Worker Exposure to Silica Dust in the Non-mining sectors: Literature Review

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Content of the presentation

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- Main consumers of silica in South Africa
## Phase 1: Identify industries with potential of silica exposure

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Date</th>
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<tbody>
<tr>
<td>1</td>
<td>Literature review on non-mining industries and activities in which silica exposure has been reported</td>
<td>07/2009</td>
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<tr>
<td>2</td>
<td>Identification of types and number of non-mining industries in South Africa where there is a potential risk of exposure to silica dust</td>
<td>09/2009</td>
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<td>3</td>
<td>Statistics on the prevalence of silicosis in the non-mining industry in South Africa, including a breakdown by industries.</td>
<td>10/2009</td>
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<tr>
<td>4</td>
<td>Statistics on the incidence of silicosis in the non-mining industry in South Africa, with a breakdown by industries.</td>
<td>10/2009</td>
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<td>5</td>
<td>Statistics on the annual number of deaths from silica-related diseases in the non-mining industry in South Africa</td>
<td>10/2009</td>
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<td>6</td>
<td>Statistics on the total number of workers eligible for compensation for silicosis (per year) and the number of individuals compensated yearly</td>
<td>10/2009</td>
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<td>7</td>
<td>Description of programmes that are in place in industry as an effort to eliminate exposure to silicosis</td>
<td>11/2009</td>
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<td>8</td>
<td>Phase 1 final project report</td>
<td>12/2009</td>
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### Phase 2: Assess personal exposure to silica dust in selected non-mining industries

<table>
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<tr>
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<th>Description</th>
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<tbody>
<tr>
<td>9</td>
<td>Conduct dust sampling at selected sites in non-mining industries where there is a potential risk of exposure to silica dust.</td>
<td>To be determined after completion of Phase 1.</td>
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<td>10</td>
<td>Develop auditing tool for the DOL inspectors to be used for auditing industries for compliance with requirements.</td>
<td>To be determined after completion of Phase 1.</td>
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<td>11</td>
<td>Compile Phase 2 final project report.</td>
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Aim of the literature review

To present the major literature review findings on occupational silica dust exposure of workers in the non-mining industries/sectors in South Africa
Silica overview

- Crystalline silica has the potential and toxicity to induce pulmonary fibrosis when inhaled

- Factors:
  - Biological activity of type
  - Particle size
  - Freshly cut or ‘aged’
Silica overview

- Silica (SiO$_2$)
  - Major natural component of sand, quartz, granite and mineral ores
  - Compound (silicon and oxygen)
  - (SiO$_2$): 75% of earth’s crust
Silica overview

- Crystalline and cryptocrystalline forms
- Particle sizes:
  - Inhalable (<50 microns, >10 microns)
  - Respirable (<10 microns)
Silica overview

- Most common forms of crystalline silica (industry and naturally occurring)
  - Quartz (mining, blasting & construction)
  - Tridymite (ceramic and refractory)
  - Cristobalite (ceramic, refractory and diatomaceous industries)
Silica overview

Diseases associated with silica exposure

- Silicosis
- Pneumoconiosis
- Silico-tuberculosis
- Pulmonary TB
- Cancer (lung)
- Interstitial fibrosis
- Industrial bronchitis

- Small airway diseases
- Emphysema
- Rheumatoid complications
- Vascular diseases
- Glomerulonephritis
- Immunologic reactions
Silicosis overview

- Serious type of pneumoconiosis
- Inhalation of dust containing free crystalline silica
- Incurable & irreversible, but PREVENTABLE
- Occur 10-20 years after exposure to silica dust has stopped
- Occupational and public health problem
- Disease: Fibrotic pneumoconiosis
- Lung disease: Silicosis
Silicosis overview

- The extend of the disease depends on:
  - Concentration and nature of the dust
  - Duration of exposure
  - Individual susceptibility
Silicosis overview

