INDOOR AND OUTDOOR ENVIRONMENTAL ASSESSMENT OF DURBAN BLOCK HOSTELS

AN INTERNAL EVALUATIONS ON EXPOSURE MEASURES AND OUTCOMES OF SELF SUPPORTED HEALTH AND WELL-BEING IN HOSTELS

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ABSTRACT

Hostel dwellers form a larger part of the urban population in South Africa (Ramphele, 1999). These hostels were initially created as temporal arrangement for African men moving from rural to urban areas seeking for employment. Due to housing shortage in urban areas they eventually became permanent residential accommodation. However, observations into the environmental conditions in these hostels have raised concerns about the health and well being of residents and neighbouring communities.

The area of study was selected on the basis of the current depleted living conditions due to mismanagement of facilities provided by both the occupants and the hostel administrators. The study was a cross sectional descriptive study involving all three Durban Metropolitan block hostels. Assessing (i) the quality of block hostel environment (indoor and outdoor) through visual inspection (walkthrough), (ii) the exposure measures and outcomes (biophysical environment assessment) by means of questionnaire survey, air testing and microbial identification. Sixty three (63) hostel inventory were completed, followed by the administration of 450 questionnaires, and 646 surface and air samples were collected in the indoors of the selected hostel blocks including the control outdoor samples.

The demographic profile of the hostel dwellers in the selected hostel blocks revealed that in the five bed type dormitories the habitable space per individual was 3 m^2 to 3.8 m^2. Whilst in the ten bed type dormitories the habitable space per individual was 3.3 m^2 to 3.6 m^2. This was not even close to the World Health Organization suggested habitable space of 12 m^2 (WHO, 2000) and was therefore regarded as overcrowding. Lack of access control in the hostels exacerbated by the socio-economic demands of the living environments, e.g. unemployment, was to blame for overcrowding. This overcrowding of the hostels was overloading the services, causing enormous number of blockages and bursts of wastewater pipes resulting in the system not functioning.

This situation resulted in the accumulation of dampness in the indoor environment, and hence creating conditions favouring the growth of indoor mouldiness in the buildings. This was further supported by evidence that 47% of the occupants in the selected hostel blocks were experiencing respiratory symptoms and 53% experiencing non-respiratory

symptoms. The most recorded respiratory symptoms were pulmonary tuberculosis (14.3%), chest tightness (12.2%), sore and dry throat (7%), sinus congestion (7%) symptoms. Whilst the most recorded non-respiratory symptoms were headache (11.5%), dry and itchy skin (11.5%), stomach upset (6.3%) and fatigue (3.6%). Forty five percent (45%) of the respondents were current smokers and 80% of them had a tendency of smoking indoors. The results of the surface and air samples indicated that the level of indoor mould growth in the selected hostel blocks was at 37, 24%. Surface moulds were at 58% and airborne spores were at 42%.

Statistical analysis of data revealed a significant relationship between exposure factors and outcomes in the 5, 10 and 15-bed type dormitories. Incidence Risk Rate (IRR) and the p-value ($p \geq 0.01$) were used to determine relationships between exposure factors and outcomes. Certain factors were very much supportive in the development of self-reported symptoms in the selected hostel blocks of the three hostels under certain circumstances and these were the hygiene state of the building, leaking pipes, smoking habits and total mea and dg surface moulds. At all levels of the analysis the hygiene state of the building was very much supportive in the development of self-reported symptoms. Other exposure factors were not supportive at all, for example, structural defects, bed-types, different floor levels and participants' perception of overcrowding.

A review process of the role of legislation in controlling the adverse health effects revealed that certain aspects of the legislation relating to building standards requirements, sanitation requirements, ventilation requirements, space and density requirements, and air quality standards requirements were violated. Therefore, the findings of the study recommended that a proper management plan must be developed to enhance living standards.

This plan shall include a routine maintenance of the building structures, the development of a culture of self-care, as well as access control in the hostels. In addition to that where there are signs of visible moulds on walls and ceilings adequate control measures are highly recommended using commercially available measures in order to provide a healthy living environment. In conclusion is the adoption of a compliance policy towards legal requirements pertaining to building standards as defined in the National Building Regulations Standards Act (Act 103 of 1977). This study has showed that necessary steps need to be taken in South Africa in order to combat this problem. Further research need to be taken in order the inhabitable buildings to be better living environment improving the existing building structures.

AUTHORS' DECLARATION

The study represents original work by the author and has not been submitted in any form to another University.

Where use was made of work of others it has been acknowledged in the text.

The research described in this dissertation was carried out under the auspices of the Centre for Occupational and Environmental Health, Nelson Mandela School of Medicine: University of KwaZulu- Natal and was supervised by Prof. Nceba Gqaleni.

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DEDICATION

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ABBREVATIONS

APA	-	Air Pollution Prevention Act (Act 45 of 1965)
AQA	-	National Environmental Management: Air Quality Act (Act 39 of 2004)
APM	-	Airborne Particulate Matter
ARI	-	Acute Respiratory Infections
ASHRAE	-	American Society of Heating, Refrigerating and Air – Conditioning Engineers.
BRI	-	Building Related Illness
BRS	-	Building Related Symptoms
CSIR	-	Council for Scientific and Industrial Research
DG-18	-	Dichloran 18%-Glycerol
DOH	-	Department of Health
EIA	-	Environmental Impact Assessment
EPA	-	US -Environmental Protection Agency
ERA	-	Environmental Risk Assessment
ETS	-	Environmental Tobacco Smoke
HVAC	-	Health Ventilation and Air Conditioning
IAP	-	Indoor Air Pollution
IAQ	-	Indoor Air Quality
IEM	-	Integrated Environmental Management
IEQ	-	Indoor Environmental Quality
IRR	-	Incidence Risk Rate
MEA	-	Malt Extract Agar
NBR	-	National Building Regulations Standards Act (Act 103 of 1977)
NEMA	-	National Environmental Management Act (Act No. 107 of 1998)
NIOSH	-	National Institute for Occupational Health & Safety
SBS	-	Sick Building Syndrome

SOCS	-	Standard Occupational Classification Systems
UKZN	-	University of KwaZulu-Natal
VOC	-	Volatile Organic Compounds
WHO	-	World Health Organization

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CHAPTER 1

Introduction

General Background and Aims of the Study

The construction of hostels in South Africa was motivated by the need for additional labour in urban areas. This need was met by housing African men in hostels and barracks in urban areas so that they would be in close proximity to their place of work. As a result, the South African Government, as stipulated under the Natives Urban Areas Act: (Act no. 21 of 1923) approved the construction and regulation of such areas (Ramphele, 1993).

The limits to permanent urbanization subsequently instituted by the National Party came to be known as influx control. One of the aims, in effect, was to perpetuate migrant labour. This is because it was as migrant workers, with the appropriate stamps in their passbooks that Africans could work in "white" cities without being permanent residents. Increasingly, moreover, migrant workers came from the old native reserves, the areas that were to become known under Apartheid as the homelands (Cox *et al.*, 2004).

According to Thomas *et al.,* (1999), access to land in urban areas of South Africa was one of the key strategies used by the Apartheid Government to limit the urbanization of African people. In addition, other strategies were put in place to address this, including the establishment of 'growth points' in the homeland areas as incentives to keep African people rurally based. National and provincial authorities controlled the provision of land and housing in urban areas as local governments could not be trusted to implement the draconian national strategies. Despite these constraints, there was a continuous stream of unemployed work-seekers to urban areas. The State had control measures in place and attempted to return the work-seekers (now hostel dwellers), who were regarded as 'illegal', to the rural homelands (Thomas *et al.*, 1999).

Hostels were erected in all urban areas in South Africa to accommodate migrant labourers. The design of these hostels demarcated areas according to different activities, for example eating and dining space on one side and sleeping facilities on the other. In situations where the same space was used for different purposes, time-space co-ordinates were used to define what activities were appropriate or could be anticipated in a given setting (Ramphele, 1993). This means that individuals used the limited space available, as there were no demarcated areas for specific activities, e.g. a suitable dining room for dining or an equipped kitchen for cooking.

Hostels were demarcated according to their structures, purpose and living arrangements. For example in the Durban Metro area there were two categories: the four –roomed type made of free standing houses shared amongst families or individuals, and the block hostels, which were either apartments where individual blocks were physically separated into family units or the dormitory types where a group of individuals shared an apartment with five, ten or fifteen beds. The former, even though it did not meet all the basic requirements, was hygienically acceptable. The latter was characterized by closeness, lack of privacy and crowding of space.

Partitioning the 10-/or 15-bed type dormitories in an attempt to increase privacy created the 5-bed type dormitories in the majority of the hostels. This was achieved by erecting solid walls cutting the 10-bed type dormitories into two or the 15-bed type dormitories into three equal dormitories. These alterations to the buildings that were orchestrated by the need to increase privacy violated the basic requirements for adequate ventilation.

Due to poor housing and the high number of immigrant influx into urban areas, these hostels became common social places and residence. They were initially developed for use by male work seekers entering the urban environment for the first time. Over the years the tenant profile was tended towards more permanent rental accommodation. The average three-storey hostel was comprised of 10 to 18, residential blocks, together with ancillary administration facilities, retail accommodation, a community hall and a sports ground. The majority of accommodation was of multi-bed dormitory type, with common ablution and cooking facilities. Some “singles” (i.e. one bedded rooms) had been developed together with some family units, but these were by far in the minority.

The number of beds provided per hostel ranged from 1500 to 4500, depending on the number of occupants and the size of the hostel, but numerous additional “illegal tenants” made use of the hostels. In the Durban Metro area, which was the study area, for example, [in SJ Smith hostel], the official number of beds provided was, 4408 but the best estimate of the population was 5500. In Dalton hostel the official number of beds provided was, 1500 but the best estimate of the population was 2200, and in Jacobs hostel where the official number of beds provided was, 1800 the best estimate of the population was 2800 (DPA, 2003).

At the time of the study ownership of these hostels was vested in the Province of KwaZulu-Natal, but they were in a process of handing over ownership to the Durban Metro Council who were managing and maintaining them. Financially hostels were running at a loss of approximately R6 million per annum each (DPA, 2003). This was due to the fact that rent charged was not based on the premise of full cost recovery (much less on interest or capital redemption), and that the payment of such rental was largely ignored by the occupants. In addition, waste, due to e.g. burst pipes or taps left running, increased operating costs.

During 1999 a partial redevelopment of the three block hostels (i.e. SJ Smith, Dalton, and Jacobs), which in fact amounted to a maintenance exercise plus the development of an additional hostel block in each hostel housing about 84 occupants, was undertaken. This exercise was completed at a cost of R 17, 2 million per hostel (DPA, 2003) and, apart from the development of the new block, the net effect on improving the overall conditions was almost nothing. The funds were effectively wasted.

Except for SJ Smith hostel, there were no documented development plans for the three hostels under investigation at the time the study was conducted. Jacobs was more concerned with other issues, like the complete removal of a squatter settlement which was hindering a development process, provided the local authority provided an alternative housing facility for the then illegal squatters. The construction of at least one block (5-bed type dormitories) was underway, which happened to be the second big development project in that hostel. Dalton hostel was in the middle of converting the unsightly, overcrowded 10-bed type block. There were no proposals on the table to convert blocks to single-family units. A social survey conducted by Mompie (1999) revealed that an overwhelming majority of hostel dwellers in Dalton hostel believed that hostels were serving a purpose, and that they were there to stay and not to be changed.

In response to different ways in which concerns have been raised with regard to the differences in regulatory pressures, research on the effects of indoor environment on indoor air quality and research on the effects of outdoor environment on indoor air quality has been done (Mauderly, 2002). It has been found that, there are more commonalties than differences regarding health issues and research needs between the two fields (Mauderly, 2002). In addition to this, the recognition of indoor and outdoor exposures to environmental issues of either indoor or outdoor origin has grown during the past three decades, but there has been no comparable consideration of the health risks to the communities. Weschler (2002) argues that the understanding of the exposure – response relationships and breadth of health effects of outdoor air pollution has grown considerably.

There is evidence that dwellings of humans have an enormous influence on their well-being and on the surrounding environment, and that construction and use of such buildings place tremendous strains on their environmental support systems and cause a great deal of environmental damage (Manahan, 2000). There is also a significant relationship between what is taking place inside a building, i.e. indoor environment, and outside a building, i.e. outdoor environment (Weschler, 2002). However, human activities and mismanagement of the building with regard to maintenance such as structural defects will exacerbate the situation. This is because outdoor and indoor environments are profitably viewed as highly connected parts of a whole (Weschler, 2002).

A number of studies investigated the impact of indoor and outdoor environmental conditions on indoor air quality in residential buildings including those in squatter settlements. However, very limited information is available on the impact of such conditions on clustered communal facilities of mainly multi-storey buildings. Communal facilities of this nature which emerged as a result of migrant labour needs are characterized by cultural diversity and unique lifestyles which in turn may have an impact on behaviour modification influencing human activities.

There is insufficient information on the legal requirements pertaining to public residential buildings and their impact on indoor environmental problems. Therefore, the researcher initiated this study as a strategy to identify the problem areas in hostels in order to provide remedial measures for future developments within these dwellings, since the struggle against housing shortage in urban areas is a continuous one. The study was therefore initiated with the following objectives in mind:

1. To describe and evaluate the levels of exposure to indoor surface and airborne moulds, by all the exposure factors, e.g. bed types, floor levels and differences between blocks of hostels;
2. To describe and evaluate the self-reported symptoms, their nature and proportions using the total symptom score from the selected hostels;
3. To review the role of legislation in controlling the adverse health effects arising from the hostel environment;

4. To identify ways in which the findings of the study could be incorporated into the hostel redevelopment plans.

CHAPTER 2

Literature Review

2.1 Environmental assessment methodology and limitations of the study

As a strategy to identify the environmental health concerns surrounding hostels as dwellings, an evaluation was done on three hostels using the Environmental Assessment process. Environmental assessment is a procedure to ensure that adequate and early information is available on the likely environmental consequences of development projects, and to provide possible alternatives and measures to mitigate adverse environmental impacts (Lynch, 1998). Unlike the environmental impact assessment which investigates the outcomes of new and existing development projects, environmental assessment evaluates the consequences of such developments projects in order to highlight possible outcomes (Department of Environmental Affairs and Tourism, 1998).

In this context, environment refers to the surroundings within which humans exist and that are made up of the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and well –being. In addition to this the term environment may be used with specialized meaning in three different contexts namely indoor environment, outdoor environment, and the work environment (National Environmental Management Act, 107 of 1998).

The Council for Scientific and Industrial Research guideline document on strategic environmental assessment in South Africa (CSIR, 1997) describes environmental assessment or evaluation as a study of the environmental effects of a decision, project, undertaking or activity. It is often used as a decision support tool to compare options (South Africa, 1998 (b)). Thus it was used to evaluate the environmental factors impacting on health in the indoor and outdoor environments of the selected hostel blocks within the Durban Metropolitan Area.

The methodologies used during environmental assessment vary, one of these, namely situation assessment, is pertinent to this study and will be discussed very briefly.

Situation Assessment

Situation assessment is done at three stages and these are, Through preparation of a resource inventory, by identifying sustainable objectives, and identifying environmental opportunities and constrains.

Preparation of a resource inventory

The purpose of a resource inventory is to identify the social, economic and biophysical resources which should be maintained and/ or enhanced. It identifies the social, economic and biophysical trends on all relevant scales which will influence the maintenance and enhancement of these resources and it identifies the existing institutions, legislation, policies, plans and programmes which will influence the maintenance and enhancement of the environmental resources. Based on this principle, a hostel inventory (Appendix E) was used to identify the environmental resources in and outside of the selected hostel blocks. The term environmental resources refer to goods, services or environmental conditions that have the potential to enhance health and well-being (South Africa, 1998 (b)).

2.2 Environment, health and well-being

Many studies have reviewed the environmental roles of socio economic status, housing quality and material circumstances and they have also claimed the increasing attention of health researchers (Martens & McMichael, 2002). Researchers have also reported concerns about the exposure or residents due to poor housing quality (Thomas et al, 1999), dampness and mouldiness in the residential homes (Sekhotha *et al.,* 2000), the use of low quality building materials (Gansan, 2004). However, it was clear that further investigations would have to be done to evaluate biophysical factors associated with health outcomes in close quarter settlements where basic standards such as ventilation as well as sanitation requirements were not met.

The relationship between the environment and health is multi-directional as environments will affect human health, whereas issues of human health and well-being will affect the environment. It is clear that human health in environments forms the context within which disease, illness and health issues are played out. A working definition of environmental health is health and well-being of human populations in specific physical, social and societal environments. Therefore, it is useful to think of a person's health as an output, and the commodities, services and the background environment that serve to determine a person's health as inputs (Dasgupta, 1993).

Well-being is viewed as the seat of utility or satisfaction and the *loci* of possible states of mind, described by the extent to which desires are fulfilled, by activities that are undertaken and the relationships that are enjoyed (Dasgupta, 1993). In this context, well-being refers to the *loci* of the possible state of mind amongst hostel dwellers The prevailing living conditions in hostels at the time of the study were viewed as being unsupportive to the well-being and health of their inhabitants. This situation therefore rendered the exposed vulnerable to indoor and outdoor environmental exposures (Matooane *et al*, 2004).

Vulnerability implies susceptibility. Blaikie *et al.* (1994) advance a broader definition of vulnerability as the characteristics of a community in terms of their capacity to anticipate, cope with, resist and /or recover from the impact of natural or man-made hazards. In this context, vulnerability refers to the ability of the hostel dwellers to be resilient to the effects of indoor and outdoor environmental exposures. Vulnerability in terms of the Intergovernmental Panel on Climate Change (IPCC) also includes degree of exposure, sensitivity and adaptability (McCarthy *et al*, 2001).

Indoor and outdoor exposure and response are influenced by several factors including vulnerability factors. These are discussed here in the South African context. Vulnerability factors are considered to influence the manner in which populations respond to environmental exposures. People experiencing these problems are less resilient to adverse effects of environmental exposures, including air pollution (Rios *et al.,* 1993). The factors discussed are examples and are by no means exhaustive as there are many more factors that may also contribute to increase in vulnerability. Only those factors that are pertinent to the study will be discussed here, and these are: unemployment, socio-economic status, education and the quality of housing conditions.

<u>Socio-economic status:</u> which is measured by occupation, income and education (Levy *et al.,* 2002) is defined by levels of social exclusion, inequality and deprivation (Friends of the Earth, 2001). These in turn determine the lifestyle and the conditions people live in and the prevalence of environmental risk factors (Friends of the Earth, 2001; Wilkins, 1998). The distribution of these factors within populations determines the differential access to employment, education, nutrition and basic social services such as health

care, housing, energy and water and sanitation (Wilkins, 1998) and vulnerabilities to environmental pollutants (Rios *et al.*, 1993). As a result, lower socio-economic status is also regarded as a predictor for mortality (McDonough *et al.,* 1997; Pensola & Martikainen, 2003).

Unemployment and/or low level of income are associated with various health problems including elevated blood pressure (Matthews *et al.*, 2002; McDonough *et al.*, 1997), and death as a result of cardiovascular diseases and other stress related conditions (Rios *et al.,* 1993). Cardiovascular conditions are also related to exposure to air pollutants such as CO and cadmium (WHO, 1999).

This indicates that people experiencing unemployment problems may be more vulnerable to the effects of air pollution. According to Wilkins (1998), approximately 40% of the South African population is unemployed. Statistics South Africa (2001) reports that 35% of the population between the ages of 15 and 65 years is unemployed. Unemployment is reported high among the previously disadvantaged population groups of South Africa and is highest among Africans (Statistics South Africa, 2001).

Education modifies exposure to air pollution (Levy *et el.*, 2002) and other environmental exposures (Rios *et al.*, 1993) as well as behaviours not conducive to health and well-being (McDonough *et al.*, 1997). Individuals with post high school education were found to have a lesser risk to $PM_{2.5}$ per annual increase of 10 $\mu g/m^3$ (dosage level) when compared with individuals with less than high school education (Levy *et al.,* 2002). In terms of education in South Africa, in 2001 approximately 8% of the population who was more than 20 years of age had received post high school qualifications while 18% had no education at all (Statistics South Africa, 2001).

The level of post high school education for men at 5.3% was slightly higher than that of women at 4.8% (Department of Health *et al.,* 2001). The disparities in education were also evident among racial groupings with the black population having the highest illiteracy levels at 23% as opposed to 8% of the coloured people, 5% of Indians and 1% of the white population (Statistics South Africa, 2001). Since level of education of an individual determines their lifestyles, it is clear that the high levels of illiteracy among the South African population may have contributed to their increased exposure to air pollution (WHO, 1999).

