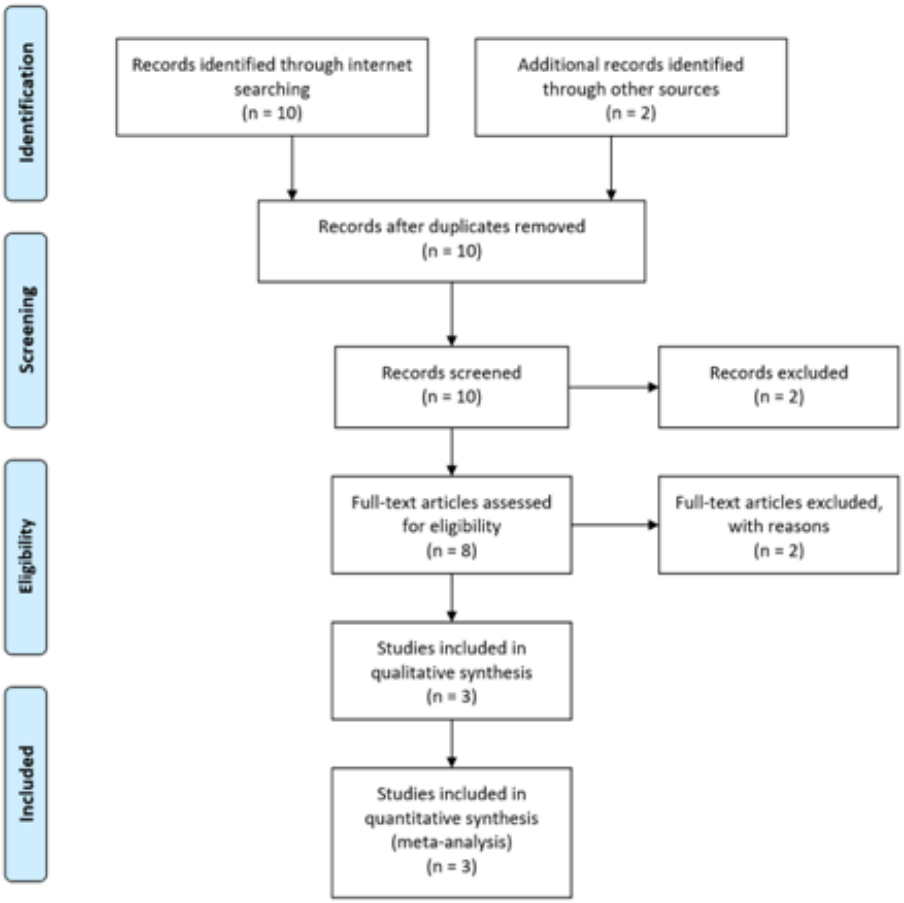

Figure 1: Process flow of literature selection

RESULTS

Surveillance and Research

The occupational exposures and diseases surveillance has not been convincing despite the policy actions from the Mineral Resources department to keep records for instance the databank on Mining Occupational Diseases, a programme which was launched in 1998 [6]. There is also another system called the Pathology Automation System (PATHAUT), which is a databank of over hundred thousand records of miners who died, dating as far back as 1975. PATHAUT helps with a data-source when one does researching and monitoring of disease trends.

Gold mining sector

Prior to the 1990s era a limited number of research works were published analysing the magnitude of silicosis in the country under review. A single cohort study over a long period, focusing on white gold miners provided the reality of the extent of silicosis post retirement. As a result, the incidence of silicosis amongst black gold miners in the early days was distorted even though exposure to black miners was very high. Three later studies of former mine workers from Botswana, Lesotho as well as in the Eastern Cape showed incidences of silicosis topping 36% [8, 9]. By 2001, the category of black miners suffering from silicosis shot fourteen times more than those observed in the early 1980s [7, 8, 14]. From the recorded 19,143 deaths of gold miners from other causes, 85.7% were black and 14.3% were from the white race. The population of black mine workers affected by silicosis went up tenfold from 3 to 36% whilst for white men the increase was insignificant, with a rise from 18% to 22%. White miners were the most affected by silicosis in 1975 averaging 6 times more than their black race equivalents largely due to under reporting, but, by 2007, this pattern changed with blacks now getting 1.5 times increase. Overall, the study noted that the numbers of black mine workers with silicosis almost doubled compared to white miners over a 33-year window.