- High exposure: Very short latency period and rapid disease progression
- Clinical features: Increased susceptibility for tuberculosis (TB)
- Association with TB and HIV/AIDS: Major Occupational and Public Health concern in South Africa
Silicosis overview

- Three types of silicosis
  - Acute
  - Accelerated
  - Chronic
    - Simple
    - Complicated
Silicosis overview

- Acute Silicosis (Silicoproteinosis)
  - Intra-alveolar deposits
  - Exceptionally high concentrations of crystalline silica
  - Reactions: Weeks to two to five years after initial exposure
Silicosis overview

- Accelerated Silicosis
  - Rounded nodular lesions
  - Very high concentration of silica dust over short period
  - Progression faster than other types
Silicosis overview

- Chronic Silicosis
  - Most common form
  - Low and frequent exposures to dusts with 18-30% crystalline silica
  - Accumulation of silica dust
  - Structural changes in lungs, usually in upper lobes
  - Occurs after 10-30 years of exposure
  - Simple (nodules 1cm or less) and complicated (nodules exceed 1cm)
Silicosis overview

<table>
<thead>
<tr>
<th>Acute</th>
<th>Accelerated</th>
<th>Chronic</th>
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<tbody>
<tr>
<td>Sandblasting</td>
<td>Silica flour milling</td>
<td>Sandblasting</td>
</tr>
<tr>
<td>Rock surface drillers</td>
<td>Blasting</td>
<td>Stone dressing</td>
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<tr>
<td>Silica flour milling</td>
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<td>Refractory</td>
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<tr>
<td>Ceramic making</td>
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<td>Foundry</td>
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<td>Grinding</td>
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Silicosis Elimination: A Global Action

- Joint ILO/WHO Committee on Occupational Health proposed a joint Programme on Global Elimination of Silicosis in 1995
Silicosis Elimination: A Global Action

- **Immediate Objective:**
  Promote the development of a National Programme on Elimination of Silicosis in countries to significantly and globally reduce the incidence rates of silicosis by 2015

- **Development Objective:**
  To establish international cooperation on global elimination of silicosis in order to eliminate it as an occupational health problem by 2030
Silicosis Elimination in South Africa

- Two activities:
  - The National Programme for the Elimination of Silicosis by the DOL, initiated in 2004
  - Regional Work and Health in Southern Africa initiative (Sida-sponsored) 2004
Silicosis Elimination in South Africa

- The National Programme for the Elimination of Silicosis (NPES)
  - Outlines government commitment to reduce the prevalence of silicosis by 2015
  - Totally eliminate silicosis in workplaces by 2030
Silicosis Elimination in South Africa

- As part of the NPES a National Working Group (NWG) has been established to:
  - Develop and manage the programme
  - Monitor the implementation of the programme
  - Develop criteria to evaluate the success of the programme
  - Review the programme
  - Update the programme
- Will also establish Provincial Working Groups (PWG): Three already formed for KZN, EC and WC
Silicosis Elimination in South Africa

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Silicosis Elimination in South Africa

- Regional Work and Health Southern Africa (WAHSA)
  - Major objectives are:
    - Reduction of dust exposure in key industries
    - Improved prevention of tuberculosis in silica exposed workers (Rees, 2005)
Non-mining industries and silica exposure: Globally

- Building, highway, bridge construction
- Sand blasting
- Masonry work
- Concrete finishing
- Drywall finishing
- Rock drilling
- Sand and gravel screening
- Rock crushing
- Ceramics, including pottery, sanitary ware and tiles
- Foundries
- Stone working or -cutting
- Glassmaking
Non-mining industries and silica exposure: Globally

- Jewellery manufacturing, especially in the agate industry
- Agriculture
- Ship building
- Railways
- Paint abrasive and chemical manufacturing
Non-mining Industries and silica exposure: South Africa

