INDOOR AIR QUALITY RESEARCH IN SOUTH AFRICA

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ABSTRACT
This paper will describe research and activities carried out by the Africa Center for Indoor Air Quality. The Center serves in the areas of information management/dissemination, capacity development, and research and policy formulation on aspects of indoor air quality. The paper will also present results of more than 200 homes and buildings that have been monitored for indoor dampness and mold in Durban. Outdoor, indoor (air and surface) mold samples have been collected. Several fungal isolates have been identified to genus and species level. The results indicate that Aspergilli, Cladosporia and Penicillia predominate in indoor environments, constituting a high percentage of respirable material. These genera are well known for their ability to produce mycotoxins and possible pathogenicity.

INDEX TERMS
Indoor environmental health, South Africa, households, mold

INTRODUCTION
In South Africa, household indoor environments are increasingly being recognized as an important, but neglected, public health matter. A study by (Nriagu et al., 1999) in Durban showed that cigarette smoking, outdoor industrial pollution, use of insecticides and home ownership were strongly associated with high prevalence of asthma and respiratory symptoms. This study could not find an apparent association between asthma among children and a number of household known household risk factors including dampness, carpet, pets or use of pesticides.

However, (Thomas et al., 1999) showed that residents of Port Elizabeth experienced problems in the household environment that included mold and dampness, thermal inefficiency, overcrowding and the sitting of shacks in poor locations. Other problems were related to poor ventilation rates and use of paraffin (kerosene), the main cooking fuel used by less wealthy communities. This study further showed that about 80% of households using paraffin had soot on the walls and ceilings and the community reported negative health impacts (pain in the chest and eyes, headaches and problems with the skin) of using paraffin, an area that requires further study.

An initial survey in (Durban by Gqaleni et al., 1999) aimed at investigating the correlation between mold bioaerosols and respiratory health showed 20-40% of children reported frequent respiratory tract (RT) symptoms. Most (60%) of the shacks showed signs of dampness and moldiness. It was in these homes that most RT symptoms were reported.

These and other studies have contributed to the establishment of the Africa Centre for Indoor Air Quality. This paper will describe research and activities carried out by the Center as well

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present results of more than 200 homes and buildings that have been monitored for indoor dampness and mold in Durban

AIMS OF THE CENTER
The Center serves in the areas of information management/dissemination, capacity development, and research and policy formulation on aspects of indoor air quality. It is expected to develop into a National and International Center of excellence for indoor environmental health, working in partnership with local research institutions, government, private sector, community and trade union organizations, NGOs and other International Centers.

RESEARCH ACTIVITIES
The South African Medical Research Council, National Research Foundation and the University of Natal Research Fund finance the research conducted by the Center. Since 1997, we have carried out questionnaire surveys and indoor environmental evaluations in more than 200 urban homes, offices and libraries. The respiratory health of occupants is assessed by use of a questionnaire and clinical tests such as lung function, reversibility lung functions and allergy skin prick tests. We have started carrying out educational workshops for affected communities together with local health and housing officials. The aim of the workshops has been on detection and prevention of moisture damage and related mold problems, improved maintenance of buildings as well as general hygiene and health promotion.

Several local health officials have enrolled for further postgraduate studies and research through the Center. To date there about 10 graduates who have successfully completed their studies, some of whom are playing important roles nationally and internationally in industry, local governments and higher education institutions. A training program with courses for health and housing inspectors, construction engineers and architects, as well as physicians is planned to start in 2003.

The Center also provides research support to local industries on the manufacture of building materials and products resistant to mold and dampness.

RESEARCH RESULTS
The details of methods used in the studies have been published elsewhere before (Gqaleni et al., 1999, Danaviah et al., 2000, Sekhotha et al., 2000, Shadwell et al., 2000, Danaviah, 2001, Sekhotha, 2001). Studies conducted on residential indoor environments indicated that about 42% of homes were moldy while the ratio of indoor to outdoor mold in these homes was generally >1 (Figure 1). The rooms most affected included the kitchens, bathrooms, living rooms and bedrooms, respectively (Table 1).

High temperature, relative humidity and poor building materials (Figure 2, Table 2) were identified as potential amplification factors. Predominant organisms isolated were members of Cladosporium (28-88%), Aspergillus (10-40%) and Penicillium (6-86%). The species profile included several pathogenic, infective and allergenic organisms such as A. clavatus, A. flavus, A. fumigatus and A. niger.
**Figure 1.** The indoor:outdoor colony forming unit ratios in study homes.

**Table 1.** Extent of moldiness of residential homes

<table>
<thead>
<tr>
<th>Affected rooms</th>
<th>% Mold affected rooms per home studied</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No mold</td>
</tr>
<tr>
<td>Kitchen</td>
<td>-</td>
</tr>
<tr>
<td>Living room</td>
<td>48</td>
</tr>
<tr>
<td>Bathroom</td>
<td>52</td>
</tr>
<tr>
<td>Bedroom</td>
<td>-</td>
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* Average of three bedrooms
- not detected
Figure 2. Construction materials used in the area

Table 2. Types of floor coverings used in homes.

<table>
<thead>
<tr>
<th>Floor covering</th>
<th>Study (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vinyl over sand</td>
<td>20</td>
</tr>
<tr>
<td>Vinyl over cement</td>
<td>40</td>
</tr>
<tr>
<td>Carpet over cement</td>
<td>20</td>
</tr>
<tr>
<td>Vinyl and carpet over sand</td>
<td>10</td>
</tr>
</tbody>
</table>

About 32% of children tested reacted positively to mold allergens only when compared to 7% that reacted to dust mite only (Figure 3).

LEGISLATION AND GUIDELINES
In South Africa, environmental health law is guided by the Constitution, which states that everyone has a right to live and work in a healthy environment (SA Constitution, 1996). Along with research and training, existing laws are being reviewed with respect to indoor air quality. Although the Occupational Health and Safety Act (1993) and the Atmospheric Pollution Act (1965) focus on industrial and occupational settings, there are no national guidelines on indoor air quality and on measurement of indoor air quality exposures aimed at residential buildings (Gansan et al., 2002). It is intended that the work of the Center will contribute to the development of such laws and guidelines.
Figure 3. Incidence of mono- and multiple sensitisation to dust and mold allergens.

FUTURE ACTIVITIES
South Africa will be hosting the United Nations World Summit for Sustainable in August 2002 provides where environment, health and development will feature prominently. The Center intends utilising the ideal opportunities this meeting will provide for increasing public awareness of indoor environmental health issues. The National Department of Health and all its local structures support the work of the Center. This will provide impetus for increased multidisciplinary research outputs that will make positive contribution this country.

REFERENCES


South African Constitution. 1996