The quality of housing conditions plays a decisive role in health status of residents, because many health problems are either directly or indirectly related to the building itself, the construction materials that were used, and the equipment or the size or structure of the individual dwellings (Al-Khatib *et al.,* 2003). In 2001 approximately 64% of households in South Africa lived in formal housing with 47% living in three or fewer rooms (Statistics South Africa, 2001). The mean number of persons sleeping per room was 2.1 (Department of Health *et al.,* 2001). To address the objectives of the current study, a questionnaire (Appendix D) was administered to quantify the vulnerability factors as outlined in Chapter 4 (Results) which are discussed later in the study.

2.3 The occurrence of indoor dampness and moulds in residential buildings

The association between ill health and the occurrence of mould growth and dampness in indoor and outdoor environments is of particular importance (Brunekreef *et al.,* 1989; Stracham and Sander, 1989). Dampness from the ground is a common problem in buildings that have basements that are one or/ two floors below ground level and have poorly constructed foundations. Such buildings tend to have a problem of high level of indoor humidity that results from insufficient ventilation (Lacey, 1994). A study by Thomas *et al.* (1999) also revealed that dampness contributes to ill health, especially continuous fever, sinus problems and pneumonia.

Sanders and Cornish (1982) state that the principal cause of mould growth is dampness resulting from condensation, rising dampness, leaks and rain penetration that may be involved. In rooms that are commonly used by occupants, their activities such as cooking, washing, watering indoor plants and warming up the interior environments during cold and rainy seasons may generate moisture (Singh, 1994). Therefore, moisture generated will condense on cold surface areas due to temperature differences between outdoor and indoor environments, increasing dampness. This will create a suitable growing environment for mould growth on surfaces where condensation occurs.

Moulds are microscopic fungi, a group of organisms that includes yeasts. Fungi are highly adapted to grow and reproduce rapidly, producing spores and mycelia in the process. Moulds can be useful to people. The drug penicillin is obtained from a specific type of mould (*Penicillium notatum).* Some food and beverages are made by the actions of moulds, e.g. cheeses and soy sauce. Moulds are undesirable when they grow where we don't want them, such as on building materials in our homes (Storey *et al.,* 2004).

A study on the occurrence of indoor moulds in the residential buildings in Durban (Sekhotha *et al.,* 2000) has revealed that the most affected rooms in most mouldy homes are bathrooms and kitchens with inadequate or no ventilation at all. It is in these rooms that flushes of moisture can be generated during cooking or bathing. The bad signs on the walls and ceilings in most houses created by indoor surface moulds are indicative of individual house lifestyles of the occupants as well as their financial status. This might result in a lack of proper building maintenance, which promotes indoor surface mould growth (Sekhotha *et al.,* 2000).

Findings by Metiainen (2000) reveal that mould problems in bathrooms are usually a combination of different causes, which can occur separately or simultaneously. These are long wet periods, high relative humidity and dirty surfaces. They are affected by the design of structures, lack of heating and ventilation as well as the use, cleaning and maintenance of bathrooms (Metiainen, 2000).

5. This investigation on the occurrence of indoor moulds in residential buildings which are stand alone dwellings including squatter settlements is well documented, but investigation on the occurrence of indoor moulds in communal multi-storey residential buildings is not. Therefore this study will provide additional information on the occurrence of indoor dampness and moulds in multi-storey buildings where living conditions are viewed as not conducive to the health and well being of their inhabitants. As it has been described in the previous chapter, hostel blocks consist of multi-storey buildings with a maximum of three floor levels of different bed types, i.e. 5, 10 and 15-bed types. However the objectives of the study seek to evaluate the levels of exposure to indoor surface and airborne moulds, by all the exposure factors, e.g. bed types, floor levels and differences between blocks of hostels. These moulds require certain physical factors to growth in residential buildings, it was therefore necessary to review such factors as briefly discussed in the next paragraph.

2.4 Physical requirements for mould growth

Mould has modest demands for growth: a warm, damp environment with an organic food source. If we keep things dry, moulds do not grow. Unfortunately most houses offer just such an environment. Building materials such as wood and drywall fit the bill. Temperatures that suit humans also suit moulds; and so does water coming in from the outside, through the floor, walls or roof or from plumbing leaks, which may seep, leak, condense, or otherwise appear in homes.

The main requirements for fungal growth in buildings are: a source of infection (spores), favourable temperatures (0 –25^0 C), nutrients, oxygen and water. Fungal spores are ubiquitous, although number and types differ with time of day, weather or other factors. Fungi differ in their temperature tolerance; some species still grow below 0^0 C and others tolerate up to 60^0 C. The nutrient requirements of fungi are satisfied in the built environment by dust and organic deposits and air movement can provide sufficient oxygen (Adan & Samson, 1994). This development of moulds in the indoor environment of residential buildings may expose occupants to respiratory and other health problems as will be discussed in the paragraphs to follow.

2.5 Health effects due to indoor environmental exposure

Hirvonan (2000) confirms that it has not been determined why low concentrations of microbes seem to cause adverse health problems in mouldy buildings, whereas much higher concentrations of the same microbes in outdoor air do not cause the described symptoms. However, the concentrations in indoor environments are only a fraction of those observed in industrial or agricultural environments (outdoors), where similar occupational diseases i.e., allergies or alveolitis have been reported (Toivola *et al.*, 2000).

Several epidemiological cross sectional studies and case-control studies based on questionnaire data have demonstrated an association between mould growth in structures of buildings and increased frequency of respiratory symptoms among the inhabitants or occupants (Huttunen *et al.*, 2000). Not only does mould or mildew have the potential to cause sickness, but it also damages buildings and their contents. Moulds thrive on paper, leather, and glues used to hang wallpaper and vinyl and they can invade plasterboard and other construction materials. The white, green and grey growth that appears on these surfaces is very damaging and costly to correct (Grounds, 2000).

Another factor that influences health is air pollution. Urban air pollution is known to influence the lives in urban ambient and urban rural indoor environments. Health effects are observed in the populations, which are caused by exposure to increased ambient and indoor air pollutant concentrations in, in particular, developing countries (Schwela, 1996). A recent study by the World Health Organization reveals that about 1.5 billion people are exposed to increased ambient air pollution concentrations of suspended particulate matter, sulphur dioxide and ozone gases (Schwela, 1996). Observations during the study revealed human activities associated with indoor environmental exposures in hostels. These are:

2.5.1 Smoking habits and their health impact on smokers and non-smokers

Numerous studies have suggested that exposure to tobacco smoke can increase the risk of developing asthma (Azizi & Hendry 1991; Azizi *et al.*, 1995; Flodin *et al.*, 1995; Martinez *et al.*, 1992; Stracham & Cook 1998; Thorn *et al.*, 2001). Cigarette smoke is probably the most addictive and dependence producing form of objective-specific self-gratification known to man (Russel, 1974). For example, London drug users rated tobacco as their most needed drug, more than heroin, methadone, amphetamine, cannabis, LSD, or alcohol (Blumberg *et al.*, 1974).

The excess mortality in cigarette smokers dying of lung cancer, cancer of other respiratory sites, chronic bronchitis and emphysema and cancer of the oesophagus can be directly attribute to smoking. It is also evident that cigarettes smoking causes lung cancer, chronic bronchitis, emphysema and heart disease in woman (Doll *et al.*, 1980).

Increasingly, states are passing regulations requiring smoke-free publicly owned buildings and separate space for smokers and non-smokers in restaurants. However, the reduction of exposure to environmental tobacco smoke in the home is entirely voluntary. The physical separation of smokers and non-smokers in a home reduces but does not eliminate the non-smoker's risk. The same is true for ventilation. The only effective way to eliminate the risk of exposure to environmental tobacco smoke in the home is to eliminate smoking in the home.

2.5.2 General housing conditions and related diseases

According to Connelly (1999) there is evidence that certain specific and general housing factors (such as dampness and overcrowding) cause disease, or more generally ill health. Unlike other diseases, these ill health infections are defined by the self–reported symptoms of the people themselves. There has been increased concern over health effects related to potential exposure of occupants of buildings to bio-aerosols. Building-related illnesses include a variety of recognized disease entities that are characterized by objective clinical findings related to specific indoor environments. These illnesses are preventable if greater efforts at improving building design, construction, indoor environmental controls, and maintenance to reduce exposure to potential etiological agents are implemented (Trout *et al.*, 2001).

2.5.3 Crowding, housing and health

The most widely used indicator of spatial crowding is the number of square meters per person in a housing unit. However, it is useful to use a definition of crowding that includes not only the concentration of people in residential space but also their concentration with respect to the use of limited environmental resources and services. Studies show that crowding facilitates the spread of respiratory infection. This is because the risk of transmission of infectious agents causing secondary diseases spreads via air (e.g. tuberculosis) or via the faecal–oral route (e.g. dysentery). Such infection is partly dependent upon the number of people sharing living space (Kellet, 1989). Additionally, exposure to cooking smoke can increase susceptibility to infections and is likely to compound the effects of crowding (Connelly, 1999).

However, Mauderly (2002), Weschler (2002), Thomas *et al.* (1999) argue that environmental conditions in the indoor environment may be affected by outdoor environmental factors. This argument therefore necessitates the review of health effects due to simultaneous outdoor and indoor environmental exposure, as will be discussed in the next paragraph.

2.6 Health effects in the indoor environment due to outdoor environmental exposure

Exposure to outdoor ambient environment is mainly caused by air pollution problems. The main sources of ambient air pollution in South Africa are burning of coal, oil and natural gas in industrial processes, power generation and exhaust fumes of vehicles (Diab, 1999; Oliver, 2001; Terblanche *et al.*, 1992). Air pollution and health impacts studies in South Africa reflect that the people exposed to air pollution experience health problems including respiratory conditions such as wheeze, shortness of breath, blocked and runny nose, sinusitis, rhinitis, hay fever, productive cough, bronchitis, bronchiolitis and pneumonia (Ehrlich *et al.*, 1995; Nriagu *et al.*, 1999; Robins *et al.*, 2002; Terblanche *et al.*, 1992; Von Schirnding *et al.*, 1991).

Many epidemiological studies associate air pollution with *respiratory diseases* such as asthma, bronchitis, chronic pulmonary disease, and pneumonia (Keiding, Rindel & Krongborg, 1995; Schwartz *et al.,* 1994). These diseases are also related to other factors such as viruses and bacteria, moulds, pets and genetic predisposition (Rios *et al.*, 1993). People suffering from these conditions have increased susceptibility to air pollution effects (Levy *et al.,* 2002; Rios *et al.* 1993). Respiratory diseases, particularly those that are chronic in nature, are reported to be high among people of low socio-economic status (Rios *et al.,* 1993). However, the biggest challenge facing this country is that health professionals have traditionally viewed the influence of weather and climate change on health as part of the natural backdrop to life, and that it has no effect to health and well-being (Kovats & Bouna, 2002). A brief discussion of the influence of weather and climate change on health and well-being in the next paragraph may help to shed light with regard to this challenge.

2.7 Health effects in the indoor environment due to outdoor climate change

High temperature (37°C and above) and humidity (60% and higher) encourage the growth of surface and airborne moulds in the indoor environments of residential buildings (Storey *et al,* 2004). This is because of the heat transfer from the outdoor environment causing dampness in the indoor environments due to condensation (Tyson & Preston-Whyte, 2004). Therefore climate change in the outdoor environment will always have an impact on indoor micro-climate. The growth of surface and airborne moulds in the indoor environments is known to cause respiratory health problems to the exposed (Huttunen *et al,* 2000). Our survival in the indoor environment is based on the fact that there should be adequate ventilation to dilute contaminated indoor air with fresh (presumably) outdoor air. This argument therefore necessitate the review of ventilation systems in residential buildings such as the study area (block hostels) as will be discussed in the next paragraph.

2.8 Ventilation standards and efficiency

Ventilation is the process of exchanging indoor (polluted) air with outdoor (presumably fresh and clean) air. Its main purpose is to create optimal conditions for humans in indoor environments, taking into account their health, comfort, and productivity by providing air for breathing, for removing and diluting indoor pollutants, for adding or removing moisture, and for heating and cooling (Wargocki *et al.,* 2002).

When moisture sources in the homes are small, increased ventilation may reduce indoor humidity and thereby eliminate fungi and mites. However, the strength of the moisture sources is crucial for the ability of ventilation to control the moisture content of the indoor air. Problems caused by high relative humidity at cold surfaces are only in some cases controllable by ventilation. Ventilation is therefore an essential element in the control of any indoor environment, to provide a healthy living environment. However, this could only be achieved if residential buildings comply with the ventilation requirements in terms of the legislation. The requirements are discussed in the next few paragraphs.

The National Building Regulation number 9613 Schedule 1 state: " Where for the purposes of natural ventilation a room is provided with an opening or openings, the position of such opening or openings in relation to each other and to any internal doors to such room shall be such as to ensure that such room will be ventilated. Every such opening shall be either: (i) an open able glazed window in an external wall or in a suitable position in the roof; or (ii) an opening in the external wall so designed as to exclude ingress of rain.

The opening or operable area of any openings referred to in (i) and (ii) shall not be less than 5% of the floor area of the room or 0.2 m^2, which ever is greater" (National Building Regulations and Building Standards Act, 103 of 1977). The only means of natural ventilation usually found in communal facilities such as the three hostels are airbricks. The lack of knowledge about the importance of the airbricks resulted in residents blocking them during cold winter months in order to maintain warm indoor temperatures. This rendered the system inadequate and for ventilation the required standards were not met.

These requirements could only be achieved if residential buildings complied with the ventilation requirements as promulgated in the National Building Regulations and Building Standards Act, 103 of 1977. Even though ventilation could be effective, it is important to control indoor environmental factors encouraging dampness and the development of moulds in the indoor environments. These factors are leaking or blocked waste and water pipes. A review of sanitation requirements, availability and utilization as discussed in the next paragraph was therefore essential to shed some light with regard to this challenge.

2.9 Sanitation availability and utilization

In much of South Africa, in both urban and rural areas, significant proportions of the population do not have access to adequate sanitation facilities. This inadequacy impacts negatively on the quality of life, health and productivity of people, as well as on the local environment (Scott, 1998). Sanitation can be defined in different ways depending on the circumstances. However, it is generally acknowledged that it includes a range of elements such as:

- Physical infrastructure
- Hygiene-related behaviour
- Disposal of wastewater, excreta and other solid wastes, in the context of household and institutional activities

Because these aspects are inter-related and of equal importance, the following broad definition has been adopted for the purpose of this study; "The term sanitation refers to the principles and practices relating to the collection, removal or disposal of human excreta, refuse and wastewater, as they impact upon users, operators and the environment (Draft White Paper on Sanitation Policy, 1996).

In addition to that, wherever sanitation is provided it must be adequate to conquer the consequences that could result in the destruction of the human element. However, the question that is always raised is "What is adequate sanitation?" Opinions vary widely on this. In this study the term adequate sanitation means the provision and ongoing operation and maintenance of a system of disposing of human excreta, wastewater and household refuse, which is acceptable and affordable to the users (Draft White Paper on Sanitation Policy, 1996). The system must be structurally safe, hygienic and easily accessible to all residents. Occupants of the buildings should have access to their own facilities. Furthermore the provision of sanitation should be accompanied by correct hygienic practices and must have an acceptable impact on the environment.

To ensure adequate sanitation the National Building Regulations Standards Act set the minimum number of sanitary fixtures to be provided in any building. Such sanitary fixtures are to be:

- fixed in approved positions convenient of access and where necessary facilities shall be designed for the use of males and females or both.

- based on the population for which a building is designed, as calculated in terms of regulation T20: Provided that where fixtures are situated in separate groups the number of fixtures in any group shall be based on the calculation of that portion for which the group is intended.

It was noted that even though residents of the three selected hostels had access to all the basic services, they were exposed to mass ablution facilities which were unacceptable to the users. These facilities were vandalized, water was wasted and they were not maintained or cleaned. Experience has shown that mass utilization of facilities does not guarantee accountability. It appeared that the drainpipes outside the ablution facilities were leaking as there were plants growing from the external walls adjacent to them. This situation was contradictory with the concept "adequate sanitation" and was viewed as a serious concern with regard to the health and well-being of hostel dwellers and the neighbouring community. However, one of the objectives of this study was to review the role of legislation in accordance to minimum requirements pertaining to public buildings used for residential purposes in order to maintain a healthy living environment as discussed in the next paragraph.

2.10 Legal requirements pertaining to public buildings used for residential purposes

The constitution of a country guarantees basic human rights and provides guiding principles for society. The rights and obligations in the Constitution belong to each person and community in South Africa. We are fortunate in South Africa, because unlike many other countries, our Constitution recognises that a healthy environment is a basic right.

In terms of section 27(2) of the Constitution of the Republic of South Africa (Act 108 of 1996) the State must take reasonable legislative and other measures within its available resources to achieve the progressive realization of the right of the people of South Africa to have access to health care services. In terms section 24(c) everyone has the right to an environment that is not harmful to their health or well-being. Everyone has this basic right, and everyone can take action to protect this right. In addition to that, the objectives of the National Health Act are to regulate national health and to provide uniformity in respect of health services across the nation by protecting, respecting, promoting and fulfilling the rights of the people of South Africa to an environment that is not harmful to their health and well-being. Based on this constitutional right the following acts were promulgated to extend objectives of the constitution to protect the exposed from the environment. These are:

The Tobacco Products Control Act (Act 83 of 1993), whose main aim is to prohibit or restrict smoking in public places; to regulate the sale and advertising of tobacco products in certain respects and to prescribe what, is to be reflected on packages. Suppliers must acknowledge that tobacco use is extremely injurious to the health of both smokers and non-smokers and warrants, in the public interest, a restrictive legislation. The Act stipulates that smoking of tobacco products in any public place is prohibited. The Act defines a public place as any indoor or enclosed area which is open to the public or any part of the public and includes a work place and a public conveyance. In terms of this Act a hostel is a public place. It is therefore the responsibility of this act to protect individuals from the effects of tobacco smoke.

The Housing Act (Act 107 of 1997) schedule repeal of laws by section 20 defines housing development as means the establishment and maintenance of habitable space, stable and sustainable public and private residential environments to ensure viable households and communities in areas allowing convenient access to economic opportunities and to health, education and social amenities in which all citizens and permanent residents of the Republic will, on a progressive basis, have access to permanent residential structures with secure tenure, ensuring internal and external privacy and providing adequate protection against the elements. However these regulations do not address important concerns about the minimum habitable space to be provided in a public building.

The National Building Regulation defines the requirement that a building must protect humans against the elements as stipulated in the Housing Act. The aim of the National Building Regulation is to provide for the promotion of uniformity in the law relating to the erection of buildings in the areas of jurisdiction of local authorities; for the prescribing of standards; and for matters connected therewith, e.g. the number and size of sanitary facilities to be provided in a public building to maintain a healthy living environment.

The Atmospheric Pollution Prevention (Act 45 of 1965) now been repealed by section 60 of the National Environmental Management: Air Quality Act (Act 39 of 2004), to reform the law regulating air quality in order to protect the environment by providing reasonable measures for the prevention of pollution and ecologically sustainable development while promoting justifiable economic and social development. In addition, this Act provides for national norms and standards regulating air quality monitoring, management and control by all spheres of government, and for specific air quality measures. However it does not provide maximum exposure levels to airborne moulds in the indoor environment of residential or public buildings such as hostels.

In addition to that, these regulations must be strictly adhered to in order to protect exposed residents to either indoor or outdoor environments. Therefore the study was initiated on the premise that poor living conditions, inadequate ventilation, dampness and mouldiness are associated with negative respiratory and other health effects. Based on the objectives of the study, methods were designed to evaluate the environmental health concerns affecting hostel dwellers as outlined in the next chapter.

CHAPTER 3

Methods

3.1 Study Area

Three dormitory type hostels (referred to as block hostels) in the Durban Metropolitan area, namely Dalton hostel, Jacobs hostel, and SJ Smith hostel, were selected for this study (Figure1). The study was conducted during the period January 2003 to December 2005. Dalton hostel is approximately 5 km south of the Durban central business district (CBD), with a population of 1500 at the time of the study. Jacobs hostel approximately 10 km south of the CBD had a population of 1800. The SJ Smith hostel, which is located approximately 15 km south of the CBD, within the industrial area of Mobeni West, had a population of 4408.