- Construction: tunnelling, rock drilling
- Power tool grinding of surfaces that contain silica
- Sandblasting
- Foundries
- Ceramic, brick, clay and pottery
- Jewellery manufacturing
- Glass manufacturing
- Agricultural sector
- Railways
- Manufacturing of soaps and detergents
- Stone or granite cutting
Silica exposure: Global trends and effects

- **U.S.A.**: From 1985-90 & 1990-99 silicosis caused 11% & 13%, workplace deaths in construction, respectively (Alazab, 2004; NIOSH, 2003)

- **U.S.A.**: Exposure level to silica is sometimes 10-50 times OSHA PEL (Park *et al.*, 2002)

- **Japan**: 41% of foundry workers’ exposure level exceeded OSHA PEL (Koo *et al.*, 2000)

- Total number of potentially silica exposed workers in non-mining are more than twice the amount of mining industry (de la Hoz *et al.*, 2004)
Silica exposure: South African trends and effects

- **Foundries**
  - Estimated 21,652 exposed workers in SA (Excluding admin staff) (Rees & Weiner, 1994)
  - 83% of reported cases of silicosis were from non-mining industries, including ferrous foundries (50%), refractories (11%), ceramic factories (13%) and stone and ore crushing (9%) (Ehrlich et al., 1988)
  - 10% of workers had pneumoconiosis and prevalence increased with years of service (Meyer et al., 1987)
Silica exposure: South African trends and effects

- **Construction**
  - About 543 686 employed (Stats SA, 2007)
  - Western Cape: 94% of workers reported exposure to dust in their working history (Deacon *et al.*, 2005)
Silica exposure: South African trends and effects

- **Agriculture**
  - About 614,962 permanent and seasonal employees (Stats SA, 2006)
  - Three RSA farms studied - Typical sandy soil and sandy loam soil farms in the Free State (2) and North West Provinces (1)
  - TWA results of respirable crystalline silica (RCS) were:
    - 13% > DOL OEL
    - 22% > NIOSH REL
    - 46% > ACGIH TLV-TWA (Swanepoel *et al.*, 2009)
Silica exposure: South African trends and effects

- **Ceramics and Pottery**
  - Highest exposure to crystalline silica in the dust: 6.6 mg/m$^3$
  - Higher than reported in England (Rees *et al.*, 1992)

- **Sandstone**
  - Occupational Hygiene report of three sandstone companies in RSA revealed that exposure to RCS was 5-48 times the DOL OEL
Major silica deposits in South Africa

- RSA clay deposits have high quartz concentration
- Quartz percentage of 30%-60% can be found in Grahamstown (Rees, 2005)
- Rocks with large quartz content:
  - Igneous Rock (Granite, Rhyolite & Pregmatite)
  - Metamorphic Rock (Quartz)
  - Pure Deposits (Sand) (DOL, 2007)
Major silica deposits in South Africa

- Silica is mostly mined in:
  - Gauteng
  - Western Cape
  - Mpumalanga
  - Eastern Cape (see Diagram 1 & 2)
Simplified map of South Africa’s major silica mines and deposits

Adapted, Council for Geoscience map
Simplified map of Gauteng’s silica sand mines and deposits

- Active silica sand mines
- Abandoned silica sand mines
- Dormant silica sand mines
- Silica sand deposits, never exploited
Consumers of silica in South Africa

- Main consumers:
  - Metallurgical industry (54%)
    - Foundry sands and steel manufacture (30%)
    - Silicon and ferrosilicon production (12%)
    - Non-ferrous fluxing applications (9%)
    - Refractories (3%)
  - Glass (20%)
  - Construction (19%)
Consumers of silica in South Africa

- Two smaller users of silica:
  - Applications for filter media (4%)  
  - Recreational sands (3%)
References

- DEPARTMENT OF LABOUR (DOL): Republic of South Africa. 2007. Silica exposure and its effects on the physiology of workers. [Web:]
References


Thank You!