Silicosis elimination in South Africa

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ABSTRACT: South Africa has a serious silicosis problem with inadequate dust control and high disease rates in traditional "silica industries". The strong association between silicosis and tuberculosis in southern Africa combined with the HIV epidemic make elimination of silicosis an important public health issue. Substantial activities to achieve this elimination have been initiated, including the National Programme for the Elimination of Silicosis, under the leadership of the Department of Labour, the Mine Health and Safety Council's Elimination of Silicosis Programme and the Sida-sponsored regional Work and Health in Southern Africa initiative. These programmes are briefly described in this paper. The elimination of silicosis has raised a number of issues. Three are mentioned: an appropriate occupational exposure limit for quartz, the burden of disease in retired formerly exposed workers and prioritisation of industrial sectors for intervention.
A sustained and thoughtful effort over many years is required if South Africa is to eliminate silicosis and silica-related diseases.

1. INTRODUCTION: THE NEED

A powerful case can be made for substantial efforts to eliminate silicosis in South Africa: (1) dust control is inadequate in both mining and non-mining sectors (Rees & Kielkowski 1991, Rees & Weiner 1994, Commission of Inquiry 1995); (2) there is a large burden of undetected lung disease in former silica exposed miners now living in labour-sending areas (Steen et al. 1997, Trapido et al. 1998); (3) silicosis is common in industrial workers Rees & Kielkowski 1991, Rees & Weiner 1994) and in gold miners (Hnizdo & Sluis-Cremer 1993, Murray J et al. 1996, Churchyard et al. 2004) , and the attendant tuberculosis risk is high (Cowie 1994, Hnizdo & Sluis-Cremer 1998, Churchyard &Corbett 2001); and (4) fairly recent research has found that silica dust, independent of silicosis, increases the risk of tuberculosis (Hnizdo & Murray 1998), and that this risk is compounded in HIV infected workers (Corbett et al. 2000).

Inadequate dust control is widespread in the region. For example, only 24% of South African foundries responding to a postal questionnaire actually measured dust, and an uncontrolled dust hazard was evident in **all** foundries surveyed by the National Centre for Occupational Health, South Africa, between 1983 and 1992 (Rees & Weiner 1994). In the late 1990's, only 8 of 48 gold mines (Rees et al. 1999) had all estimated quartz concentrations below the widely used reference level of 0.1 mg/m^3.

Silicosis rates in former gold miners now living in labour-sending areas illustrate the importance of silicosis in the region. Steen and co-workers (1997) found a silicosis prevalence of 26 to 31% in former miners living in Thamanga, Botswana, and Trapido et al. 22-37% in Libode, Eastern Cape, South Africa (1998). Generalising these rates to an estimated two million former miners living in southern Africa produces an astonishing 480 000 cases of pneumoconiosis (Trapido et al. 1998).

Silica, silicosis and tuberculosis

The elimination of silicosis would probably not be a priority in South Africa, a country faced with many major occupational and general health problems, were it not for the association between tuberculosis and silica exposure. The association is well known, and has been for centuries (Balmes 1990), but the impact of this increased risk in countries with high background tuberculosis rates, such as South Africa, is often not fully appreciated.

One example of the increased risk of tuberculosis is described by Cowie (1994) who found an increasing incidence of the disease with increasing severity of silicosis in South African gold miners: 1% per annum in men without silicosis; 2.2% in men with mild silicosis; 2.9% with moderate silicosis; and 6.3% with advanced silicosis. Cowie suggested that one quarter of his subjects with silicosis would have developed tuberculosis by 60 years of age (Cowie 1994). This was before the surge in the HIV epidemic.

Recent studies have found that it is not only silicosis but silica dust itself that confers an increased risk of tuberculosis and that this risk persists even after silica dust exposure ends, probably for life (Hnizdo & Murray 1998); a finding with profound implications for public health policy including surveillance of workers and workers' compensation. The concentration of silica dust at which the risk of tuberculosis is increased to a clinically important degree is not known, so theoretically communities heavily exposed environmentally may have increased rates of tuberculosis.

The relations between silica and tuberculosis are compounded by HIV. Corbett et al. (2000) have shown that the risks of silicosis and HIV infection combine multiplicatively for tuberculosis, so that tuberculosis remains as much a silica-related occupational disease in HIV-positive as in HIV-negative miners.

Combined with significant levels of migrant labour and among the highest HIV infection rates in the world, the interactions between inadequate silica dust control, high rates of silicosis, HIV infection and tuberculosis, including the multi-drug resistant forms, present major challenges for occupational and general public health in the region.

2. WHO IS AT RISK?

Describing the population at risk of silica-related diseases is a preliminary part of many elimination programmes; an example is the United States (Yassin et al 2005). South Africa's National Institute for Occupational Health has tentative data based on the Statistics SA Census 2001 Database and an estimate of the proportions of workers potentially exposed in usual "silica industries" (Sawry et al., in prep). Table 1 shows only a part of the NIOH data. It can be seen that the preliminary estimate is that between 199 000 to 796 000 workers are exposed in South Africa.

Table 1. Estimates of occupational exposure to silica in South Africa.

Major industrial division	Number employed	Potential number of exposed		
		20%	50%	80%
Mining and quarrying	356 289	71 258	178 145	285 031
Manufacturing	286 782	57 364	143 391	229 426
Construction	352 451	70 490	176 226	281 960
Total	995 522	199 104	497 761	796 418

20% = 20% of all employees in the division.