Table 1: Hostel Profiles

Name of hostel	SJ Smith hostel	Dalton hostel	Jacobs hostel	Total
Estimated number of occupants	4408	1500	1800	7708
Actual number of occupants	5500	2200	2800	11200
Number of 5-Bed type dormitories	72	14	40	128
Number of 10-Bed type dormitories	48	17	30	95
Number of 15-Bed type dormitories	0	18	24	42
Number of single bedrooms	72	0	0	72
Number of family units	0	0	0	0
Total number of blocks per hostel	18	4	4	26

Initially a preliminary study was conducted to evaluate the environmental health conditions in the hostels during 1999 to 2000. Hostels were categorized according to their structure based on previous surveys conducted in hostels, namely; the Dalton Hostel Redevelopment Programme (Mompie, 1999), and the Final Redevelopment Business Plan for SJ Smith Hostel (DPA, 2003). These were 4-roomed type, block hostels which were either dormitories or apartments. The dormitories are shared compartments made of 5/10/15 beds per dormitory. In this study only block hostels (dormitories) were selected. They were chosen on the basis that they could aid in the housing shortage crisis facing this country, if they were properly maintained.

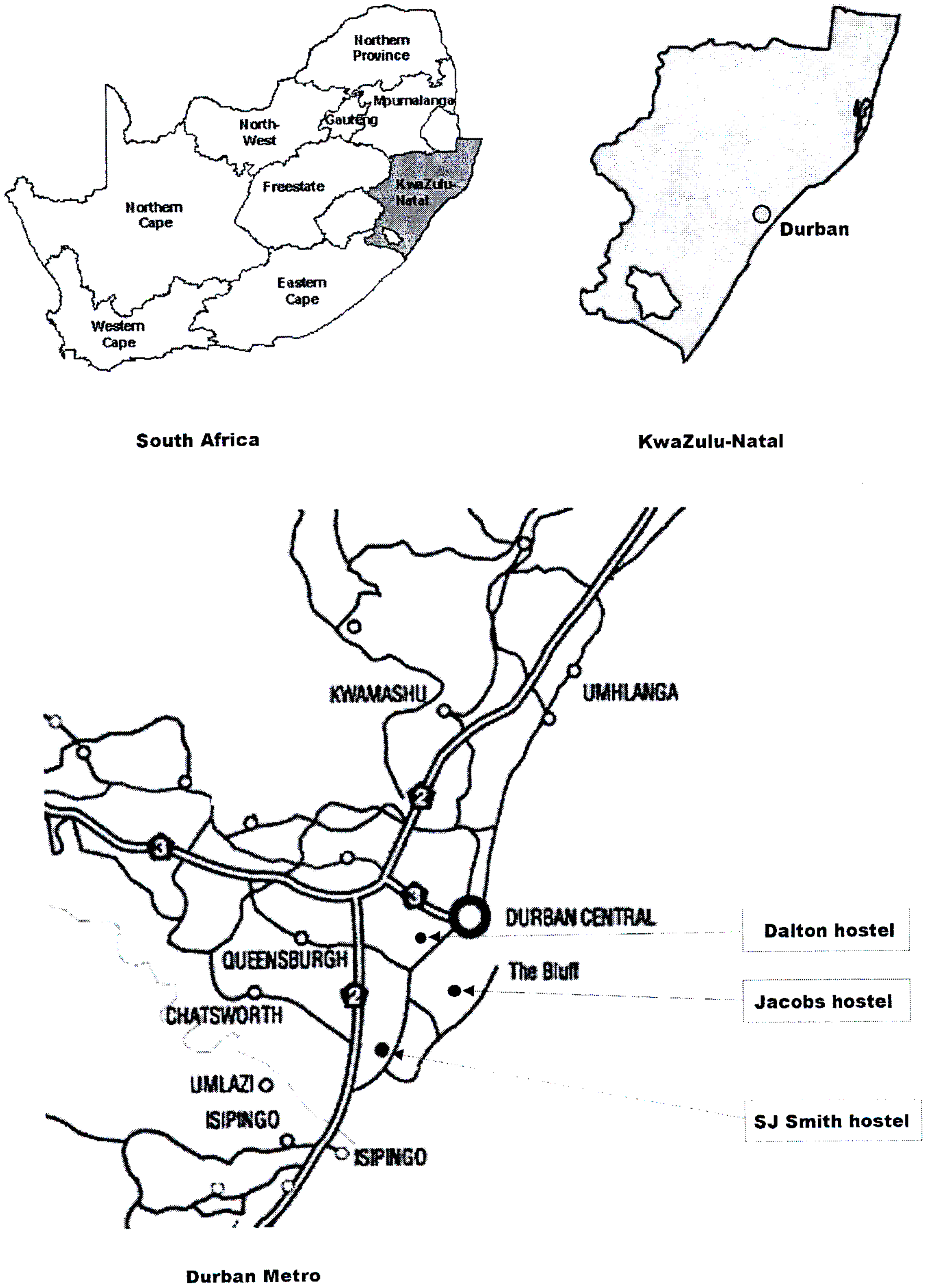

Figure 1 **The location of the three block hostels of the Durban Metropolitan area, KwaZulu-Natal, South Africa. (SA-GIS)**

The study was approved by the Ethics Committee of the Nelson R. Mandela School of Medicine (H 149/03). After their approval a permission to conduct the study was also requested from the Local Negotiation Group (Residence Committees), (Appendix A) the Hostel Administrators, and the Durban Metropolitan housing department, who all supported the study. As the study was underway, other role-players, namely the ward councillors, political structures (Youth organizations, Women's organizations, & labour organizations), were consulted, thereby increasing intersectoral collaboration.

3.4 Study Design

The study was a cross sectional descriptive study involving all three Durban Metropolitan blocks hostels. An investigating into the quality of the block hostel environment (indoor and outdoor) through visual inspection was done (Appendix E). This was followed by structured Interviews using a questionnaire (Appendix D) to determine the extent of the exposure of individuals to the environment, and the biophysical environment was the assessed by means of air testing and microbial identification. In addition to that, there was a review of the legislative requirements pertaining to the minimum standards that public residential buildings must satisfy was conducted. All participants were informed about the objectives of the study (Appendix C), and were invited to participate voluntarily. Prior to the commencement of the study, participants were asked to sign a written consent form. (Appendix B). In addition to the formal investigations, numerous other consultations were conducted during the study with relevant role players in an attempt to make provision for the on-going development process of the hostels.

3.5 Sample Selection

Hostel blocks and participants were selected using clusters. Sampling was multistage (Dooley, 2001). First hostel blocks were divided into clusters/bunches using site plans. Three blocks were selected in each hostel. Two dormitories per level were selected (six per block). Individuals to be interviewed were randomly selected from the selected dormitories in a block. Fifty (50) individuals were selected in each block. The sample size (with a power of 80% and 95% confidence interval) was thirty percent (30%) of the entire population on average (i.e. 30% of 1500 which is 450), making it 150 participants per hostel.

The sample size was selected on the basis of previous studies (Sekhotha *et al.*, 2000, Gqaleni *et al.*, 1999), thus the sample size was 30% of the average population in hostels.

Financial viability was also an influential factor in the selection of the sample size. The participants included employed and unemployed hostel dwellers aged 21 to 65 years. Participants must have been permanent residents for a period of six months or more in the same block of hostel. Participation was voluntarily.

3.6 Sampling Methods

A number of techniques are used for quantitative and qualitative enumeration of the different environmental factors in any built environment. These methods range from simple visual investigations and source sampling to complicated analytical methods of sampling. In this study the following methods were employed :

3.6.1 The Hostel Environment Inventory

A walkthrough visual inspection was conducted in and around the selected hostel blocks and the following environmental factors were observed.

<u>Pollutant sources</u>

- This included sources observed outside the buildings.

<u>Human activities</u>

- This included cooking and cleaning facilities.
- The smoking habits and personal hygiene of residents were noted.

<u>Maintenance activities</u>

- The general repairs and routine household maintenance procedures were noted

<u>Ventilation systems</u>

- The number of airbricks and open able windows in a given area per square metre was determined. The size of airbricks is standardised (National Building Regulations and Building Standards Act, Act no. 103 of 1977). The size and type of open able windows are standardised in terms of the building requirements (National Building Regulations and Building Standards Act, Act no. 103 of 1977). These types of windows were found in all three hostel blocks selected for the study.

<u>Waste management systems</u>

- The frequency of refuse removal including the number of facilities available for refuse removal was determined.

The general appearance of the buildings

- Structural defects and external wall surfaces

A total of 56 dormitories were inspected, resulting in the completion of 56 hostel environmental inventories. In addition to the indoor inspection an outdoor inspection around the selected hostel blocks was conducted which increased the total to 63 hostel environmental inventories. These were distributed as follows: 2 dormitories per level per block (3 levels), 3 blocks per hostel for three hostels, i.e. 2(3) x3x3 = 54 for indoor environment, 1 per block (3 blocks), for 3 hostels which was 1(3) x 3 = 9.

This hostel inventory (Appendix E) was adapted from the New York State Energy Research and Development Authority (Department Of Health Report, 1995), which was redeveloped at the Centre for Occupational and Environmental Health- Nelson R Mandela School of Medicine- University of KwaZulu-Natal. In addition to the hostel inventory, indoor and outdoor photos were taken (Figures 3, 4 & 5) in and around the selected hostel blocks.

3.6.2 The Questionnaire

Structured interviews by either the researcher or research assistants (trained B Tech students registered for Epidemiology IV /Research Methodology IV at the Durban University of Technology) were conducted, using questionnaires. Interviews were conducted in a language acceptable to the interviewee. Each interviewer was assisted by a member of the hostel community who was fluent in or familiar with different languages spoken in the hostel. The interviewers were chosen on the basis that they were competent enough to administer the questionnaires and had a good understanding of the subject content. The quantification of data was not based on individual responses but was based on dormitories per level, due to the nature of the study, i.e. descriptive. There were 434 respondents from the 450 questionnaires that were distributed. The questionnaires were administered to reveal the following information about the study population: -

3.6.2.1 The Socio-Demographic Profile

Socio-demographic data collected included the type of job, income, gender, age distribution (21 to 65), and the period of stay in the hostel in order to establish the health and social status of the study population. Data on the type of job were gathered based on the Standard Occupational Classification System (SA Explorer, 2002). While age categories were classified according to Statistics South Africa data system in order to allow for data comparisons.

3.6.2.2 Self Reported Symptoms

Data were gathered to reveal information about the occurrence and natural progression of reported health symptoms, viz. respiratory symptoms, non-respiratory symptoms, and pulmonary tuberculosis symptoms. Self-reported symptoms were recorded only if they had occurred within the six months prior the date of the investigation. This was because participants data were based on the fact that they must had to be residents of same block for at least six months prior to the initial date of investigation, as documented under sample selection.

3.6.2.3 Occupational History

Data on the occupational history of residents were collected to establish any pre-existing medical conditions, based on previous exposure, and the period of exposure in the working environment as possible confounding factors to existing self-reported symptoms or infections.

3.6.2.4 The Environment

Respondents were required to report on the state of the environment with regard to cleanliness, cooking times and facilities, air and noise pollution complaints, and complaints related to structural defects such as leaking water and waste water pipes as observed by the occupants of the buildings.

The questionnaire was an extract of the National Institute for Occupational Safety and Health - Indoor Environmental Quality Survey Questionnaire (NIOSH, 2000). It was adapted from that of the Centre for Occupational and Environmental Health: Nelson R Mandela School of Medicine- UKZN. The latter had been used in earlier studies (Sekhotha *et al.*, 2000, Gqaleni *et al.*, 1999).

3.6.3 Mould Bio-aerosols and Surface Mould Sampling

Surface samples to determine the extent of surface mould were collected using pre-sterilized cotton buds (Lasec, Durban, and SA) to quantify the indoor surface mould growth, by swabbing the surface of the walls and ceilings, where there was evidence of microbial growth. The cap was replaced, sealed and marked with identification information. At the end of the sampling each day, samples were taken to the laboratory.

Air samples were collected using an Anderson (single stage) viable (microbial) particle sizing sampler (Labotec: USA) to investigate the presence of airborne spores (bio – aerosols) in the indoor environment. These samples were collected in duplicate (one using Malt Extract Agar (MEA) and the other using Dichloran 18%-Glycerol (DG-18) as the suitable media) from the breathing zone (approximately 1.5m off from the ground) when air particles were aerosolized, for example, during the cleaning of floors. Eight control outdoor samples were collected from each block in duplicate from each side of the block, i.e. North, East, South and West sides. All outdoor air samples were collected 1.5m of the ground floor level. Each sample took a maximum period of 5 minutes, except where there was evidence of heavy contamination, when a shorter time was needed (at a flow rate of 28.3l per minute of air).

All microbial culture procedures were carried out in the laminar flow (Labotec: USA) containing a UV light. Prior to work, the cabinet was swabbed/sterilized with a mixture of ethanol and methanol (70:30 v/v) solution. The cabinet hood was continuously on during the procedures to ensure the area was kept sterile. Malt Extract Agar (MEA) Oxoid (Lasec, Durban, SA) and Dichloran –18% glycerol (DG-18), Lasec, Durban, SA) were prepared according to methods of Samson *et al,* (1995) and as described in Appendix G, and autoclaved at 120^0 C and 121 kpa for 15 minutes. Chloramphenicol was added as an antibiotic. Cotton buds were sterilized at 120^0 C, 121 Kpa for 15 minutes in an autoclave.

Before each run, the sampler stage was washed thoroughly with rubbing alcohol and allowed to dry on a dust free environment. Sampling media was loaded into the sampler after removing the covers. Stringent measures were taken to prevent contamination of medium during loading and unloading by using protective gloves to prevent contact by hand of the agar surface. In addition to that, protective clothing was used, i.e. laboratory coat. After sampling, the plates were removed from the sampler and the cover replaced. Samples were kept cool in a cooler box (4^0 C), and were taken to the laboratory there after.

Each plate was sealed with a tape and marked on the bottom with identification information i.e. the date on which the sample was taken, the name of hostel e.g. Dalton Hostel/SJ Smith Hostel/Jacobs Hostel, the name of block e.g. Block A and the Room/Dormitory no: e.g. A (3), type of media e.g. MEA, GD-18. At the end of the sampling each day, samples were taken to the laboratory and placed in an incubator (25^0 C) with the cover facing down (for 5 to 7days).

In the laboratory each swab was plated on the surface of the culture (MEA, DG-18). Samples were finally placed into an incubator at 25^0 C for 5 to 7 days. After seven days fungal colonies were enumerated and identified. Colonies were identified based on their morphology, using a dissecting microscope (Zeiss Opton, Germany).

During the sampling period, humidity and temperature were measured over a period of 5 hours. Measurements were taken indoor and outdoor respectively. Weather reports using the weather focus from the website of the National Weather Bureau (http//www.saweather.com, February 2004) were obtained in addition to the on site measurements.

3.7 Temperatures and Humidity

A continuous indoor and outdoor monitoring of temperature and humidity (every five hours) during the study was conducted in the selected hostels using a Thermohygrometer (Labotec: USA). This was done over and above daily readings obtained from the National Weather Reports. Temperature and humidity are known environmental factors that play a role in the development of surface and airborne moulds in the in- and outdoor environments of residential buildings (Storey, 2004). It was therefore essential to monitor temperature and humidity as to make an informed decision during the study.

3.8 Legislation

The following legislation was studied with respect to indoor and outdoor environments in hostels

3.8.1 The Constitution of the Republic of South Africa Act (Act 108 of 1993)

To determine individuals' basic human rights with regard to availability of resources. i.e. rights to adequate ventilation and sanitation

3.8.2 The Tobacco Products Control Act (Act 83 of 1993)

To define the role of the act in controlling the use of tobacco products (public smoking) in public places.

3.8.3 The Housing Act (Act 107 of 1997)

To define housing needs for a habitable environment in a residential building.

3.8.4 The National Building Regulations Standards Act (Act 103 of 1977)

To define the standard building requirements pertaining to residential buildings.

3.8.5 National Environmental Management Air Quality Act (Act 39 of 2004)

To define activities contravening the act in the hostel environment.

3.8.6 National Environmental Management Act (Act 107 of 1998)

To identify environmental factors affecting the indoor environment in the selected hostel blocks.

3.9 Limitations of the study

- Time and space to conduct the physical inspections were very limited. In some instances it was very hard to obtain records of information due to the following reasons:
- -the management duties of the hostels rested upon too many authorities
- -the managers were changed every now and then.
- Some questions were not answered, as certain respondents were not comfortable with the questions. However all attempts were made not to introduce bias.
- Due to time and financial constraints a limited number of samples were taken within a short space of time, and this was done from May to November 2004. As a result data were aggregated at dormitory levels and not at individual levels, and this is not a true

reflection of a direct influence of the environmental factors (independent variables) on the health outcomes (dependant variables) in the selected hostel blocks.

3.10 Data Management and Statistical Analysis

Data was captured using Microsoft Excel 2000 analysed using SPSS for Windows (version 11.5). Data were aggregated at dormitory level (n=23), not on the individual person level, as measurements were done at the dormitory level. This did not permit direct comparisons to be made between air/surface mould measurements and health status variables. Thus descriptive statistics were mainly used. Parson's correlation analysis was used to examine the relationship between quantities of each type of mould in the surface and air. Statistical tests were carried out at 5% significance level. Appropriate p-values ($p < 0.05$) were used for decision-making purposes. These p-values have been quoted where applicable. The Incidence Risk Rate (IRR) was used to determine the relationship between exposure factors and outcomes in the indoor environment of the selected hostel blocks.

CHAPTER 4

Results

4.1 Visual Inspection

A walkthrough visual inspection was conducted in and around the selected hostel blocks of the three hostels and resulted in the completion of 63-hostel environmental inventories (Appendix E). It revealed the following environmental concerns, which are quantified in Tables 2,3, 4,5 and 6 as follows:

4.1.1 General observations during a walk- through inspection

1 Pollutant sources

Contaminated ambient air: There was evidence of dust, smoke, fumes and industrial contaminants from different locations in each hostel. In almost all hostels smoke and fumes from burning flames were observed. Occasionally, air pollutants from construction sites were observed, e.g. blackening of walls. Since Jacobs hostel is closer to industries, possible industrial contaminants were prevalent, e.g. offensive smell, possibly from Mondi Papers or the Engen Oil Refinery station could be perceived.

Emissions from nearby sources: Vehicle exhaust fumes from either parking areas or loading zones were not common due to spacing of blocks which were a considerable distance from the parking bays or roads.

Soil Gas: No signs of radon were observed at any of the three hostels. However sewage odour was very common in the majority of the six blocks, which came as a result of blocked sewer lines, blocked ablution facilities and possibly overcrowding.

2 Human Activities

Personal Activities: Cigarette smoke was observed from all blocks in all three hostels, due to indoor smoking by a majority of the residents. An informal interview with a few residents in each block indicated a lack of awareness about the danger of smoking in public places.

Housekeeping Activities: No formal cleaning procedure was evident in any of the three hostels. There was no evidence of cleaning materials available. However, Dalton hostel had some blocks that were cleaned twice or more times a week by residents.

3 Maintenance activities

Moisture or stagnant water: Blocked storm water drains and blocked roof gutters were very common in most blocks and as a result there was evidence of stagnant water near the drains and in gutters.

Structural defects such as broken windows were evident in many parts of the hostels. Certain areas of the building were defective but some renovations were observed in all three hostels as an ongoing process of refurbishing the hostel.

Unsatisfactory Conditions/Water damage: There was evidence of microbial growth in toilets, laundries, bathrooms, sleeping areas as well as in kitchens also referred to as common rooms. Microbial growths were also found in or on soiled or water-damaged furnishings e.g. wash-hand basins and cisterns.

4 Ventilation systems

HVAC System equipment: There was evidence of dust, dirt and microbial growth in ducts in all selected blocks. This was more evident in ablution facilities, dining halls and kitchens.

5 Waste management systems

Refuse was dumped everywhere although there were bulk containers for each block. This was more evident at SJ Smith and Jacobs hostels. The predominant type of refuse found was domestic refuse, as well as scrap metals, motor tyres, oil and grease. Industrial refuse was not in evidence.

6. The general appearance of the building

Hostels complexes were isolated from other residential areas, and were located within industrial areas, which included a number of "noxious" industry operations. On the one hand this precluded the natural integration of hostel residents into greater community, while on the other it might actually prejudiced the health of such residents. Each hostel complex consisted of a number of free standing, mostly 3 storey, residential units.

Figure 2: - The external walls of an ablution block with leaking wastewater pipes and overgrown vegetation.

These buildings were dilapidated and showed little signs of ongoing maintenance or even necessary repair work (Figure 5). Externally, spilling of reinforced concrete elements and damaged plumbing pipes was immediately noticeable. The leaking pipes were of such a long-term nature that shrubs and even small trees had taken root, sometimes high above ground level. With regard to the spilling, this was widespread, despite some areas having been repaired in the past. The undeveloped areas between the blocks, whether grassed or asphalted, were unkempt and dirty, with the roads in need of repair. Old vehicle wrecks were bounded together as general garbage. Grass was uncut and weeds sprouted ubiquitously.