It is critical to note that most studies conducted so far were cross-sectional and utilised chest radiography which is said to be an unreliable tool for diagnosis. Current studies are handicapped in that they downplay the degree of silicosis since most victims manifest the disease post-employment [10]. Mostly likely this could be due to long term latency of silicosis after exposure to dust environments.

Diamond mining sector

Studies specially targeted at the diamond mining sector though very few in number also indicate that diamond mine workers in South African mines are no better off as they are also at risk of silicosis disease. Kimberlite is said to have some fragments with a low silica content. Diamond deposits according to existing studies are also found near asbestos in a number of provinces in South Africa. Two studies, released in 1995 and 2001, revealed evidence of asbestos dust particles in the various diamond mining sites [10].

Platinum mining sector

Platinum group metals are being mined at the Bushveld Complex area in South Africa. The area contains crystalline silica as well as many other minerals. This therefore means any miner in this area is equally exposed to silica dust. Studies however show very limited silica dust assessments by the platinum mines. One study came up with a value of 0.45% silica content from two studied platinum mines in comparison with 9.9% and 39.1% coming from two gold mines [10]. From deceased mine workers who had an autopsy done in the period covering 1975 - 2008, 1,887 showed evidence of prior work in a diamond mine. A total of five hundred and fifty-nine or (29.6%) had exclusively been with the diamond mines with no evidence of working elsewhere before. Of these 24 (4.3%) showed evidence of one or more diseases related to asbestosis during autopsy. The review shows that this research showed, only 6 diamond miners with silicosis, 4 autopsies showed asbestosis, 1pleural plaques, and 1 with malignant mesothelioma [11].

Silicosis prevalence among black miners in Southern Africa

Two research groups carried out studies into labour source areas of rural Botswana and rural Transkei in an attempt to analyse the correct burden of lung disease, and silicosis more especially, among ex-gold miners [9, 10]. The Thamaga research in Botswana on a study by Steen et al revealed that 25 percent of a random sample of former miners had silicosis (defined as a profusion $\geq$1/0 on the International Labour Organisation scale) [11]. The second study, carried out by Trapido et al. in Libode district, Transkei, came up with a prevalence of silicosis (using a stricter definition of an ILO profusion $\geq$ 1/1) of between 20 and 26 percent, depending on

reader [10, 11]. These findings came as a shock to the mining industry and it confirmed earlier studies by Davies who sounded the alarm bells "when he observed that former mine workers were being violated of their rights. Perhaps the shortcoming of these two studies is that they consisted of samples in which older or disabled miners are likely to have been concentrated hence should not be relied on completely. The migrant labour system, fueled the development of silicosis. Oscillating migration is a risk factor for occupational diseases like silicosis. With the mining sector slowing down on account of depleting minerals, health services in countries of origin for migrant labour have been overstretched by the returning former mine workers. The mining sector for a long time largely depended on migrant workers, from neighbouring countries. The dependence on migrant labour was due to excess and cheap labour from those nations, as well as locals' attitudes towards mining jobs, which they despised [12].

The studies note that there is an increased incidence of between 20% and 25% of silicosis in the miners of older ages currently working black mineworkers and this verifies that there is a notable presence of silicosis in the gold mining sector. Researched studies have also shown that the length of being exposed is a critical factor to contracting silicosis. As the service or length of time at work of black miners continues to increase, the burden of silicosis inversely goes up too. Assuming that the concentrations averages have been constant over a period of time, then these miners developed silicosis even though they came into contact with a mean quartz level that is less than the accepted occupational exposure limit of 0.1 mg/m3.

Data sources

Studies researched show that there has been no databank found in South Africa that has complete employment histories and records of exposures that one can rely on. As such various sources of data were relied on and in effect is secondary data. The pathology department under the National Institute for Occupational Health, South Africa is responsible for providing an autopsy service on miners who died in service and those who died after having left employment. The division also does the verification of diseases that qualify for compensation, subject to next of kin consent, irrespective of circumstances leading to the death. The above is governed by the Occupational Diseases in Mines and Works Act. Details for each autopsied case are electronically posted into the Pathology Automation System. The databank therefore will now provide demographic exposure and disease related information.