There are many uncertainties in these estimates, the most obvious being the proportion of workers exposed in a particular industrial sector, hence the 20%, 50% and 80% options. Another is which industries to exclude.

Agriculture is not included in Table 1 as the authors do not consider this industrial sector to present a real risk to the vast majority of farm workers, but a case could be made that at least some are at risk of silica-related diseases. Quartz percentages in the respirable fraction of some sandy-loam soils from farms in North Carolina, USA, have been shown to range from 9.1 to 21.3% (Stopford & Stopford 1995). Also, surprisingly high levels of respirable silica were found on personal sampling of farm workers in North Carolina (Archer et al. 2002); by far the highest being a mean of 3.91 mg/m^3 for 5 sweet potato transplanters. Case reports of silicosis in farm workers, particularly tractor drivers, are not unknown, albeit with unconvincing histories; some cases have been reported in South Africa (Dubovsky, 1999). The NIOH Occupational Medicine Clinic has not seen a case of silicosis in an agricultural worker since its inception in 1975; nevertheless an evaluation of respirable quartz exposure in geologically "promising" farming areas would be of value.

3. SUBSTANTIAL PROGRAMMES

Despite competing needs, infectious diseases and traumatic injury prominent examples, silicosis elimination is gaining momentum. Three large programmes make the point.

1.1 *National Programme for the Elimination of Silicosis*

This Programme, under the leadership of the Department of Labour, is a major development, but is described elsewhere in this Publication by Motshelanoka.

1.2 *Silicosis Elimination Programme, Mine Health and Safety Council*

Planned for five years initially, there are three parts to what is probably the largest research-based effort to eliminate silicosis ever in South Africa. The Programme is for the mining industry but many products will be of general value. Part A is to improve exposure assessment and the measurement of dust and quartz; Part B to improve dust control methods and reduce exposure; and Part C to develop training methods and materials for miners, mine managers and health and safety representatives, and to communicate the importance of silica control and the elimination of silica-related diseases. The Safety in Mines Research Advisory Council (SIMRAC) website has details of the Programme: www.simrac.co.za.

1.3 *Work and Health Southern Africa (WAHSA)*

This is a strategic 12-year programme to build sustainable capacity in southern Africa and to undertake key interventions to improve occupational health. It is supported by Sweden's National Institutes for Working Life and Public Health, and has interventions on Silica, Silicosis and Tuberculosis. The major objectives are reduction of dust exposure in key industries and improved prevention of tuberculosis in silica exposed workers. Details of WAHSA are available from the NIOH in Johannesburg: www.nioh.ac.za.

4. SELECTED ISSUES

An appropriate occupational exposure limit (OEL) for quartz

A typical OEL for respirable quartz is 0.1 mg/m^3. But there is increasing evidence that this limit is not protective against silicosis. South African gold mine data have been used to support this contention (Churchyard et al., 2004). Also, OELs should be protective against all the major health effects of an agent. Tuberculosis is a major concern following silica exposure and a South African standard that does not address this health outcome will be partially satisfactory at best. But, although a case can be made for lowering the respirable quartz OEL, South Africa has isolated capacity to reliably measure quartz even at 0.1 mg/m^3, and many enterprises have yet to achieve this level of control. What will be gained by introducing an OEL that cannot be assessed? It might be sensible to vigorously and widely enforce the 0.1 mg/m^3 limit while capacity to measure quartz is further developed and the tuberculosis issue is considered.

Sectoral prioritisation

South Africa has limited resources, so focus on the key industrial sectors is necessary to use these efficiently. There are sufficient data to conclude that gold mining tops the list, but what of the others? We cannot decide with available information. Exposure while working clay deposits illustrates the difficulty. It is well known that some South African clay deposits have high quartz concentrations, although these vary by location and through profiles. Quartz percentages of 30% are not unusual and can reach 60% in the Grahamstown area clay deposits (Jacob, pers. comm.), but the risk to workers has not been determined reliably, and it has been suggested that other minerals in clay may alter quartz surface characteristics (Hnizdo & Wallace 2002). A good argument can be made for simple dust measuring and case-finding surveys in sectors with a poorly defined risk, but the disease rates in former workers may need to be established to assess the importance of the sector.

Silica-related disease in former workers

Silicosis and silica related diseases may manifest many years after exposure has stopped (Hnizdo & Sluis-Cremer 1993). This latency has many implications: cross-sectional surveys are likely to underestimate disease burdens, substantially if there is heavy exposure and high staff turnover; many former workers will present to general health services, rather than workplace services, and so awareness of the conditions needs to be created among health care professionals; and new cases will continue to be diagnosed years after dust control is adequate.

5. CONCLUSION

Silicosis elimination is gaining momentum in South Africa, and large programmes are being implemented. Activity is uneven across industrial sectors, however, and while the mining industry has publicly-stated targets, industry-specific programmes with substantial funding and numerous enterprise level interventions, the non-mining industries' response has been desultory. Possible explanations for this disappointing response have been published elsewhere (Rees 2002), but it shows clearly that a sustained and thoughtful effort over many years is required if South Africa is to eliminate silicosis and silica-related diseases.

6. REFERENCES

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