4.2 Legal requirements

1. Spatial Distribution

Table 2 and Figure 3 indicate that in the 5-bed type dormitories the habitable space per individual was 3 m^2 to 3.8 m^2, whereas in the 10-bed type dormitories the habitable space per individual was 3.3 m^2 to 3.6 m^2. This was far less than the recommended 12 m^2 (WHO, 1997). Based on these observations, conclusions were drawn to suggest gross overcrowding of space. 10-dormitories, which were never designed to afford the slightest privacy, were even more crowded.

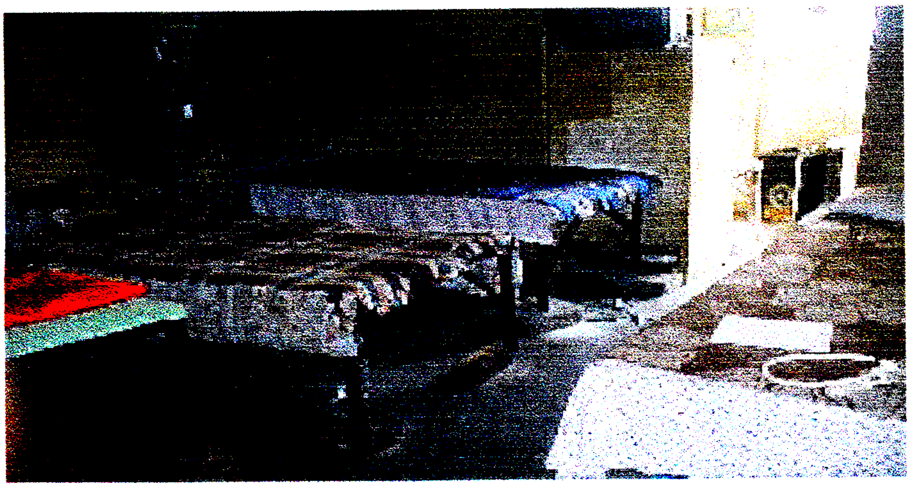

Figure 3: - Internal arrangement of a dormitory in a block hostel.

Table 2: Number of occupants and habitable space

Name of Hostel	SJ Smith Hostel		Jacobs Hostel		Dalton Hostel	
Dormitory type	5	10	5	10	5	10
Number of occupants/dormitory	4	18	5	20	5	18
Habitable space/dormitory	15m^2	65 m^2	15m^2	65 m^2	15m^2	65 m^2
Habitable space per individual in a dormitory	3.8 m^2	3.6 m^2	3 m^2	3.25 m^2	3 m^2	3.6 m^2

2. Ventilation

Table 3 suggests that the amount of ventilation from airbricks in the 5-bed dormitories covered 2.9% of the surface area per square meter, whereas in the 10-bed type dormitories it only covered 2%. The amount of ventilation from openable windows covered 6 % in the 5-bed type dormitories and 3% in the ten –bed type dormitories.

Table 3: Type and the number of ventilation systems

Name of Hostel	SJ Smith Hostel, Jacobs Hostel & Dalton Hostel (5-bed type)				SJ Smith Hostel, Jacobs Hostel & Dalton Hostel (10-bed type)			
Description	/Dorm	/Level	/Block	% Area in m^2 /level	/Dorm	/Level	/Block	% Area in m^2 /level
Air Bricks	1	35	105	2.9%	3	51	153	2%
Openable windows	2	70	210	6%	4	68	204	3%

3. Pollutant sources

Observations as indicated in Table 4 and Figure 4 revealed that there were visible signs of mould on the indoor and outdoor walls and ceilings of the 5- and 10-bed dormitories as well as on the internal and external walls of the ablution blocks. Walls were covered by visible mould extending to 30-40% of the wall space. This high percentage of wall coverage by mould was an indicative of a health hazard.

Table 4: Pollutant sources in the indoor and outdoor environment

Name of Hostel	SJ Smith Hostel				Jacobs Hostel				Dalton Hostel			
Dormitory Type	5	10	5	10	5	10	5	10	5	10	5	10
Description	Indoors		Outdoors		Indoors		Outdoors		Indoors		Outdoors	
Signs of visible moulds and dampness >3 m^2	(85) 38%		(20) 40%		(74) 33%		(15) 30%		(65) 29%		(15) 30%	

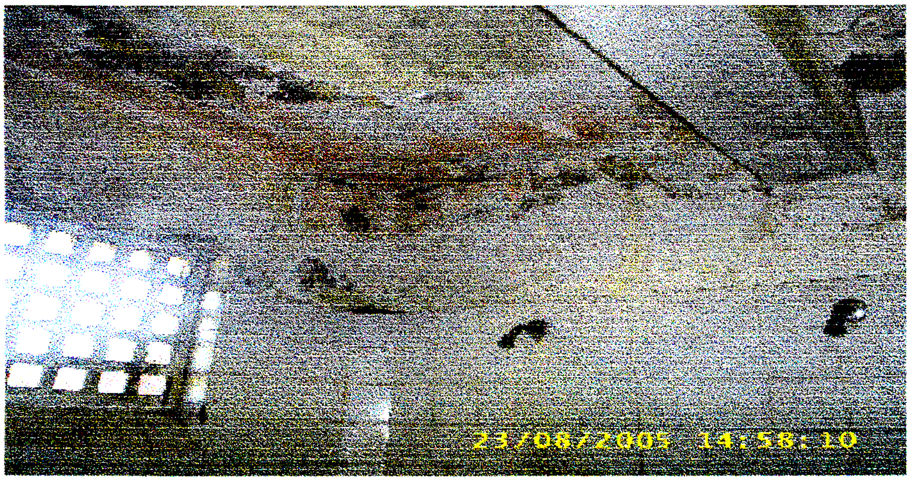

Figure 4 Visible moulds on the internal walls and ceilings of an ablution facility

3. Sanitation

Physically, hostels were run down, dirty and overcrowded (Figure 6). Ablution facilities, which were initially designed to serve 80 occupants, and which were inadequate even then, were serving far more than that number. Communal facilities were dirty and neglected. Internal engineering services, such as sewer reticulation and storm water drains were in an extremely poor state of repair. Garbage collection was obviously inadequate as was evidenced by the overfilled and spilling garbage cans that were available.

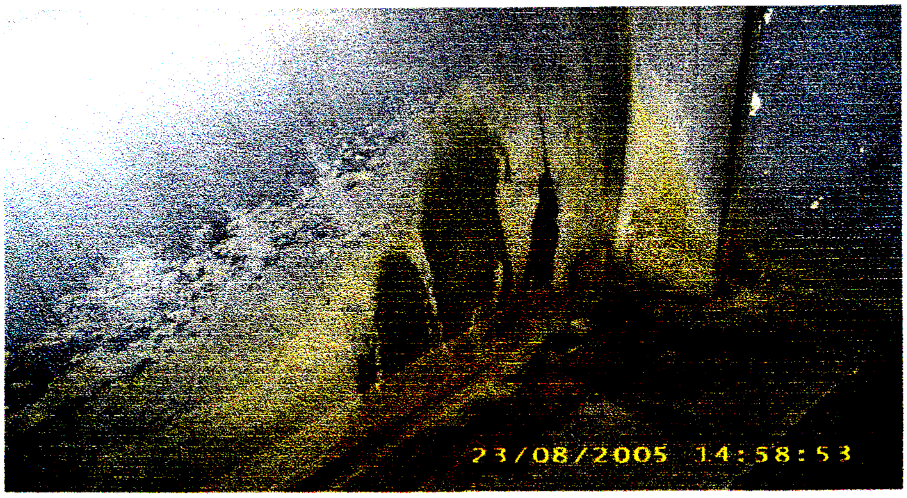

Figure 5: - The condition of a urinal in a male ablution facility.

Internally the buildings were dirty, especially in the overcrowded ablution facilities of the 10-bedroom dormitory blocks, where 80 occupants were supposed to be using single ablution block which provided 8 shower roses, 3 wash hand basins, 4 sinks, 1 urinal and 5 toilets, and with this sort of pressure it was almost impossible to maintain hygiene standards. Communal ablution facilities were extremely unhygienic with most facilities being saturated with water and toilets being blocked. In some cases human excrement was seen on the floors of the toilet areas.

Table 6 suggests that 5 toilets serviced 245 to 260 occupants per level in a block, instead of the expected 80 occupants. This situation was observed from all other hostel blocks. Similar practices were observed in urinals, showers, and wash-hand basins. This overloading of the ablution facilities may have placed the entire system under pressure resulting in blockages, burst pipes and system not functioning properly. In addition, these facilities were initially designed for single male occupants but were then used by number families, i.e. wives and children. These hostel blocks were initially designed to accommodate single male occupants on a temporal basis.

Table 5: Sanitation and ablution facilities

Name of Hostel	SJ Smith, Jacobs & Dalton Hostels		National Building Regulations' Requirements for Sanitary Facilities	Occupants using the facilities	
Dormitory Type	5	10		5	10
Number of Toilets/Level	5	5	80	245	260
Number of Showers/level	8	8	170	245	260
Number of Urinals/Level	1	1	176	245	260
Number of Wash hand basins /level	3	3	36	245	260

Maintenance service such as repairs on damaged pipes or blocked drains was very poor and inadequate. This was supported by observations that 60% to 80% taps were leaking and 60% to 80% drains were blocked. This was most noticed in bathrooms and toilets where more signs of visible moulds were observed (Table 4). Some of the taps/showers were left running which increased drainage problems. Refuse dumped in drains was a major cause of blockage outdoors.

Table 6: Leaking taps and blocked drains

Name of Hostel	SJ Smith Hostel				Jacobs Hostel				Dalton Hostel			
Dormitory Type	5	10	5	10	5	10	5	10	5	10	5	10
Description	Number		Percentage		Number		Percentage		Number		Percentage	
Taps	3/5		60%		4/5		80%		3/5		60%	
Blocked drains.	3/5		60%		4/5		80%		4/5		80%	

4.3 Questionnaire Survey

Since the modification of risks factors associated with human behaviour, rather than with physical structures, require different approaches, they were dealt with separately in this section, which gave greater emphasis to qualitative data relating to people's perceptions of the living environment. Four hundred and fifty questionnaires were administered out of which 434 were completed correctly. Not all questions were answered in some questionnaire. This was because some respondents were reluctant to answer some questions. Therefore, responses vary from one question to another.

4.3.1 Socio-Demographic Profile

Five distinct respondent's profiles were investigated from which data was collated and these were: - gender distribution, monthly individual's income, age distribution, residency and individuals' type of jobs. The results of this survey are shown in Tables 7 to 10: -

1. Gender distribution

Gender distribution was uneven (Table 7); this was because these hostels were designed for African males seeking for employment. But eventually males and females were sharing the hostels at a ratio of 97% male and 3% female. The idea of sharing between males and females was initially not a permanent arrangement.

Table 7: The number of male and female respondents

Gender	SJ Smith Hostel		Jacobs Hostel		Dalton Hostel		Total	
	N	%	N	%	N	%	N	%
Male	154	36%	136	31%	133	31%	423	97%
Female	6	1%	5	1%	0	0%	11	3%
Total	160	37%	141	32%	136	31%	434	100%

Female partners were allowed to visit their male partners for a limited period of fourteen (14) days within a three months cycle. A separate accommodation was provided called visiting wives blocks (two blocks per hostels). However, due to mismanagement of facilities this became a permanent accommodation arrangement for females and sometimes couples.

2. Monthly individual's income

According to the results in Table 8, two hundred and twenty one (221) of the respondents were earning less than R400 per month, and 29 were earning between R1502 & R2500 per month. This number was very high when compared with similar earnings in the Durban Metropolitan area. The study also revealed that the unemployed survived by doing temporary jobs, which were very scarce.

Table 8: Monthly income of individuals

Monthly earnings	SJ Smith Hostel	Jacobs Hostel	Dalton Hostel	Total
	N	N	N	N
<400	85	75	61	221
401-800	24	20	31	75
801-1500	31	41	26	98
1502-2500	7	10	12	29
2501-3500	9	5	0	14
>3500	1	0	0	1

3. Age distribution

Of the 434 respondents who participated in the study, 234 were aged between 21 and 30 years (Table 9). This age group was predominant in Dalton and Jacobs hostels. This suggests that the majority of the male respondents were young and productively and economically acceptable. A review of the population demographics in the Durban Metro area revealed age dominance between 15 and 20 years.

Table 9: Age breakdown of the respondents

Age Categories	SJ Smith Hostel	Jacobs Hostel	Dalton Hostel	TOTAL
	N	N	N	N
15-20	3	27	4	34
21-30	68	85	81	234
31-50	35	65	49	149
51-60	4	6	1	11
61 and over	3	2	1	6

The ages of the eleven (11) female respondents were not considered in the study. This was because there were no female participants in Dalton hostel, and the eleven females were from SJ Smith (6) and Jacobs (5) hostels only. This does not suggest that there were no female occupants in all three hostels, as females occupied this territory illegally and hence were very scared to participate in the study.

4. Residency

Table 10 suggests that a majority of participants (202) had lived in the same hostels for a period of 1 to 5 years. A fraction of that, two (2) had been in the hostel for as long as 30 years. One hundred and eight respondents (108) had been there for 6 to 10 years. Therefore, this data provided sufficient evidence to suggest that a majority of the respondents were permanent residents of the hostels.

Table 10: Residency of the respondents

Response	SJ Smith Hostel	Jacobs Hostel	Dalton Hostel	Total
	N	N	N	N
1-11 months	2	53	1	56
1-5 yrs	73	64	65	202
6-10 yrs	22	32	54	108
11-15 yrs	2	15	10	40
16-20 yrs	2	9	4	15
21-25 yrs	3	3	2	8
26-30yrs	2	0	0	5

5. Individuals' type of jobs

Data were collected to determine each participant's employment status, viz. labour, technical, semiskilled, self-employed, pensioner, schooling, unemployment, and professional. Two hundred and sixty one (261) of the respondents were unemployed, 131 employed as labourers, 25 self -employed, and 4 semiskilled (Table 11).

Table 11: Individuals' type of occupations (respondents)

Response	SJ Smith Hostel	Jacobs Hostel	Dalton Hostel	Total
	N	N	N	N
Labour	17	75	39	131
Technical	6	1	0	7
Semi	0	1	3	4
Self	3	14	8	25
Pen	0	0	2	2
Schooling	5	2	0	7
Unemployed	73	104	84	261
Professional	0	1	0	1
Other	4	0	0	4

4.3.2 Health and Behaviour Survey

The study revealed the following health and behaviour survey; viz. respiratory symptoms, non-respiratory symptoms, smoking habits, social mobility (movements in and out of the hostel), and time spent by individuals' indoors and outdoors, and individuals occupational history.

1. Respiratory symptoms

It was noted that individuals reported more than one poor health symptom. Forty seven percent (47%) reported respiratory symptoms. The most recorded respiratory symptoms were chest tightness (12.2%), sore and dry throat (7%), and sinus congestion (7%). Fourteen and a half percent (14.5%) respondents confirmed taking TB treatment, of which 3.8% were from Jacobs Hostel, 5.2 % from Dalton hostel, and 5.8% from SJ Smith hostel (Table 12). These were self-reported as no medical records were obtained from respondents to confirm their TB status.

Table 12: Reported respiratory symptoms in the six months prior to the study

Response	SJ Smith Hostel		Jacobs Hostel		Dalton Hostel		Total	
	n	%	N	%	N	%	n	%
Reported to have respiratory symptoms	58	13%	75	17%	73	16.5%	206	47%
Sore & dry throat	16	3.6%	5	1.1%	10	2.3%	31	7%
Chest tightness	10	2.3%	22	5%	22	5%	54	12.2%
Stuffy or runny nose	1	0.2%	9	2%	1	0.2%	11	2.5%
Sinus congestion	4	0.9%	7	1.6%	20	4.5%	31	7%
Receiving TB treatment	23	5.2%	17	3.8%	23	5.2%	63	14.3%
Sneezing	8	1.8%	0	0%	2	0.5%	10	2.3%
Shortness of breath	1	0.2%	2	0.5%	3	0.7	6	1.4%

3. Non-respiratory symptoms

The most recorded non-respiratory symptoms were headache, dry or itchy skin and stomach upset (Table 13). These symptoms when put together are classified as "Sick Building Syndrome" or SBS (Godish, 1995). Eleven and a half percent respondents of the (11.5%) reported headache and dry or itchy skin, 6.3% stomach upset, and 16.2% reported other illnesses.

Table 13: Reported non-respiratory symptoms in the six months prior to the study

Response	SJ Smith Hostel		Jacobs Hostel		Dalton Hostel		Total	
	N	%	N	%	N	%	n	%
Dry/itching/irritated eyes	0	0%	9	2%	0	0%	9	2%
Headache	24	5.4%	14	3%	13	2.9%	51	11.5%
Fatigue	1	0.2%	1	0.2%	14	3%	16	3.6%
Dizziness	0	0%	7	1.6%	0	0%	7	1.6%
Dry or itchy skin	10	2.3%	21	4.8%	20	4.5%	51	11.5%
Stomach upset	11	2.5%	11	2.5%	6	1.4%	28	6.3%
Other	31	7%	17	3.9%	24	5.4%	72	16.2%

4. The respondents' smoking habits

According to Table 14, forty five percent (45%) of respondents reported that they were current smokers and 36% reported smoking indoors. However that only 4% reported that they were smoking outdoors. At least thirty one percent (31%) were non- smokers. This raised concerns about public health risks to environmental tobacco smoke (ETS) since there were no demarcated or restricted areas for smoking. Studies on ETS have shown that passive smokers are more susceptible than active smokers to health risks (Korgan, 1993).

Table 14: Smoking habits

Response	SJ Smith Hostel		Jacobs Hostel		Dalton Hostel		Total	
	N	%	N	%	n	%	n	%
Current Smokers	45	10.4%	86	20%	66	15.2%	197	45%
Non- Smokers	56	13%	77	18%	0	0%	133	31%
Indoors	32	7.4%	63	15%	63	15%	158	36%
Outdoors	14	3.2%	1	0.2%	1	o.2%	16	4%

5. Social mobility

Response to the questionnaires (Table 15) on the time spent by respondents away from the hostel revealed that thirty two percent (32%) were away from the hostel once a month, and three percent (3%) once a year. Sixty percent (60%) of the respondents who were away from the hostel once a month were from Dalton Hostel. This information suggested that a majority of the respondents were permanent residents spending most of their time in the hostels.

Table 15: Period away from hostel

Response	SJ Smith Hostel		Jacobs Hostel		Dalton Hostel		Total	
	N	%	N	%	N	%	n	N%
Once a week	14	3.2%	23	5.3%	7	1.6%	44	10%
Once a month	38	9%	17	3.9%	82	19%	137	32%
Once in twelve months	6	1.4%	1	0.2%	5	1.2%	12	3%

6. Time spent indoors and outdoors

Poor health resulting from indoor environmental factors depends on the length or time of exposure. If the source of the pollution is believed to be in the same room as the occupant, chances are that the more time they spent in that room the more they are exposed. According to Table 16, seventy five percent (75%) of the respondents from the three hostels were spending 13 to 24 hours indoors. The highest recorded percentage was thirty percent (30.4%) in Jacobs hostel. This suggested that most respondents were spending more time indoors than outdoors (Table 16).

Table 16: Time spent by individuals indoor and outdoors

Hrs spent indoors/outdoors in a 24 hr period	SJ Smith Hostel		Jacobs Hostel		Dalton Hostel		Total	
	N	%	N	%	n	%	n	%
1-12 hrs –indoors	11	2.5%	54	12.4%	34	2.8%	99	23%
13-24 hrs –indoors	94	22%	132	30.4%	100	23%	326	75%
1-12 hrs- outdoors	88	20.3%	11	2.5%	128	29.5%	227	52.3%
13-24 hrs- outdoors	3	0.7%	75	17.3%	1	0.2%	79	18.2%

7. Occupational history

Thirty four percent (34%) of the respondents were previously employed as labourers and forty eight percent (48%) of them were employed fulltime (Table 17).