DISCUSSION

Silica Dust Exposure and Silicosis

The limited research and data to create the whole picture as part of the historical studies were only biased towards white miners and black workers were excluded by the apartheid system. As such only a few studies post 1994 have looked at the relationship between dust exposure levels and silicosis. There are however recorded results that show that prevalence of silicosis among older generation of black mineworkers increases linearly as different exposure variables also change. Examples would be duration of employment, length of exposure to both dust from asbestos and quartz in gold mines [9, 10]. As concerns dust levels at which risk of silicosis increases, an earlier study reported silicosis prevalence of nearly 25 percent among white South African miners at a length of exposure to inhalable dust level of 9 mg/years/m3 [9]. Churchyard et al, had more or less same results, as they found that prevalence of silicosis was estimated to be around 23 percent among older black gold mineworkers who were still at work at a cumulative exposure to respirable dust level between 8.6-10.4 mg/years/m3 [10,12].

The study also shockingly came up with results that showed that miners in the study developed silicosis nonetheless despite exposure to quartz below the recommended South African occupational levels of exposure in the workplace. The worrying point is that there are high levels of silicosis in gold mines and there is also an association of silicosis and tuberculosis [13]. The disturbing autopsy results showing silicosis in gold miners is an indication of a failed system by the companies and government in managing silica dust levels to acceptable standards. As mine workers grow older, work long hours and work in unsafe conditions, the problem of silicosis and related diseases will persist. The impact is increased health costs and increased morbidity, mortality and the image of the mining industry will suffer. In summary, therefore the analysis by the studies show the following. The researched studies have shown that there is a correlation between duration of exposure and length of service in employment. This was the pioneering research on exposure and the associated silicosis response in South African black gold industry workers using records from exposure to dust.

Interventions by the mining companies

Although the big mining companies appear to address silicosis, there is lack of implementation of effective measures to address the issue. Reviewed articles show that the 1995 Leon Commission report which called for the stricter enforcement of laws and regulatory bodies to regulate the safety and health of mineworkers, resulted in legislating the Mine Health and Safety Act (1996) and later the setting up of a Safety Council, a tripartite body which consists of equal representation of the mining sector, the Department of Minerals and Resources and the mineworkers [14]. However, reports show that there is strong evidence that the Chamber of Mines, the main lobby group for the mining sector, often overrides the intentions of the state as well as the mineworkers making the whole fight against silicosis ineffective [15].

Interventions by Government

The reviewed studies promoted policy and legislative actions, including health systems strengthening. South Africa from the reports has implemented some of the suggestions, although a limited number of these have encouraged government to implement serious remedial action. From all the studies reviewed it is evident that there is a disconnect between policy, what has been researched and implementation in practice on silicosis and related diseases in the mining industry. South Africa has affirmed its objectives to eliminate silicosis by 2030.

The writer recommends for all mining houses to keep complete records and databanks of employment histories of all workers from recruitment to separation as well as histories of other jobs outside the mining sector. This will obviously help families when they are applying for compensation for occupational insurance. Thirdly, this will help in the disease management through development of analysis of disease associations that come with particular jobs and exposures during mining processes.

Silica dust records from the gold mines are usually thumb suck, and not accurately quantified, as such it is recommended that the regulatory authorities should enforce this requirement. The reliability of the data is compromised as the mines self-regulate by submitting dust measurements for risk assessment for determining the level of levies to be paid by the mines. There is therefore a need for an external independent agency to carry out this exercise. Asbestos should be measured and checked regularly in most mines mine environments even in areas where it is not known to be present. This is so because both silica and asbestos are found all over South Africa, hence may be found in many other mines as well [9].

There is further need for a regional policy approach, that covers both the countries which provide or provided the source of most of the migrant labour for instance by addressing health issues from where they come from, work and live. As required by law to carry out disease surveillance systems safety and health officers must widen the scope to cover silicosis dangers in the mining industry. With the high HIV infection rates within the mining industry, exposure to silica dust should be managed to curb susceptibility to tuberculosis. [10, 12]. Whilst funding may be a limitation, this writer recommends that there be an encouragement of the next generation of scholars and academics to research further in occupational health issues like silicosis and fill the knowledge gap. Further there is need for health professions to create more awareness among public health and medical students on the importance of dealing with the problem that is a challenge for the industry [15, 16].

These suggestions are not peculiar to South Africa but apply to neighbouring countries with gold, platinum and diamond deposits. As such there should be cross pollination of ideas since there is labour migration between these countries.

CONCLUSION

There is need for more scholarly work and research on the incidence of silicosis in the mining sector and the studies should widen their scope to neighbouring countries as the impact has widened. The Mining sector needs to adopt a zero tolerance and target to achieve zero levels of silica dust and asbestos. A tripartite approach will adequately address the burden of this disease and create a safe and sustainable, workforce, communities and business.

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