Table 17: Occupational history of the occupants

Response	SJ Smith Hostel		Jacobs Hostel		Dalton Hostel		Total	
	N	%	n	%	N	%	N	%
Employed f/time 40hrs/week	59	14%	95	21.8%	54	12%	208	48%
Not employed f/time 40hrs/week	47	10.8%	65	15%	82	19%	194	45%
Were employed as labourers	27	6.2%	74	17%	48	11%	149	34%
Were employed as technicians	13	3%	1	0.2%	3	0.7%	17	3.9%
Were employed as professionals	4	0.9%	0	0%	0	0%	4	0.9%
Were employed as semiskilled	2	0.5%	0	0%	4	0.9%	6	1.4%
Were self-employed	1	0.2%	0	0%	0	0%	1	0.2%
Were pensioners	0	0%	0	0%	0	0%	0	0%
Were schooling	2	0.5%	0	0%	0	0%	2	0.5%
Were unemployed	0	0%	4	0.9%	0	0%	4	0.9%
Other	10	2.3%	0	0%	0	0%	10	2.3%

4.3.3 The Environment

Unhealthy conditions were prevailing in the communal facilities of the 5- and 10-bed dormitory blocks as well as in the communal open spaces. Refuse removal and cleaning of facilities were not taking place, leading to extremely unhygienic conditions. Waste was discarded in some cases into the open drains in the internal courtyards. Responses related to these living environments were as follows:

1. The use of refuse bin

It was observed that refuse was dumped all over the place, which was in contrast with the responses that almost everyone was using a refuse bin to dispose of waste. Table 18 reflects that 99% of the respondents were using refuse bins to dispose of refuse.

Table 18: Use of refuse bin

Response from those who	SJ Smith Hostel		Jacobs Hostel		Dalton Hostel		TOTAL	
	N	%	N	%	n	%	N	%
Use a refuse bin	106	24%	196	45%	131	30%	433	99.8 %
Do not use a refuse bin	0	0%	1	0.2%	0	0%	1	0.2%

Observations during visual inspections (Table 4) revealed that there were no refuse bins in the majority of the dormitories inspected and that only a few were seen lying on the passage with no sign that they were ever used at all.

2. Cleaning times

An overwhelming majority of the respondents claimed they were cleaning their rooms at least two times a day as per data in Table 19. This was in contrast to the observations from the visual inspections (Table 4) where it was noted that hostels were untidy and unhygienic. Lack of access control to the hostels which, resulted in overcrowding of space may have been the reason for the dirty premises.

Table 19: How often cleaning is done in the hostel

Response	SJ Smith Hostel		Jacobs Hostel		Dalton Hostel		Total	
	N	%	N	%	n	%	n	%
Those that clean their dormitories	106	24%	186	43%	135	31%	427	98.4%
Those who do not clean their dormitories	0	0%	5	1.2%	0	0%	5	1.2%
Those who clean once a day	13	3%	71	16.4%	23	5.3%	107	24.7%
Those who clean twice a day	32	7.4%	82	18.9%	100	23%	214	49.3%
Those who clean three times a day	40	9.2%	12	2.8%	1	0.2%	53	12.2%
Those who clean once a week	1	0.2%	13	3%	4	0.9%	18	4.1%
Those who clean twice a week	3	0.7%	8	1.8%	6	1.4%	17	3.9%
Those who clean 3 times a week	6	1.4%	0	0%	2	0.5%	8	1.8%

3. The condition of water pipes

Seventy five percent (75%) of the respondents agreed that there were leaking water pipes in the building (Table 20). However, there were differences of opinion, as 66% suggested that the leaks were from the bathrooms and the toilets, while 28% sited the leaks in the kitchens. This was further confirmed by observations of the visual inspections (Table 5) where 60 to 80% of leaking taps was recorded from the 5- and 10-bed type dormitories.

Table 20: Perceptions of the condition of water pipes

Response	SJ Smith Hostel		Jacobs Hostel		Dalton Hostel		Total	
	N	%	N	%	N	%	n	%
Aware of leaking pipes	85	19.6%	115	26%%	126	29%	326	75%
Not aware of any leaks	20	4.6%	62	14.3%	10	2.3%	92	21.2%
Those who think the leaks are in the kitchen	43	10%	63	14.5%	14	3.2%	120	27.6%
Think the leaks are in toilet/bathroom	70	16%	94	21.7%	123	28%	287	66%
Think the leaks are in the living room	2	0.5%	0	0%	0	0%	2	0.5%

4. The condition of waste pipes

Fifty nine percent (59%) of the respondents agreed that there were blocked waste pipes, while 31% denied there were blocked waste pipes in the building (Table 21). Fifty three and a half percent (53.5%) sited blocked waste pipes in the bathrooms and the toilets, while 14% sited the blockage in the kitchen. Observations during visual inspections revealed 60 to 80% (Table 5) blocked drains occurred in the bathrooms and outdoor open spaces in the courtyard.

Table 21: Perceptions of the condition of waste pipes

Response	SJ Smith Hostel		Jacobs Hostel		Dalton Hostel		TOTAL	
	N	%	N	%	N	%	N	%
Aware of blocked waste pipes	85	19.6%	82	18.9%	89	21%	256	59%
Not aware of blocked waste pipes	18	4.2%	71	12.4%	44	5.3%	133	31%
Think the blockage is in the kitchen	2	0.5%	55	12.7%	4	0.9%	61	14%
Think the blockage is in toilet	84	19.4%	59	13.6%	89	21%	232	53.5%

5. Cooking facilities and times

An overwhelming majority of the respondents (99.5%) were cooking food for themselves, and 0.7% never cooked (Table 22). Electricity was the main source of energy. Ninety percent (90%) of the respondents used electricity, while only 10% used paraffin for cooking. Fifty percent (50%) cooked their meals twice a day, and 43% once a day. At least 3% cooked their meals three times a day.

However, it was noted that cooking was taking place in the dormitories and not in the designated kitchen facilities. The so-called kitchen facilities on the other hand were virtually empty and unused. This was because no actual facilities were provided other than a concrete table and several electrical plug points. This cooking practice may have contributed to indoor dampness and mouldiness in the 5- and 10-bed dormitories as indicated in Table 4 (signs of visible moulds and dampness >3 m^2).

Table 22: Facilities used for cooking in the hostels

Response	SJ Smith Hostel		Jacobs Hostel		Dalton Hostel		Total	
	N	%	N	%	N	%	N	%
Cook food for themselves	106	24.4%	195	45%	131	30.2%	432	99.5%
Do not cook food for themselves	0	0%	3	0.7%	0	0%	3	0.7%
Use an Electric stove	102	23.5%	155	36%	133	30.7%	390	90%
Use a Paraffin stove	2	0.5%	42	9.7%	0	0%	44	10%
Cook once a day	67	15.4%	104	23.9 %	15	3.5%	186	42.9%
Cook twice a day	30	6.9%	68	15.7 %	118	27.2%	216	49.8%
Cook three times a day	8	1.8%	5	1.2%	0	0%	13	3%

6. Living conditions

Each hostel complex had engineering services including water, waterbome sewerage and electricity. The overall service infrastructures appeared to be over subscribed. Population densities were putting an enormous strain on infrastructures. It was noted that residents blamed the poor state of the infrastructure on poor workmanship, substandard materials and failure to respond timeuosly to reported breakages and leaks. The infrequent removal of refuse was one example quoted by residents as an important contributor to damaged service infrastructure as solid waste incorrectly found itself in storm water drains and other inappropriate places (Figure 7).

Figure 6: Refuse dumped outside a hostel block

There were mixed feelings about the living conditions in the hostel environment as people expressed different concerns. Table 23 suggests that 27% of the respondents expressed concerns about overcrowding. These concerns were from SJ Smith hostel

(10%), while 17% of respondents from Jacobs hostel. There were no concerns about overcrowding in Dalton hostel (Table 23).

Table 23: General comments by respondents about living conditions

Response	SJ Smith Hostel		Jacobs Hostel		Dalton Hostel		Total	
	N	%	N	%	N	%	n	%
Concerns about overcrowding	43	10%	73	17%	null	null	116	27%
Feel there is no overcrowding	0	0%	72	16.8%	null	null	72	16.8%
Concerns about cleanliness	59	13.6%	49	11.3%	null	null	108	24.9%
No concerns & satisfied	0	0%	34	7.8%	null	null	34	7.8%
Concerned about structural defects	7	1.6%	10	23%	null	null	17	3.9%
Concerned about sharing of male & female	2	0.5%	2	0.5%	null	null	4	0.9%
Complained about electric cut offs	5	1.2%	11	2.5%	null	null	16	3.7%
Complained about noise disturbance	14	3.2%	11	2.5%	null	null	25	5.8%

Twenty five percent (25%) of the respondents expressed concerns about cleanliness in the hostel. At least 8% had no concerns and were satisfied with the living conditions (Table 23). Four percent (4%) of the respondents expressed concerns about the conditions of the buildings. They were complaining about broken windows, cracked walls and ceilings, and dampness on the floors due to leaking water pipes (Table 23). Another four percent (4%) expressed concerns about electric cut-offs, which were occasional during maintenance periods, and occupants were not informed in advance (Table 23).

In a hostel environment a number of activities take place as individuals and not families have different ways of doing things characterized by different cultural beliefs and habits, e.g. listening to different radio stations. This may result in the emission of disturbing noise, causing annoyance. However, it was noted that only 6% of the respondents were concerned about the noise disturbance (Table 23).

4.4 Moulds in the indoor environment

Four genera of fungi or moulds were identified, namely: *Aspergillius, Cladosporium, Penicillium*, and *Rhizopus*. Mycologists classify fungi by their presumed evolutionary biological relationships. The three most common groups of fungi are *Zygomycetes, Ascomycetes*, and *Basidomycytes.* Although all can contaminate buildings, the predominant fungi that colonize building materials belong to the *Ascomycetes* group, (Burge, 1997).

In chapter 19 of *Bio-aerosols and Control* (Macher, 1999), Burge and Otten refer to fungi as a "kingdom of eurokaryotic organisms without chlorophyll, that have cells bound by rigid walls usually formed of chitin and glucans." They further state that the term "mould" is an artificial grouping similar to the term "weed" used by gardeners. It has no taxonomic significance. Mould generally refers to a visible colony of fungi growing in an indoor environment. Mildew is a layman's term referring to mould growing in and on substances such as fabrics and wood.

4.4.1 *Aspergillius*

The genus *Aspergillius* is large, consisting of approximately 150 species. To the untrained eye, many *Aspergillius* species are similar or identical, and misidentification is common. Spores belonging to the genus *Aspergillius* are common components of the outdoor aerospora, but their isolation frequently is not as common as those of *Cladosporium*, *Penicillium*, and mushroom spores. Species of *Aspergillius* are notorious for producing mycotoxins. In addition, several *Aspergillius* species are a serious concern in health care facilities and to immune-deficient individuals because of their infection potential (Storey *et al.*, 2004).

4.4.2 *Cladosporium*

This is another large fungal genus with more than 500 names. The most common are; *C. herbarum, C. cladosporiodes, and C. sphaerospermum*. They are associated with leaves and vegetation in nature throughout the world; their spores are the most abundant in outdoor air. However, they are also common colonizers of fibrous glass insulation materials in heating, ventilation, and air-conditioning (HVAC) systems. Cold surfaces subjected to condensation (window panes, storage rooms, etc.) are frequently colonized by them (Storey *et al.*, 2004).

4.4.3 *Penicillium*

This genus consists of approximately 250 to 300 species. Some are extremely common in the environment, but a few species have very unique ecological niches. Some are soil borne and used in cheese production. Some species are known to produce mycotoxins (Storey *et al.*, 2004).

4.4.4 *Rhizopus*

Sometimes called the black bread mould, this genus is a zygomycete. It is a primitive mould with aseptate hyphen; this hyphen is not divided into individual cells. Although there may be many nuclei in aseptate hyphen, they are not separated by cell walls (septa) (Burton & Engelkirk, 1996).

4.5 Temperature and Humidity

A continuous monitoring of the humidity during the sampling process using a thermo hygrometer (every five hours) revealed a relative humidity ranging from 54% to 65% on average. Data obtained from the SA Weather Bureau (http//www.saweather.com) confirmed the humidity levels. The on site temperature measurement remained unchanged at 18 ^{O}C to 27 ^{O}C for the duration of the sampling process (readings from the Thermo hygrometer). The review of the literature revealed that relative humidity of fifty to sixty percent (50 - 60%) favours the growth of indoor moulds if the temperature is at 27 ^{O}C (EPA, 2004).

4.6 Descriptive Analysis of data

4.6.1 Health data matched with the respondents' demographic profile

Health status of respondents (self-reported symptoms) was matched with their socio-economic status in the three selected hostel blocks where a variation of responses was recorded as demonstrated in Figures 8,9,10 & 11.

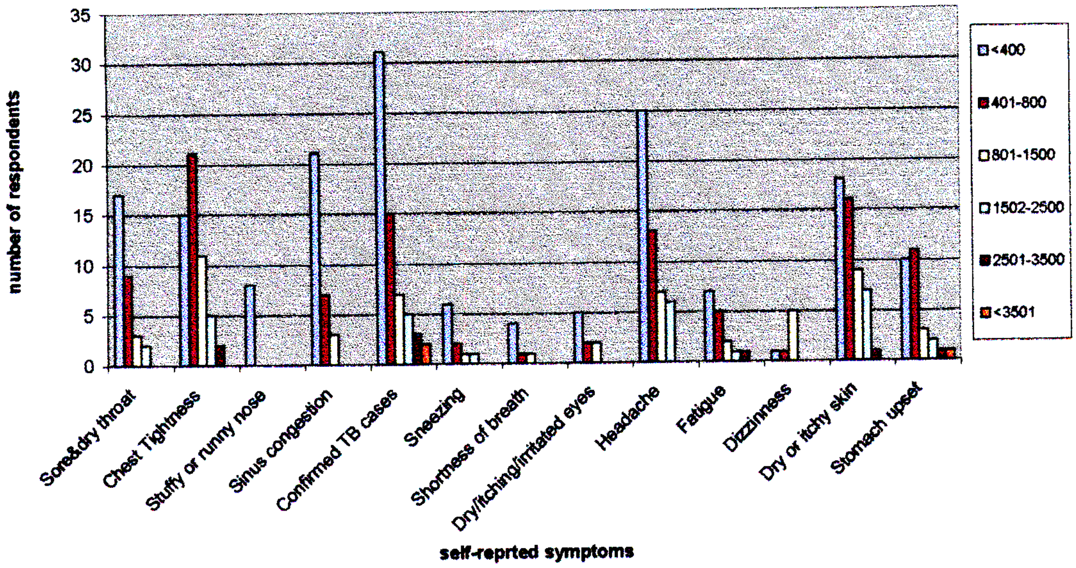

Figure 7: Health data represented according to monthly income of respondents

The number of respondents, who confirmed that they were taking a TB treatment in all three selected hostels, was predominantly higher amongst respondents who earned less then R 400 per month. This was also observed when comparing all other symptoms with monthly income levels. Whiles a less number of respondents who were earning above R 800 a month have reported any respiratory health problem.

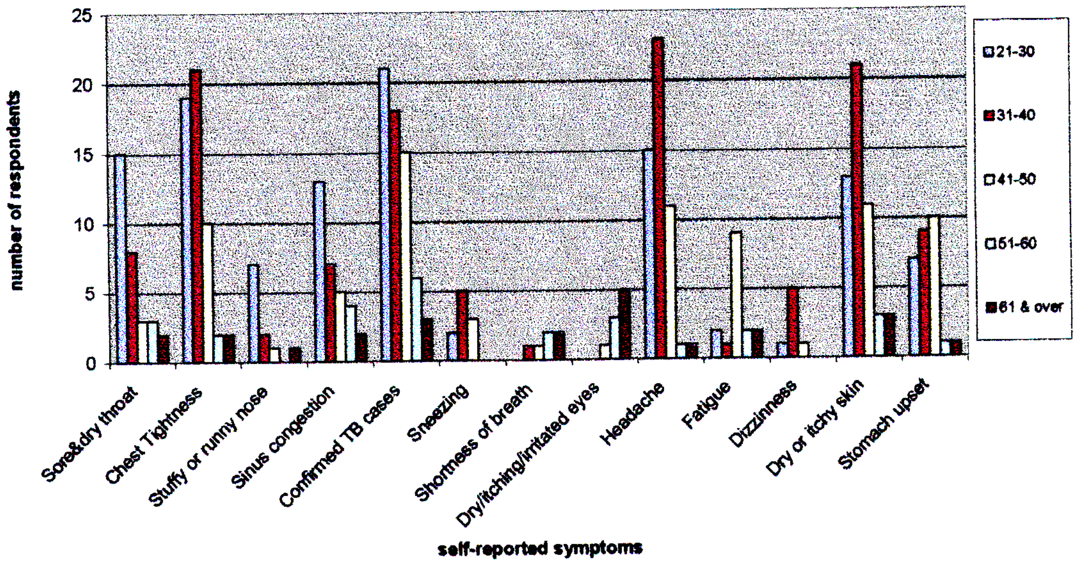

Figure 8: Health data represented according to age categories of respondents

In this graph the number of respondents who reported any respiratory health problem was higher between age categories 21 to 40 years. The number of respondents was lower between age categories 51 to 60 years.

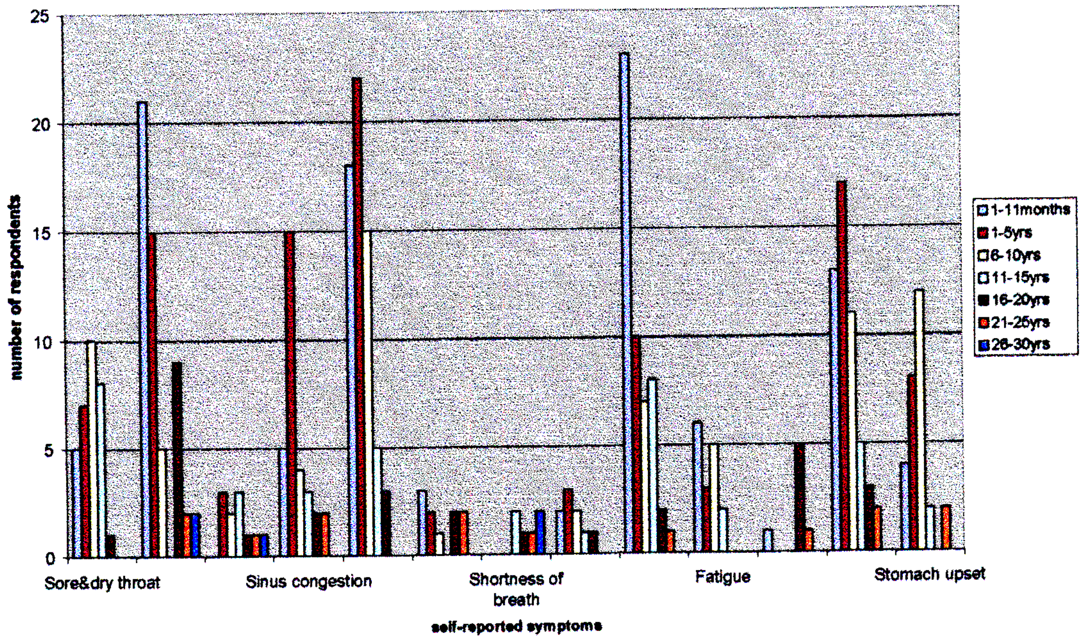

Figure 9: Health data represented according to residency of respondents

The number of respondents who reported any respiratory health problem was higher amongst those respondents who had been to the hostel for a period of 1month to 5 years and slightly lower amongst those who had been to the hostel for a period 6 to 10 years.

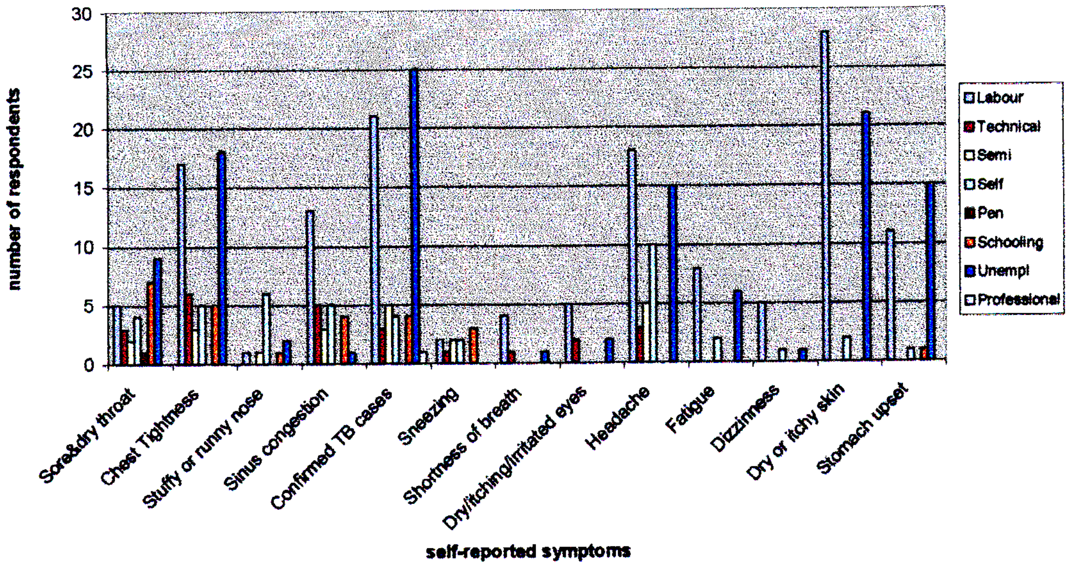

Figure 10: Health data represented according to occupations of respondents

The number of respondents who reported any respiratory health problem was higher amongst those respondents who were unemployed and those who were employed as labourers. Very few or/ non of the professionals had reported any respiratory health problem.

4.6.2 Surface and Air Samples analysis (Tables 24- 25 and Figures 12- 13)

Six hundred and forty six (646) surface and air samples were collected from the selected blocks in the three hostels. This included indoor and the control outdoor air samples that were taken at strategic points. However, the outdoor samples were taken for control purposes and are not recorded in the table but are discussed briefly in the text.

Surface moulds resulting from the indoor samples of the 5-beds type dormitories summated to 39% of the entire sample, and the indoor airborne spores sampled were as high as 61%. The outdoor surface and airborne samples taken at four points outside each selected block were as high as seventy five percent (75%) and eighty one percent (81%) respectively.

Table 24: Surface and airborne sample results

5 Bed type dorm-level	SJ Smith Hostel n=241		Dalton hostel n=191		Jacobs hostel n=214	
	Surface samples					
	Colony Forming Units	%percentag e	Colony Forming Units	%percentag e	Colony Forming Units	%percentag e
Level 1	428	29%	123	24%	50	23%
Level 2	320	21%	134	26%	58	27%
Level 3	748	50%	257	50%	108	50%
Total	1496	100%	514	100%	216	100%
	Bio-aerosol samples					
Level 1	749	32%	223	24%	461	44%
Level 2	425	18%	243	26%	59	6%
Level 3	1174	50%	466	50%	520	50%
Total	2348	100%	932	100%	1040	100%

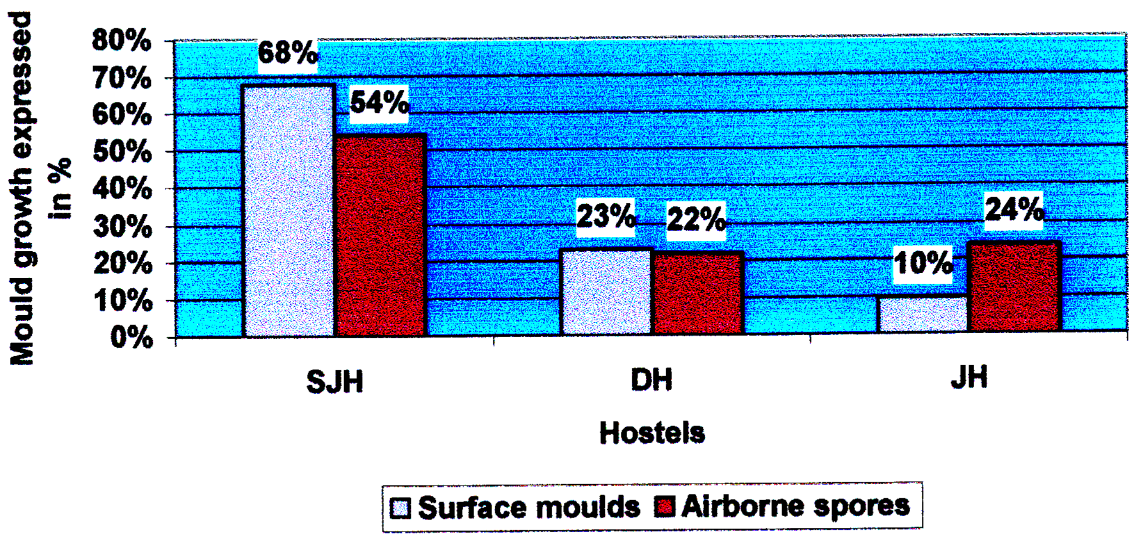

Figure 11: Surface moulds versus airborne spores in 5-bed type dormitories

Figure 8 represents the sum total of surface moulds compared to airborne spores in the 5-bed type dormitories expressed in percentage. These were ranging from 10% (JH) to 68% (SJH) surface moulds and the airborne spores from 22% (DH) to 54% (SJH). It was noted that surface mould growth in the 5-beds type dormitories at SJ Smith hostel was the highest at sixty eight percent (68%). This percentage was very high when compared to Dalton hostel at twenty three percent (23%) and Jacobs hostel at ten percent (10%).

In the 10-bed type dormitories the surface mould samples constituted 42% of the entire sample, while the airborne spores went as high as fifty eight percent (58%). Conclusions drawn from Tables 24 and 25 suggest that the total number of airborne spores was higher in almost all the blocks when compared to surface moulds.

This could be an indication that indoor air quality in the selected blocks from the three hostels was polluted. The results of the outdoor surface and airborne samples registered seventy four percent (74%) to eighty nine percent (89%) respectively.

Table 25: Surface moulds and airborne spores sample results -10-bed type

5 Bed type dorm-level	SJ Smith Hostel n=241		Dalton Hostel n =191		Jacobs Hostel n=214	
	Surface samples					
	Colony Forming Units	%percentage	Colony Forming Units	%percentage	Colony Forming Units	%percentage
Level 1	704	40%	249	35%	234	22%
Level 2	583	33%	230	32%	208	19%
Level 3	468	27%	231	33%	647	59%
Total	1755	100%	710	100%	1089	100%
	Bio-aerosols samples					
Level 1	639	26%	89	16%	430	28%
Level 2	580	24%	184	34%	348	22%
Level 3	1219	50%	273	50%	778	50%
Total	2438	100%	546	100%	1556	100%

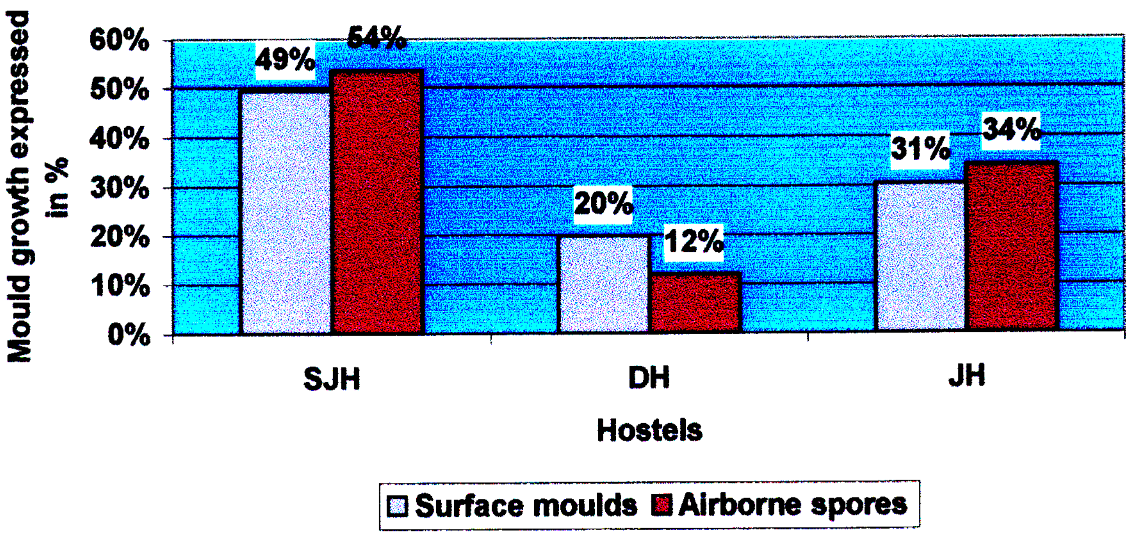

Figure 12: Surface moulds compared to airborne spores in the 10-bed type dormitories

Mould bacteria in the 10-bed type dormitories escalated in SJ Smith hostel when compared to the other two hostels, reaching 54% for airborne spores and 49% for surface moulds. The lowest findings at 12% (airborne spores) and 20% (surface moulds) occurred at Dalton hostel.

4.7 Statistical Analysis of Data

4.7.1 Exposure levels

4.7.1.1 By bed types

The average rankings of the total indoor surface and airborne moulds (colony forming units) according to bed types, i.e. 5,10 and 15-bed types revealed the following (Table 26). The total mea (malt extract agar) indoor surface moulds in the 15, 10 and 5-bed types were ranking from 11.70 to 12.44 respectively, and the total dg (dichloran-18% glycerol) indoor surface moulds in the 5 and 10-bed types were ranking from 12.33 to 12.56, and lower in the 15-bed types at 10.40. While the total mea indoor airborne moulds were ranking from 11.00 to 13.33 in the 5 and 10-bed types and 11.40 in the 15-bed types. The total dg indoor airborne moulds were ranking from 10.80 to 12.56 in the 15, 10 and 5-bed types respectively.

Table 26 Average rankings of indoor moulds levels (CFU) according to bed types

	Bed Type	N	Mean Rank
total mea surface	5	9	12.44
	10	9	11.72
	15	5	11.70
	Total	23	
total dg surface	5	9	12.33
	10	9	12.56
	15	5	10.40
	Total	23	
total mea airborne	5	9	11.00
	10	9	13.33
	15	5	11.40
	Total	23	
total dg airborne	5	9	12.56
	10	9	12.11
	15	5	10.80
	Total	23	

Mea-malt extract agar dg- dichloran 18%-glycerol

4.7.1.2 By -floor levels

The average rankings of the total indoor surface and airborne moulds according to floor levels, i.e. floor level 1, 2 and 3 revealed the following (Table 27). The total mea indoor surface moulds at floor levels 2 and 1 were ranking from 10.81 to 11.56 respectively, with floor levels 3 ranking higher at 13.86. In addition to that, the average rankings of the total dg indoor surface moulds were ranging from 10.75 to 12.38 at floor levels 2 to 1 and 13.00 at floor levels 3. While the total mea indoor airborne moulds were ranking from 10.75 to 12.00 at floor levels 2 and 1 and 13.43 at floor levels 3. The total dg indoor airborne moulds were ranking from 9.14 to 15.25 from floor levels 3, 2 to 1.

Table 27 Average ranking of indoor moulds levels according to floor levels

	LEVEL	N	Mean Rank
Total mea surface	1	8	11.56
	2	8	10.81
	3	7	13.86
	Total	23	
Total dg surface	1	8	12.38
	2	8	10.75
	3	7	13.00
	Total	23	
Total mea airborne	1	8	12.00
	2	8	10.75
	3	7	13.43
	Total	23	
Total dg airborne	1	8	15.25
	2	8	11.25
	3	7	9.14
	Total	23	

mea -malt extract agar dg -dichloran 18%-glycerol

4.7.1.3 By -hostel blocks

The average rankings of the total indoor surface and airborne moulds according to hostel blocks, i.e. A, B, C and D revealed the following (Table 28). The total mea surface moulds in blocks were ranging from 7.83 to 21.67, where block C had the highest score (21.67). The total dg indoor surface moulds revealed a similar sequence where the score in block C was ranked the highest at 18.33. While the total mea indoor airborne moulds ranked from 6.33 to 20.33 and the total dg indoor airborne moulds with a score of 8.83 to 20.00, again block C had the highest score.

Table 28 Average rankings of indoor moulds levels according to hostel blocks

	Block	N	Mean Rank
total mea surface	A	9	13.83
	B	5	7.90
	C	3	21.67
	D	6	7.83
	Total	23	
total dg surface	A	9	13.44
	B	5	8.80
	C	3	18.33
	D	6	9.33
	Total	23	
total mea airborne	A	9	15.89
	B	5	6.80
	C	3	20.33
	D	6	6.33
	Total	23	
total dg airborne	A	9	13.11
	B	5	9.00
	C	3	20.00
	D	6	8.83
	Total	23	

Mea- malt extract agar dg- dichloran 18%-glycerol

4.7.1.4 Between hostels

The average rankings (indoor surface and airborne moulds) between the selected block hostels, i.e. SJ Smith, Dalton, Jacobs hostels revealed the following (Table 29). The total mea indoor surface moulds between the three hostels ranked from 8.50 to 20.50 and the total dg indoor surface moulds ranking from 9.11 to 19.33, where SJH had the highest score and JH with the lowest score for both mea and dg surface moulds. While the total mea airborne moulds in the three hostels ranked from 8.78 to 19.50 and the total dg airborne moulds ranging from 8.44 to 19.00. It was however noted that SJH had the highest score, followed by JH and lastly DH with the lowest score all rankings.

Table 29 Average rankings of indoor moulds levels according to different hostels

	Hostel	N	Mean Rank
total mea surface	SJH	6	20.50
	DH	9	8.50
	JH	8	9.56
	Total	23	
total dg surface	SJH	6	19.33
	DH	9	9.11
	JH	8	9.75
	Total	23	
total mea airborne	SJH	6	19.50
	DH	9	8.78
	JH	8	10.00
	Total	23	
total dg airborne	SJH	6	19.00
	DH	9	8.44
	JH	8	10.75
	Total	23	

SJH- SJ Smith hostel JH- Jacobs hostel DH -Dalton hostel

4.7.1.5 Correlations between indoor mould levels in the selected hostel blocks

The total mea indoor surface moulds levels were significantly correlated to total dg surface moulds (r = 0.736 & p = 0.01) and also significantly correlated to total mea airborne moulds (r = 0.736 & p = 0.01). The total mea surface moulds were significantly correlated to total mea airborne moulds (r = 0.630 & p = 0.01), and also significantly correlated to total dg surface moulds (r = 0.855 & p = 0.01). While the total mea surface moulds levels were not significantly correlated to each other.

Table 30 Correlations between indoor moulds levels in the selected hostel blocks

		total mea surface	total dg surface	total mea air	total dg air
Total mea surface	Pearson Correlation	1	.736(**)	.736(**)	.630(**)
	Sig. (2-tailed)		.000	.000	.001
	N	23	23	23	23
Total dg surface	Pearson Correlation	.736(**)	1	.855(**)	.377
	Sig. (2-tailed)	.000		.000	.076
	N	23	23	23	23
Total mea air	Pearson Correlation	.736(**)	.855(**)	1	.457(*)
	Sig. (2-tailed)	.000	.000		.028
	N	23	23	23	23
Total dg air	Pearson Correlation	.630(**)	.377	.457(*)	1
	Sig. (2-tailed)	.001	.076	.028	
	N	23	23	23	23

** Correlation is significant at the 0.01 level (2-tailed) * Correlation is significant at the 0.05 level (2-tailed).

4.7.2 Outcomes

4.7.2.1 According to bed types

The average rankings of self reported symptoms scores according to bed types in the selected hostel blocks of the three block hostels revealed the following. The sick building syndrome symptoms scores were ranking from 10.39 to 13.61 in the 5, 10 and 15-bed type dormitories but higher in the 10-bed type dormitories. While the respiratory symptoms scores were ranking from 11.44 to 12.80 and was higher in the 5-bed type dormitories (Table 31).

Table 31 Average rankings of self-reported symptoms according to bed types

	Bed Type	N	Mean Rank
sbs symptoms	5	9	10.39
	10	9	13.61
	15	5	12.00
	Total	23	
Respiratory symptoms	5	9	11.44
	10	9	12.11
	15	5	12.80
	Total	23	

4.7.2.2 According to hostel blocks

The average rankings of self-reported symptoms scores according to hostel blocks hostel blocks revealed the following. Sbs symptoms scores were ranking from 6.17 to 15.40 in blocks A, B, C and D where block C had the lowest score and block B with the highest score. While respiratory symptoms scores were ranking from 5.83 to 15.10 in the same blocks. Again block C had the lowest score and block B with the highest score (Table 32).

Table 32 Average rankings of self-reported symptoms according to hostel blocks

	Block	N	Mean Rank
Sbs symptoms	A	9	11.72
	B	5	15.40
	C	3	6.17
	D	6	12.50
	Total	23	
Respiratory symptoms	A	9	10.83
	B	5	15.10
	C	3	5.83
	D	6	14.25
	Total	23	

4.7.2.3 According to floor levels

The average rankings of self-reported symptoms scores according to floor levels revealed the following. The sbs symptoms scores were ranking from 9.44 to 13.88 at floor levels 1, 2 and 3, where floor level 2 had the lowest score (9.44) and floor level 1 with the highest score (13.88). While the respiratory symptoms score were ranking from 10.81 to 14.64 where floor level 2 was slightly lower than floor level 1 (10.88). Floor level 2 had the lowest score (10.81) and floor level 3 had the highest score of 14.64 (Table 33).

Table 33 Average rankings of self-reported symptoms according to floor levels

	LEVEL	N	Mean Rank
sbs symptoms	1	8	13.88
	2	8	9.44
	3	7	12.79
	Total	23	
Respiratory symptoms	1	8	10.88
	2	8	10.81
	3	7	14.64
	Total	23	

4.7.2.4 Correlations between outcomes in the selected hostel blocks

The sbs symptoms scores were significantly correlated to respiratory symptoms scores ($r = 0.570$ & $p > 0.01$). There were no significant correlations between sick building syndrome symptoms and the self-reported TB cases in the selected hostel blocks. Respiratory symptoms were significantly correlated to sbs symptoms ($r = 0.570$ & $p > 0.01$). There were no significant correlations between respiratory symptoms and the self-reported TB cases in the selected hostel blocks (Table 34).

Table 34 Correlations between self-reported symptoms scores

			Sbs symptoms	respiratory symptoms	TB cases
Spearman's rho	Sbs symptoms	Correlation Coefficient	1.000	.570(**)	-.101
		Sig. (2-tailed)	.	.005	.645
		N	23	23	23
	respiratory symptoms	Correlation Coefficient	.570(**)	1.000	-.062
		Sig. (2-tailed)	.005	.	.779
		N	23	23	23
	TB cases	Correlation Coefficient	-.101	-.062	1.000
		Sig. (2-tailed)	.645	.779	.
		N	23	23	23

4.7.3 Confounding factors

4.7.3.1 Overcrowding

The level of overcrowding measured on the basis of participants' perception (yes or no) revealed the following. According to table 35, those who agreed (yes) that there was overcrowding of space scored from 5.40 for a no and 13.83 for a yes, and those who disagreed scored from 12 for a no and also 12 for a yes (Table 35).

Table 35 Average rankings of the crowding levels according to participants' perception

	level overcrowded	N	Mean Rank	Sum of Ranks
OVERCROWD	No	5	5.40	27.00
	Yes	18	13.83	249.00
	Total	23		
No overcrowd	No	5	12.00	60.00
	Yes	18	12.00	216.00
	Total	23		

4.7.3.2 Cleanliness (Participants' perceptions)

There were no significant correlations between outcomes and individuals' perceptions about the cleanliness in the selected hostel blocks. None of the computed responses (Table 36) were statistically correlated and significant.

Table 36 Correlations between outcomes and participants perception about cleanliness

			clean/yes
Spearman's rho	Sbs symptoms	Correlation Coefficient	-.124
		Sig. (2-tailed)	.573
		N	23
	respiratory symptoms	Correlation Coefficient	-.092
		Sig. (2-tailed)	.677
		N	23
	TB cases	Correlation Coefficient	.337
		Sig. (2-tailed)	.116
		N	23

4.7.4 Relationships between exposure factors and outcomes

An analysis was done to determine statistical relationships between exposure factors and outcomes using the Incidence Risk Rate (IRR) and the p-value ($p \geq 0.01$) revealed the following;

4.7.4.1 Total symptom score (surface moulds)

The following exposure factors were very much supportive in the development of self-reported symptoms (total symptom score) in the selected hostel blocks. These factors were; smoking habits (IRR = 1.209662 & p = 0.01), leaking pipes (IRR = 1.069039 & p > 0.01), cleanliness or hygiene state of the building (IRR = 1. 048329 & P = 0.01) and the total dg surface moulds (IRR = 1.005357 & p = 0.01). Other exposure factors that were not supportive in the development of the total symptom score were; individuals' concerns about cleanliness in the hostels, the use of refuse bin, structural defects, floor levels, bed types, crowding and the total mea surface moulds (Table 37).

Table 37 Relationships between total symptom score and the exposure factors (surface)

Total symptom score	IRR	Std. Err.	Z	P>|z|	[95% Conf.	Interval]
Yes smoking	1.209662	.0419567	5.49	0.000	1.130162	1. 294746
Cleanliness yes	.4524406	.0352761	-10.17	0.000	.3883244	.527143
Yes refuse-bin	.6523624	.0335601	-8.30	0.000	.5897931	.7215695
Yes leaking pipes	1.069039	.0332695	2.15	0.032	1.005781	1.136276
Yes blocked pipes	1.005492	.0163601	0.34	0.736	.9739328	1.038074
Cleanliness	1.048329	.011181	4.43	0.000	1.026642	1.070474
Structural defects	.9229527	.0353304	-2.09	0.036	.8562404	.9948628
Level	.735285	.0605521	-3.73	0.000	.6256878	.8640797
Bed-type	.9519977	.017688	-2.65	0.008	.9179534	.9873045
Crowding	.8869285	.2434348	-0.44	0.662	.5179165	1.518859
Total mea surface	.9927842	.0010496	-6.85	0.000	.9907291	.9948436
Total dg surface	1.005357	.0010148	5.29	0.000	1.00337	1.007348

4.7.4.2 Total symptom score (airborne moulds)

According to table 37, certain exposure factors were very much supportive in the development of self-reported symptoms (total symptom score) in the selected hostel blocks. These factors were; smoking habits (IRR = 1.259653 & p = 0.01), leaking pipes (IRR = 1.079164 & p > 0.01) and cleanliness or the hygiene state of the building (IRR = 1.09077 & p = 0.01). Other exposure factors that were not supportive in the development of self-reported symptoms were; individuals' concerns about cleanliness in the hostel, the use of refuse bin, structural defects, floor levels, bed-types, crowding, total mea and dg airborne moulds.

Table 38 Relationships between total symptom score and the exposure factors (airborne)

Total symptom score	IRR	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Yes smoking	1.259653	.0489181	5.94	0.000	1.167333	1.359274
Cleanliness yes	.4352171	.0336704	-10.75	0.000	.3739839	.506476
Yes refuse-bin	1.259653	.0489181	5.94	0.000	1.167333	1.359274
Yes leaking pipes	1.079164	.0360082	2.28	0.022	1.010847	1.152097
Yes blocked pipes	.9484915	.0157037	-3.19	0.001	.9182069	.979775
Cleanliness	1.090777	.0121993	7.77	0.000	1.067127	1.114951
Structural defects	9821455	.0402569	-0.44	0.660	.9063295	1.064304
Level	.5716833	.0561534	-5.69	0.000	.4715703	.6930499
Bed-type	.9940426	.0187462	-0.32	0.751	.9579714	1.031472
Crowding	1.671439	.4675046	1.84	0.066	.9660686	2.891833
Total mea airborne	.9999527	.0005428	-0.09	0.931	.9988893	1.001017
Total dg airborne	.9940473	.0008683	-6.84	0.000	.9923469	.9957506

4.7.4.3 Sick building syndrome (sbs) symptom score (surface)

Certain exposure factors were very much supportive in the development of sick building syndrome symptoms in the selected hostel blocks and these were; cleanliness or the hygiene state of the building (IRR = 1.091396 & p > 0.01) and the total dg surface moulds (IRR = 1.006454 & P > 0.01). Other exposure factors that were supportive in the development of sick building syndrome but were not statistically significant they were; smoking habits (IRR = 1.066155), leaking pipes (IRR = 1.090116) and blocked pipes (IRR = 1.000578). In addition to that there were exposure factors that were not supportive in the development of sick building syndrome and these were; individuals' concerns about cleanliness in the hostel, the use of refuse bin, structural defects, floor levels, bed-types, crowding and the total mea surface moulds.

Table 39 Relationships between sbs score and the exposure factors (surface)

Sbs symptom score	IRR	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Yes smoking	1.066155	.1102856	0.62	0.536	.870503	1.305782
Cleanliness yes	.4349356	.0998834	-3.63	0.000	.2772973	.6821883
Yes refuse-bin	.6450795	.0325956	-8.68	0.000	.5842549	.7122362
Yes leaking pipes	1.090116	.1066555	0.88	0.378	.8998955	1.320544
Yes blocked pipes	1.000578	.0455116	0.01	0.990	.9152377	1.093876
Cleanliness	1.091396	.0306441	3.11	0.002	1.032957	1.15314
Structural defects	.860717	.0914429	-1.41	0.158	.6989216	1.059967
Level	.6345817	.1368215	-2.11	0.035	.4158732	.9683096
Bed-type	.9303793	.0430655	-1.56	0.119	.8496881	1.018734
Crowding	.6514823	.4977372	-0.56	0.575	.1457399	2.912238
Total mea surface	.9913877	.0030005	-2.86	0.004	.9855242	.9972861
Total dg surface	1.006454	.0025522	2.54	0.011	1.001464	1.011469

4.7.4.4 Sbs symptoms score (airborne)

In Table 40, many exposure factors were supportive in the development of sbs symptoms in the selected hostel blocks but statistically not significant. These exposure factors were smoking habits (IRR = 1.071541), leaking pipes (IRR = 1.29913), crowding (IRR = 1.071541), and the total mea airborne moulds (IRR = 1.000853). While cleanliness or the hygiene state of the building was very much supportive in the development of sbs symptoms and also statistically significant (IRR = 1.158548). Other exposure factors that were not supportive in the development of sbs symptoms were; individuals' concerns about cleanliness in the hostel, the use of refuse bin, blocked pipes, structural defects, floor levels, bed-types, crowding, total dg airborne moulds.

Table 40 Relationships between sbs score and the exposure factors (airborne)

Sbs symptom score	IRR	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Yes smoking	1.071541	.1246148	0.59	0.552	.8531358	1.345858
Cleanliness yes	.414992	.0944816	-3.86	0.000	.2656109	.6483857
Yes refuse-bin	.7095418	.1175547	-2.07	0.038	.5128065	.9817533
Yes leaking pipes	1.129913	.1228159	1.12	0.261	.913111	1.39819
Yes blocked pipes	.9241781	.0476827	-1.53	0.126	.8352918	1.022523
Cleanliness	1.158548	.0365141	4.67	0.000	1.089148	1.232371
Structural defects	.8617894	.1009486	-1.27	0.204	.6850035	1.0842
Level	.3930539	.105456	-3.48	0.001	.2323141	.6650107
Bed-type	.9631491	.0443776	-0.81	0.415	.8799822	1.054176
Crowding	1.151244	.9701285	0.17	0.867	.2207384	6.004221
Total mea airborne	1.000853	.0012525	0.68	0.496	.9984012	1.003311
Total dg airborne	.9916248	.0021438	-3.89	0.000	.9874319	.9958356

4.7.4.5 Respiratory symptoms score (surface)

According to table 41, certain exposure factors were very much supportive in the development of respiratory symptoms in the selected hostel blocks and these were, smoking habits (IRR = 1.373635 & $p > 0.01$), leaking pipes (IRR = 1.392082 & $p > 0.01$) and the hygiene state of the building (IRR = 1.082051 & $p > 0.01$). Other exposure factors that were supportive but were not statistically significant were; blocked pipes (IRR = 1.062538) crowding (IRR = 1.09422) and the total dg surface moulds (IRR = 1.002367). The following exposure factors were not supportive in the development of respiratory symptoms and were; individuals' concerns about cleanliness in the hostel, the use of refuse bin, structural defects, floor levels, bed-types, crowding, and the total mea surface moulds.

Table 41 Relationships between respiratory symptom score and the exposure factors (surface)

Respiratory symptom score	IRR	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Yes smoking	1.373635	.129517	3.37	0.001	1.141861	1.652454
Cleanliness yes	.3367779	.0667642	-5.49	0.000	.2283484	.4966944
Yes refuse-bin	.596624	.0674092	-4.57	0.000	.4781104	.7445146
Yes leaking pipes	1.392082	.1583107	2.91	0.004	1.113947	1.739664
Yes blocked pipes	1.062538	.0440202	1.46	0.143	.9796697	1.152415
Cleanliness	1.082051	.0333184	2.56	0.010	1.018679	1.149364
Structural defects	.8735823	.0829791	-1.42	0.155	.725188	1.052342
Level	.5747181	.1226445	-2.60	0.009	.3782762	.8731739
Bed-type	.9266209	.0465084	-1.52	0.129	.8398063	1.02241
Crowding	1.09422	.8317199	0.12	0.906	.2466628	4.854064
Total mea surface	.9901822	.0031627	-3.09	0.002	.9840029	.9964004
Total dg surface	1.002367	.0036228	0.65	0.513	.9952917	1.009493

4.7.4.6 Respiratory symptoms score (airborne)

In Table 42 only three exposure factors were supportive in the development of respiratory symptoms in the selected hostel blocks and these were; smoking habits (IRR = 1.439241 & p = 0.01), leaking pipes (IRR = 1.353241 & p = 0.01) and the hygiene state of the building or cleanliness (IRR = 1.111232 & p > 0.01). All other exposure factors were not supportive in the development of respiratory symptoms in the selected hostel blocks and they were; individuals' concerns about cleanliness in the hostel, the use of refuse bin, blocked pipes, structural defects, floor levels, bed-types, crowding, total mea airborne and total dg airborne moulds.

Table 42 Relationships between respiratory symptom score and the exposure factors (airborne)

Respiratory symptom score	IRR	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Yes smoking	1.439241	.1431244	3.66	0.000	1.184367	1.748964
Cleanliness yes	.3360165	.0648531	-5.65	0.000	.2301834	.4905093
Yes refuse-bin	.5933728	.0662496	-4.67	0.000	.476751	.7385223
Yes leaking pipes	1.353241	.1653192	2.48	0.013	1.065094	1.719343
Yes blocked pipes	.9951966	.060712	-0.08	0.937	.8830418	1.121596
Cleanliness	1.111232	.0426687	2.75	0.006	1.030672	1.198089
Structural defects	.9779525	.0979106	-0.22	0.824	.8037061	1.189976
Level	.5060816	.1191755	-2.89	0.004	.3189876	.8029107
Bed-type	.9795598	.0524296	-0.39	0.700	.8820059	1.087903
Crowding	2.038632	1.636481	0.89	0.375	.422717	9.83169
Total mea airborne	.9964001	.0026995	-1.33	0.183	.9911232	1.001705
Total dg airborne	.9952829	.0039011	-1.21	0.228	.9876661	1.002958

In conclusion it appeared that certain factors were very much supportive in the development of self-reported symptoms in the selected hostel blocks of the three hostels under certain circumstances and these were the hygiene state of the building, leaking pipes, smoking habits and total mea and dg surface moulds. At all levels of the analysis the hygiene state of the building was very much supportive in the development of self-reported symptoms. Other exposure factors were not supportive at all, for example, structural defects, bed-types, different floor levels and participants' perception of overcrowding. However, it is assumed that certain limiting factors had an influence in the outcome of the results, for example, the term crowding was used to define participants' perception of the crowding levels in the hostels and not the number of people per given space.

CHAPTER 5

Discussion

5.1 General observations, space, density and legal requirements

Generally, the official number of beds provided per hostel (Table 1) was 1500 to 5000. However, it was common that "illegal" residents swelled the number by approximately another 50%. In the opinion of the researcher, this overcrowding was largely to blame for the intolerable living conditions. The fact that overcrowding was so obviously detrimental to the living conditions was borne out when inspecting a 10-beds dormitory, as opposed to a single quarter's block (Table 2). The cleanliness of the latter when compared to the former can only be attributed to the lower numbers making use of the facilities.

However, the legislation (Housing Act no.107 of 1997 as well as National Building Regulations & Building Standards Act no. 103 OF 1977), which governs the administrative and financial aspects of the housing development, does not specify the limited area per square meter (habitable space) an individual must occupy in a dwelling. The World Health Organization has suggested that 12 m^2 (WHO, 1997) is adequate habitable space for an individual in a dwelling. However, this is not a health/housing standard but a mere suggestion.

The relevant National Building Regulations states, "Any habitable room other than a kitchen shall have a floor area of not less than 6 m^2 and the minimum horizontal dimensions within such area shall be not less than 2 m^2 (National Building Regulations and Building Standards Act, 103 of 1977). This however, does not suggest a habitable space per individual in a habitable room. Whereas the findings of the study have revealed that in the 5- & 10-bed type dormitories the habitable space per individual was 3 m^2 and 3.8 m^2. This is far less then the required minimum standards and therefore an indication of overcrowding in the selected hostel blocks.

The effect of the poor physical condition of the living areas was exacerbated by overcrowding, and vice versa, making for a continuously less than satisfactory situation. On the other hand, it must be stated that at least some of the squalor and degradation was 'self inflicted', and was to be laid at the feet of those occupants who had no interest in a healthy living environment. It was particularly noticeable in the communal areas of the 10-bed dormitory blocks where the ablution facilities and the internal courtyards were very dirty and it appeared that refuse removal and cleaning were not taking place. Although men and women were residing in the hostel complex, there appeared to be no separation of facilities in the ablution blocks.

The term environment means everything that is around us; the land, the atmosphere, places of special importance, plant and animal life and well-being. The environment affects us all. We all need a healthy environment to live healthy lives: clean air, safe living areas, sufficient and adequate sanitation. When the environment gets degraded, it affects us all in the long run, but the poor are the first to suffer (Fasheun, 2004).

The environments in which people live in the selected blocks were far below the minimum standards in terms of the legislation (Tables 2, 3, 4 & 5). The reason for this could be that the legislation was not properly adhered to or incorrectly interpreted, resulting in the observed undesirable situation. It was evident that certain practices of either the management or the occupants were in contravention of the legislation and did not serve the purpose of protecting the vulnerable. If we recall, the National Environmental Management; Air Quality Act (Act 39 of 2004) stipulates that the burden of health impacts associated with polluted ambient air falls most heavily on the poor. The results of the study have revealed that the low-income trend amongst the occupants of the hostels could be an indication of the cause and wideness of the problem.

5.2 Demographics and the hostel environment

The questionnaire survey results revealed a number of observations about the demographic profile of the respondents, the health outcomes, and the living conditions, as quantified in table 7 to table 23. These observations were that there was a disparity with regard to income levels amongst the respondents, and the ages of the majority of respondents were within the reproductive category. A majority of the respondents were unemployed males who had been in these hostels for a period of 1-10 years. At least one third of the respondents were experiencing respiratory health problems, and less than a third were suffering from pulmonary Tuberculosis, and another third were complaining of Sick Building Syndrome symptoms.

Almost half (50%) of the respondents were smoking and two thirds of them were smoking indoors. This was a sign of ignorance about risk to public health associated with smoking in public places. A majority of the respondents were spending one weekend a month away from the hostel, for the past three years, which indicated that they were permanent residents of hostels. Two thirds of the respondents were previously employed on a full time basis 40 hours a week as labourers. However the type of jobs they were doing was not defined. One could not predict the history of previous exposure. The results also revealed that the responsibility of cleaning the rooms/dormitories rested upon the occupants as almost all were cleaning their rooms at least once a day. Which was controversial when one compares these efforts to the hygiene state of the building as this factor was very much supportive in the development of respiratory health problems in the selected hostel blocks.

Two thirds of the respondents confirmed that there were leaking water pipes and blocked waste pipes in the building mainly in the toilets and bathrooms. This was evident by the fact that these factors were very much supportive in the development of self-reported symptoms amongst the respondents. Each individual respondent had to cook food for him or herself using electricity once or twice a day. Since this cooking was taking place in dormitories, it may be the reason for increased indoor levels of pollutants posing high risks to respiratory health problems. In addition to that, the descriptive analysis of data revealed low income earnings which were supposedly exacerbated by high levels of unemployment in the hostels. Amongst other things was overcrowding, supposedly caused by inability to enforce rules including inability to evict illegal residents (access control) and may be due to lack of adequate habitable space. This may be the reason for the failure of services such as ablution facilities which rendered living conditions non-conducive to health.

The surface air sampling results as quantified in table 24 to table 25 revealed that: the number of surface moulds and airborne spores (bio-aerosols) was either high or low from one hostel to another in different hostels and from one block to another in each hostel. There was no consistency in the total number of surface moulds and airborne spores per floor level within hostel blocks or between hostels. The same type of mould genera discovered in one hostel was found in the other two hostels. The same type of mould species found in the surface samples was found in the air samples. The total number of surface moulds or airborne spores were compared and differed from one hostel to another and from one block to another in a hostel. The total numbers of moulds in 10-bed type dormitories were slightly lower than in 5-bed type dormitories in all three hostels. This evidence was enough to suggest that ventilation was not adequate in the 10-bed dormitories.

A study on household environment and health in Port Elizabeth by Thomas *et al* (1999) has revealed that low-income earnings as well as high levels of unemployment constitute exposure to high risks of diseases associated with poor environmental conditions. Ramphele (1999), in a study on migrant labour hostels in Cape Town, expressed almost similar concerns, stressing the role of individual lifestyles in health behaviour modification. Very recently a study on vulnerability of South African communities to air pollution by Matooane (2004) has labelled the above factors as vulnerability factors that pre-dispose communities in South Africa to health problems associated with the polluted environment.

In the current study, overcrowding was a dilemma. The numbers of dormitories per block were not proportional to the number of occupants per block. Cranshaw and White (1992) showed that more than 1/5 people per habitable room would be considered overcrowding. This is a fact that plays an important role in affecting the lifestyle of hostel dwellers in particular. Overcrowding may also lead to over usage of basic facilities, for example when bathing and cooking. These activities that prevailed in the dormitories possibly increased the level of moisture in the air, as they caused condensation on ceilings, walls and windows throughout the year.

The legislation governing minimum standards to make a building habitable and ensure satisfactory living conditions (National Building Standards Regulations Act) defines the number of people who must share sanitary facilities. This is to prevent overcrowding of such facilities. Blocked sewer lines and leaking waste water pipes cause dampness in residential buildings, which in turn encourages the development of surface moulds in the indoor environment. A study on assessment of indoor air quality and the level of surface mould growth in residential areas in Durban by Sekhotha and Gqaleni (2001) revealed that moisture in buildings where ventilation was inadequate could cause harm to occupants of such buildings. In the current study, ventilation was found to be inadequate, and this could possibly have increased the growth of indoor moulds, thus constituting a health risk to all the occupants.

5.3 The relationship between confounding factors, health outcomes and exposure factors in the indoor environment of hostels

The statistical analysis of data confirmed the results obtained during the descriptive analysis. These findings were summarised as follows:

- There was a significant correlation between surface and airborne moulds in the indoor environment of the selected hostel blocks.
- The average rankings of surface and airborne moulds varied when analysed by all the exposure factors, i.e. bed types, floor levels, hostels blocks and between hostels.
- The average rankings of self-reported symptoms (health outcomes) also varied when analysed by all the exposure factors, i.e. bed types, floor levels, hostels blocks and between hostels. These outcomes were categorised as sick building syndrome (sbs) symptoms and respiratory symptoms.
- The level of overcrowding (confounding factor) measured on the basis of perceptions (yes or no) also varied according to respondent's perception.
- There were no significant correlation between the outcomes and individual's perceptions about cleanliness (confounding factor).
- Certain environmental factors were very much supportive in the development of self-reported symptoms in the selected hostel blocks. These factors were the hygiene state of the building, leaking pipes, smoking habits and the total surface moulds. Other factors that were not supportive were the structural defects, bed-types, different floor levels, and participant's perception of cleanliness.

The term cleanliness was used to define respondent's perception of the hygiene state of the building which was highlighted to be supportive in the development of self-reported symptoms amongst the respondents. It than transpired that the respondents were not aware of the health risks associated with their living environment. This was further confirmed by evidence that these hostels were overcrowded (Table 2), and again the participants were not aware or concerned of the confounding factors putting their lives at risks to health problems associated with poor indoor environment. There were also concerns about the respondent's smoking habits which also supported the development of self-reported symptoms in the indoor environment of hostels. This also indicated a lack of awareness on public health risks associated with smoking in public places. Another factor was the leaking pipes (sewage or water) which also supported the development of self-reported symptoms amongst respondents in the indoor environment of hostels. This was also a concern regarding good housekeeping and proper maintenance of building used for residential purposes. Last but not least was a concern about the total number of surface moulds in the indoor environment of hostels which also supported the development of self-reported symptoms amongst respondents.

The review of available literature revealed that indoor and outdoor environments are mutually dependent on each other, and that environmental factors in the in- and outdoor environments can influence the development of indoor moulds in residential buildings. In addition to that, mouldiness and dampness of the buildings are associated with the development of respiratory health problems amongst occupants of such buildings. Human activities, individual life-styles, the number and the class groupings of individuals, influence living conditions in a residential building. People become exposed to the environment they live in because of how they live in that environment. In addition to the above, the review of the related legislation revealed that the Act provides for the protection of residents exposed to both indoor and outdoor environments on condition that the relevant Act are adhered to. However, there are areas that are not adequately covered by this legislation and maybe should be addressed at both policy making and planning levels. This evidence was enough to suggest that the environmental conditions in the indoor environment of these hostels were not conducive to health and may have been the possible source of the health problems revealed in this study. This also supported the reasons why this study was necessary.

CHAPTER 6

Conclusions and Recommendations

6.1 The Conclusions

The general appearance of the hostels raised concerns that were so obvious that it required no expert to recognise them. The concerns were the overcrowding of space, lack of cleanliness and the unsightly physical conditions of the buildings. In addition to theses, policy issues needed to be addressed, as the lack of adherence to these policies and legislation has exacerbated the situation. These environmental concerns could be summarised as three main areas of concern, i.e. problems arising from the mismanagement of the facilities, problems arising from the abuse of the facilities, and last but not least, problems due to lack of control measures to ensure adequate utilisation of environmental resources.

The results of this study confirmed that South Africa is not different from the rest of the world. In most of the countries inadequate insulation, poor heating, ventilation and air conditioning system were cited as the principal casual factors of high indoor mould growth (Matooane *et al.,* 2004). Apart from poor ventilation found in the present study, poor building designs also contributed to create favourable conditions for mould growth. These factors lead to poor indoor air quality and a high level of indoor surface mould growth in the hostels. Statistical analysis of the results revealed that certain exposure factors such as leaking water pipes, the hygiene state of the buildings, smoking habits of the participants and indoor surface moulds supported the development of self-reported symptoms amongst hostel dwellers in the selected hostel blocks. It is argued that, adequate housing involves various components that together make up an acceptable dwelling. It has to include friendly and healthy living environments and provide an enough space for occupants.

In addition to that, objective 4 of the study seek to identify ways in which the findings of the study could be incorporated into the hostel development plans. The findings of the study revealed that hostel development plans were based on a needs assessment and the impact on the environment was not considered. The carrying capacity of the land was never considered, i.e. plans were put on the table to increase the infrastructure of the hostels but nothing was mentioned about acquiring more land for the new developments.

Moreover, the increase in the number of multi-storey buildings within the already limited space would hinder free movement of the air between buildings and hence affect the quality of the ambient air. The many large buildings radiate long-wave radiation in all directions, some of which heats the surface below as well as other buildings (Heerden & Hurray, 1999). There were no guarantees that overcrowding which was a predominant concern would go away with the latest attempts at development.

6.2 Recommendations

Due to the fact that the hostels had been a focus area for development, a number of activities took place such as surveys and other research activities. As a result, promises were made which were, however, never honoured. This situation was further exacerbated by the delay in the delivery of services by local authorities, which created a negative attitude in the minds of the occupants who were no longer interested in any actions, which they believed would bring more false hope.

Based on the findings, the following recommendations are made to address the objectives of the study:

1. If hostels under investigation could be regarded as representative of other hostels in the country, then this study showed that necessary steps needed to be taken in South Africa in order to combat the health risk problem in hostels. Further research needs to be conducted in order to transform the uninhabitable buildings into better living environments by improving the existing building structures and hence the living conditions.

2. Management of facilities: A routine maintenance plan with regards to repairing or replacing of defective or broken building components should be in place. In addition to this, the development of a culture of self-care and the maintenance of hygiene principles amongst hostel dwellers as detailed in Appendix G should be encouraged. However, this plan will only succeed if there is full co-operation or participation from the residents, i.e. in the form of residents committees

3. Access control: The question of access control, i.e. control of the movement of occupants in and out of the hostels must be addressed. This was mentioned in all development plans of the three hostels (DPA, 2003), but there was mixed feelings about this idea. All well-maintained communal residential properties insist on access control as

a major tool to control the distribution and allocation of facilities. This prevents the unnecessary overcrowding of facilities.

4. Visible Moulds: Where there are signs or evidence of visible moulds on walls and ceilings, adequate control measures must be taken to remove mould growth completely as detailed in Appendix H., as well as sources of dampness.

5. Compliance with the legal requirements whether during the operational stage or planning stage of a residential structure, is essential. It is very important to fully comply with building requirements as well as space and social requirements from the planning stage or proposal stage of a dwelling, as this will help to meet future development needs.

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APPENDIX: A

Letter of Request: For Permission to Conduct Research

The Hostel Administrators/
Hostel Reside Committee/
Durban Metropolitan

Dear Sir, Madam

Request for permission to conduct research:

Title: Indoor and outdoor environmental assessment of Durban hostels.

I would like to request for written permission from the Hostel Administrators as well as relevant Residence Committees to conduct the above mentioned research towards a Masters Degree at the following hostels: Dalton Hostel, Jacobs and SJ Smith Hostel.

In addition to the letter referred to above, the researcher will obtain individual permission from all participants in the study by means of the administration of an informed consent form (Appendix B). In order to measure the health outcome (effectiveness) of the intervention, it will be necessary for the Hostel Administrators to implement the most economically viable options that are recommended as a result of the study. Since the research will be funded externally the only cost to Durban Metro may be the implementation of interventions.

The study aims at highlighting the important environmental concerns to assist the developers to make decisions from an informed platform. That is to avoid repeating similar mistakes when developments are to take place in the near future. The results of the study will be published in the scientific literature and will be made available to Administrators on request.

This research is subject to receiving approval from the Hostel Administrators, Durban Metro and the relevant Residence Committees, as well as University of Natal Durban, Nelson R Mandela School of Medicine, Ethics, and Higher Degrees Committees.

Please feel free to contact me should you require any further information.

With Regards

____

Sikhumbuzo Archibald Buthelezi
Researcher: Centre for Occupation and Environmental Health
Nelson R Mandela School of Medicine
719 Umbilo Road, Durban

For your attention,

Please note that additional information with respect to this study can be obtained from the Medical Research Administration (contact details given below) And that you are free to report any concerns about this study by either telephone, fax or email as listed below:-

Director Centre for Occupational and Environmental health: Dr N Gqaleni- Tel (031) 260 4280, Fax (031) 260 4455, email: gqalenin@nu.ac.za

APPENDIX: B

Letter of Consent

I agree to participate in the interview on the indoor and outdoor environmental assessment of Durban block hostels conducted by Sikhumbuzo Archibald Buthelezi.

I voluntarily accept this opportunity and I am not forced or influenced by anyone.
I am satisfied with the explanation given to me that the information will be used for study purposes only and nothing else

I also agree on the basis that the information shall be treated with confidentiality and will not be published or given to any other person then the researcher and his supervisor.

I understand that as the participant in this study I have the right to decide whether or not to answer a question and also to refuse or withdraw at any time of the study without any negative consequences to myself.

Signed ....

Participant

Signed ....

Researcher

For your attention,

Please note that additional information with respect to this study can be obtained from the Medical Research Administration(contact details given below) And that you are free to report any concerns about this study by either telephone, fax or email as listed below:-

Director Centre for Occupational and Environmental health: Dr N Gqaleni- Tel (031) 260 4280, Fax (031) 260 4455, email: gqalenin@nu.ac.za

APPENDIX: C

Information Given to Participants

I would firstly like to introduce myself. My name is Sikhumbuzo Archibald Buthelezi and I am a student at the University of Natal – Medical School, undertaking a study about the assessment of indoor and outdoor environment in the hostels you live in. It is important that the environment in your hostels be conducive to your health.

Your hostel has been selected, together with 2 others to participate in this study. I will be visually inspecting your hostel and asking you to complete a questionnaire about your health and your living environment in the hostel. I will use instruments to take measurements the air in your hostel environment from which I will make deductions on its potential impact on your health.

Temperature measurements will also be taken to gather data using scientific instruments to be explained to you during the sampling process. On completion of the study you will be informed of the potential risks that you may be exposed to with regard to Air Quality and Building Designs. The study hopes to find ways that can be utilized to improve the situation.

You will be expected to answer the questionnaire on a voluntarily basis and should you not be interested to participate you are free to do so.

Please note that any information given by you will be confidential and data gathered will be used solely towards my study programme. Kindly assist by answering all questions, however, you are free to withdraw at any time without suffering any disadvantage

APPENDIX: D

The Questionnaire

AN EVALUATION OF ENVIRONEMTAL HEALTH PROBLEMS ASSOCIATED WITH INDOORS ENVIRONEMTAL QUALITY IN BLOCK HOSTELS WITHIN THE CITY OF DURBAN IN THE PROVINCE OF KWAZULU/NATAL, SOUTH AFRICA

FOR OFFICE USE ONLY

AREA CODE

DH		SJH		JH	
BLOCK		BLOCK		BLOCK	

Dear Research Assistant

Thank you for your willingness to assist in the administration of this questionnaire. Please read the questions thoroughly and refer back to the training manual if you encounter any problem.

This is the questionnaire you are asked to fill out. Please complete the questions as frankly and accurately as possible.

Where a responded is not sure about the answer or don't remember, leave the column empty or simply put "Don't know" or "Don't remember"

NB All information obtained in the study must be treated with confidentiality and names and addresses must not be recorded.

SECTION A: INFORMATION ABOUT SOCIO-DEMOGRAPHIC PROFILE

Q.1. Present kind of job

Labour		1
Technical		2
Professional		3
Semiskilled		4
Self-employed		5
Pensioner		6
Schooling		7
Unemployed		8
Other (spec.)		9

Q.2. Monthly income

<R400		1
R401-R800		2
R801-1500		3
R1502-R2500		4
R2501-R3500		5
>R3500		6
Other (spec.)		

Q.3. Are you?

Male		1
Female		2

Q.4. How old was you on your last birthday?

21-29		1
30-39		2
40-49		3
50-59		4
Over 59 years		5

Q.5. How long have you lived in this hostel?

SECTION B: INFORMATIO ABOUT HEALTH AND WELL-BEING

Q.1. Do you have any respiratory problems?

Yes		1
No		2

1. If your answer to Q1above is "yes", what respiratory problems do you have?

1.	
2.	
3.	

2. When did they start?

3 months ago		1
6 months ago		2
12 months ago		3

3. What happens to these health problems when you are away from the hostel?

Got worse		1
Stayed same		2
Got Better		3

4. Do you smoke?

Yes		1
No		2

5. If your answer to no.2 above is 'yes". Do you smoke indoors?

Yes		1
No		2

Q.2 Do you have any other health problems?

Yes		1
No		2

1. If your answer to Q.2 above is "yes", what are those health problems?

1.	
2.	
3.	

2. When did they start?

3 months ago		1
6 months ago		2
12 months ago		3

3. What happens to these health problems when you are away from the hostel?

Got worse		1
Stayed same		2
Got Better		3

4. How often do you go away from the hostel?

Specify...

5. How many hours per day do you spend in the hostel?

5.1. Indoors...

5.2. Outdoors...

SECTION C: INFORMATION ABOUT OCCUPATIONAL HISTORY

Q. 1. Have you ever-worked full time (40 HOURS PER WEEK) for six months or more?

Yes		1
No		2

Q 2. What has been your occupation or job?

2.1 Job title.

Labour		1
Technical		2
Professional		3
Semiskilled		4
Self-employed		5
Pensioner		6
Schooling		7
Unemployed		8
Other (spec.)		

SECTION D: INFORMATION ABOUT THE ENVIRONMENTAL CONDITIONS

1. Do you clean your room/block?

Yes		1
No		2

2. If your answer to no.1 above is "yes" how often do you clean your room/block?

Specify...

3. How do you dispose off unwanted waste?

Specify...

4. Are there any leaking water pipes in this building?

Yes		1
No		2
Don't know		3

5. If your answer to no.4 above is "yes" where about in the building?

Specify...

6. Are there any blocked waste water pipes in this building?

Yes		1
No		2
Don't know		3

7. If your answer to no.6 above is "yes" where about in the building?

Specify...

8. Do you cook food for yourself?

Yes		1
No		2

9. If your answer to no.8 above is "yes" what do you use for cooking?

Specify...

10. If your answer to no.8 above is “yes how often do you cook?

Specify………………………………………………

GENERAL ISSUES

PLEASE USE THE REMAINING SPACE TO DISCUSS ANY ASPECTS OF THE BUILDING ENVIRONMENT OR RESIDENCE HEALTH THAT YOU FEEL APPROPRIATE.

For your attention

Please note that additional information with respect to this study can be obtained from the contact details given below. And that you are free to report any concerns about this study to the same contacts by either telephone, fax or email and this are:

Director Centre for Occupational and Environmental Health: Dr N Gqaleni-Tel: (031) 260 4280,

Fax: (031) 260 4455, email: gqalenin@nu.ac.za

THANK YOU///////////////////////////////THANK YOU////////////////////////////////THANK YOU///////////////

APPENDIX: E

Hostel Environmental Inventory

AREA CODE

DH		SJH		JH	
BLOCK		BLOCK		BLOCK	

1. SOURCES OUTSIDE BUILDING				
1.1 Contaminated Ambient Air				
Source Category	Yes	No	Location	**Comments**
Dust				
Smoke/Fumes				
Industrial Contaminants				
General vehicular Contaminants				
1.2 Emissions From Nearby Sources				
Source Category	Yes	No	Location	Comments
Vehicle exhaust (parking areas, loading docks, roads)				
Dumped refuse				
Debris near outside air intake				
1.3 Soil Gas				
Source Category	Yes	No	Location	Comments
Radon				
Sewage smells				
Pesticides				
1.4 Moisture or Stagnant Water				
Source Category	Yes	No	Location	Comments
Rooftop				
Crawlspace				
Blocked Storm water drain				

Blocked Roof gutters				
2. EQUIPMENT				
2.1 HVAC System Equipment				
Source Category	Yes	No	Location	Comments
Combustion Gases				
Dust, dirt, or microbial growth in ducts				
Microbial growth in drip pans, chillers, humidifiers				
Leaks of treated boiler water				
2.2 Non HVAC System Equipment				
Source Category	Yes	No	Location	Comments
Office equipment				
Suppliers for equipment				
Laboratory equipment				
3. HUMAN ACTIVITIES				
3.1 Personal Activities				
Source Category	Yes	No	Location	Comments
Smoking				
Cosmetics (odours)				
Body odours				
3.2 Housekeeping Activities				
Source Category	Yes	No	Location	Comments
Cleaning materials				
Cleaning Procedures (e.g., dust from sweeping, vacuuming)				
Stored refuse				
Stored supplies				
3.3 Maintenance Activities				
Source Category	Yes	No	Location	Comments
Use of materials with volatile compounds				

(e.g. paint & adhesives)				
Stored supplies with volatile compounds				
Use of pesticides				
4. BUILDING COMPONENTS/FURNISHINGS				
4.1 Locations Associated with Dust or Fibers				
Source Category	Yes	No	Location	Comments
Dust-catching area (e.g., open shelving)				
Deteriorated furnishings				
Asbestos-containing materials				
Cracks on the walls				
Structural defects				
4.2 Unsanitary Conditions/Water Damage				
Source Category	Yes	No	Location	Comments
Microbial growth in or on soiled or water-damaged furnishings				
Microbial growth in or on leaking ablution facilities (e.g., wash-hand basins, cisterns, etc)				
5. OTHER SOURCES				
5.1 Accidental Events				
Source Category	Yes	No	Location	Comments
Spills (e.g., chemicals)				
Water leaks or leaking				
Fire damage				
5.2 Special Use/Mixed Used Areas				
Source Category	Yes	No	Location	Comments
Smoking lounges				
Food preparation				

areas				
Underground or attached parking garages				
Laundries				
Print shops, art rooms				
Beauty Salons				
Barbershops				
Illegal spray painting & panel beating areas.				

5.3 Redecorating/Repair/Remodelling

Source Category	Yes	No	Location	Comments
Emission from new furnishings				
Dust, fibbers from demolition				
Odours, volatile compounds				

6. SPECIFIC DETAILS OF EACH BLOCK

BLOCK TYPE e.g. 5/10/15 beds including floor levels.	SJH	JH	DH	TOTAL
Number of windows				
No. Of windows open able				
Area per square meter				
Number of beds				
Number of Occupants				

	Yes	No	ESTIMATED QUANTITY			
Signs of visible moulds and mildew						

APPENDIX F

Media Preparation for Fungal Sampling and Analysis

Supplies:

1. Weighing boat and balance
2. Volumetric flask (e.g., 1 L or 500 ml), sterile cotton wool and aluminium foil
3. Sampling media to be prepared according to manufacturer's recommendations:

a. Malt extract agar (MEA) for fungi.

b. Dichloran 18% glycerol agar (DG 18) for xerophilic moulds,

4. Hot plate and magnetic stirrer
5. Autoclave and laminar flow cabinet
6. 70 % ethanol solutions and Bunsen burner
7. Petri dishes and refrigerator

1.1 Malt extract agar (MEA)

- Weigh 50 g of MEA into weighing boat and transfer into a 2 litter volumetric flask
- Add 1 litter distilled water
- Cover the top with sterile cotton wool and aluminium foil
- Heat the contents, but don't boil, whilst stirring using hotplate and magnetic stirrer
- After the contents have become homogenous, add about 0.01g antibiotic (streptomycin)
- Autoclave the flask for 15 minutes at 120^{0}C
- Whilst the medium is autoclaved swipe the laminar flow cabinet with 70% ethanol
- Take medium to the laminar flow cabinet and let it cool (DON'T LET IT SOLIDIFY)
- When medium is cool pour to Petri dishes and cover them, light the burner when transferring the medium
- Let the medium solidify in the Petri-dishes
- Store the medium in the refrigerator until needed

- *Dichloran 18% glycerol agar (DG18)*

- Weigh 39.5 g of DG 18 into weighing boat and transfer into a 2 litter volumetric flask
- Add 300 ml distilled water
- Cover the top with sterile cotton wool and aluminium foil
- Heat the contents, but don't boil, whilst stirring using hotplate and magnetic stirrer
- After the contents have become homogenous, add about 0.01g antibiotic (streptomycin)
- Add 100 ml glycerol and make up to 500 ml
- Autoclave the flask for 15 minutes at 120^0C
- Whilst the medium is autoclaved swipe the laminar flow cabinet with 70% ethanol
- Take medium to the laminar flow cabinet and let it cool (DON'T LET IT SOLIDIFY)
- When medium is cool and then pour to Petri dishes and cover them, light the burner when transferring the medium
- Let the medium solidify in the Petri-dishes and label them
- Store the medium in the refrigerator until needed

APPENDIX G

Introducing an environmental sanitation programme

Environmental Sanitation is (a) the promotion of hygiene and (b) the prevention of disease and other consequences of ill -health, relating to environmental factors

Environmental Sanitation covers two basic dimensions:

1 Environmental factors

These are environmental factors, which impact on the infectious agents and transmission of disease. These include:

- Disposal of waste water
- Household waste and other waste likely to contain infectious agents
- Water drainage
- Housing conditions

2 Sanitation Practices

These are various hygiene practices of the communities, basic knowledge, skill and human behaviours as well as social and cultural factors concerning health, life-styles and environmental awareness. These include:

- Personal Hygiene (washing, dressing, eating, etc)
- Household Cleanliness (kitchen, bathroom cleanliness, etc)
- Community Cleanliness (waste collection, common places, etc)

Environmental sanitation strongly depends on social and cultural practices and beliefs and these have to be considered when planning interventions.

To allow for transmission of infectious agents they have to be present in the immediate human environment, exposure has to take place, and transmission has to occur by uptake of the agents through unsafe practices. To interrupt the transmission, environmental sanitation can act on reducing exposure to infectious agents by limiting contact to wastes or polluted media, and by changing hygiene and socio –cultural practices.

APPENDIX H

Preventing and controlling the spread of mould growth

There are basically two (2) broad themes that are recommended in controlling fungal growth and these are: -

Control by management of physical and biological factors.

The use of fungicides/biocides

1 Management by control of physical and biological factors

This includes various aspects of non-chemical control, including management of the environment and manipulation of microbial agents. These approaches depend on a thorough understanding of the target fungus and the external factors that influence it. In general, these approaches should be considered before all others because often they are the cheapest, safest and most durable.

1.1 Moisture control is the key to mould control

In the indoor environment –

- When water leaks or spills occur indoors, act quickly.
- If a wet or damp area materials are dried 24-46 hours after a leak or spill happens, in most cases mold will not grow.
- Clean and repair roof gutters regularly
- Make sure the ground slopes away from the building foundation, so that water does not enter or collect around the foundation

1.2 If mould is a problem in your home, you should clean up the mould promptly and fix the water problem

- Fix plumbing leaks and other water problems as soon as possible.
- Dry all items completely
- Scrub mould off hard surfaces with detergent and water, and dry completely.

- Absorbent or porous materials such as ceiling tiles and carpet may have to be thrown away if they became mouldy. Mould can grow on or fill in the empty spaces and crevices of porous materials, so the mould may be difficult or impossible to remove completely.
- Do not paint or caulk mouldy surfaces. Clean up the mould and dry the surfaces before painting. Paint applied to moldy surfaces is likely to peel.

2 The use of Biocides

Biocides are substances that can destroy living organisms. The use of chemical or biocide that kills organisms such as mould (chlorine bleach, for example) is not recommended as a routine practice during mould clean-ups. There may be instances, however, when professional judgment may indicate its use (for example when immune-compromised individuals are present). In most cases, it is not possible or desirable to sterilize an area; background level mould spores will remain- these spores will not grow if the moisture problem has been resolved.